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"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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WORLD POPULATION AND RESOURCES

IT is generally conceded that a great effort will be required to supply the world's increasing population with adequate food, fuel and raw materials during the next half-century; the complexity, magnitude and seriousness of that problem is well stated in simple terms in a broadsheet (No. 362) dated April 26, issued by Political and Economic Planning. Prepared essentially as a contribution to the World Population Conference in Rome, the broadsheet formulates the main issues in a way that every citizen can understand, and its summary and conclusions should contribute also to a much more intelligent appreciation of the value and limitations of the Technical Assistance Programme of the United Nations, the Colombo Plan and the projects promoted by the United States in accordance with the Point Four Plan than is frequently apparent in discussions in Parliament and elsewhere. The fact that it limits its survey to no more than A.D. 1980 may well help to drive home the urgency of the situation.

The situation to which Prof. A. V. Hill referred in his presidential address at Belfast to the British Association is here presented, not as a dilemma, ethical or otherwise, but as a problem demanding imperatively constructive thought and concerted action. P E P points out that during the past two hundred and fifty years medical science has been developing gradually in Western countries, and its effect on the population has been gradual; corresponding reductions in birth-rates have kept the repercussions within bounds. Now the conquest of disease is making its impact felt much more rapidly on the much larger non-European populations. These are expanding on such an enormous scale that it is possible that the world increase during 1950–80 may about equal the entire world population in 1900.

The reception of Prof. Hill's address two years ago would in itself seem to justify the contention by P E P that even informed opinion has scarcely begun to appreciate the magnitude of the economic, social and political problems which are being generated by a current net increase of more than 70,000 persons a day that is still tending to rise. Such books as "Four Thousand Million Mouths" and "Soil and Civilization" only direct attention to one facet of the problems, and probably the only one to which the ordinary citizen has given even passing attention. The most pressing of these problems is, as P E P points out, that of finding food, materials, fuel and power to take care of the vast increase and at the same time to enable reasonable improvements to be made in the standards of life of the large numbers at present below a decent minimum level. Whether simultaneously it will be possible to realize some of the existing expectations for rising standards of life in the more advanced countries is certainly open to question, and likely to depend on conditions not yet sufficiently clearly understood: it can scarcely be taken for granted, as the broadsheet seems to imply.

The examination of the present position presented by P E P suggests that the growth of world food supplies holds a precarious and narrow lead over the growth of world population. The practical problem, however, is for each country to feed itself, since for most countries imports offer no regular relief to home production. The implication of this view for the United Kingdom is reinforced, moreover, by a firm warning against over-optimistic expectations of large increases in agricultural output in particular areas compared with that long maintained by the more agriculturally advanced and favourably placed food-producing countries. With about sixteen per cent of the land area of the world, the U.S.S.R. still has difficulty in feeding its eight per cent of the world population.

In many of the worst-fed countries, the rate of increase in population is above the average and the rate of expansion of food supply only average or below the average. These countries are also faced by exceedingly difficult economic problems, especially in regard to provision of essential capital and the development of industry and public services. These factors have already damped the optimism with which the Colombo Plan was at first regarded, and the report of the Indian Planning Commission which Prof. Hill quoted has also prompted a more realistic view of the situation. The analysis of the highest rates of increase in the production of food to be attained in the most favourable circumstances and of foreseeable technical improvements as given in the P E P broadsheet discloses no sound basis for the view that production will more or less automatically keep pace with the needs of growing population. Indeed, in the absence of a much more rapid reduction in birth-rates than is at present in sight, it is obvious that the increasing control of disease in the less developed countries is likely to lead to a further expansion in population which will render this most improbable.

The broadsheet does not enter into a discussion of the situation in regard to fuel and power supplies and raw materials, or the demand on the world's economy, for example, that is entailed in the provision of the fertilizers required for the increased production of wheat and other foodstuffs. It notes that implication, for the group which prepared the broadsheet considered also the possibilities of creating resources without calling on any material at present of economic value or likely to become scarce. Its extensive inquiries, however, disclosed no such developments affecting foodstuffs likely to prove of first-rate importance during the next thirty years.

In this respect the broadsheet is less optimistic than Sir Harold Hartley was in his recent Fawley Foundation Lecture (*Nature*, June 12, p. 1126); but it is only fair to add that the broadsheet attempts no more than a presentation of the broad outlines of a problem to be discussed more fully in a subsequent report, which will also review the relationship to population of supplies of fuel and power and of raw materials. It aims at stimulating the searching, informed and dispassionate discussion of the facts in all countries and among all shades of opinion, with the view of agreeing on a diagnosis. This is the immediate need, for only a few governments, notably that of India, have shown a lively awareness of their own problems of matching resources with population.

So far as the broadsheet touches on the long-term outlook for supplies of raw materials, fuel and power, it is quite as realistic as Sir Harold, and though less reassuring it does not anticipate that unmanageable difficulties will be encountered in these fields in the near future. Apart from its warning about the limits set to the general achievement of the best rates of increased production of food in particular areas, and of the danger that the rate of increase in population may itself increase with the rate of increase of food production, the broadsheet is of real value for the way in which it indicates, even more clearly than did Sir Harold Hartley, that we are faced with a series of competitive—not complementary—demands and problems. The four unsolved problems are: increasing existing food production sufficiently to supply extra suitable foods for the annual increase in population; providing suitable foods for the undernourished section in the existing population; producing without detriment to food supply sufficient raw materials, fuel and power to enable the increased world population to earn its living and add to its wealth; and ensuring either access for the increased population to areas where extra food and raw materials can be produced, or the transport and distribution of an increased supply of food and raw materials to countries deficient in home supplies on terms which they are able to pay.

It is this note of realism that requires sounding to-day. Sir Harold Hartley, in his Fawley Foundation Lecture, and also the P E P broadsheet, admit that possibly entirely novel methods discovered as a result of biochemical, microbiological or photochemical research may offer an important contribution to increased food production without the strain on limited resources which the expansion of conventional agriculture would involve. There, however, he reminds us of the importance of an ecological approach. The careless disturbance of the balance of Nature may have unforeseen and serious consequences. If the dangers to mankind depicted with some journalistic licence in Jungk's "To-morrow is Already Here" are to be avoided, much more serious ecological research will be required in forestry, agriculture and horticulture, pest control and animal health and nutrition, nor is such research likely to bring quick returns.

Meanwhile, as P E P points out, no serious evidence has been produced to show that there is extra cultivable land anywhere of sufficient extent and quality and capable of sufficiently rapid development to make any worth-while contribution to the urgent task of feeding the world's daily increment of population; nor can that increment be fed on generalizations or on hopes of what might be done assuming levels of capital and equipment, technical skill, education and management which are not, and are unlikely to become, available. Much can be done fairly quickly to improve yields and output from existing farmlands through better seed and livestock, better farming, more and improved fertilizers, simple but more effective equipment, more double cropping in suitable climates, and through reducing waste. Unfortunately, the very countries where the urgency of achieving these improvements is greatest and where the opportunities are most obvious are also those in which deficiencies in education, adaptability, capital, equipment, communications and physical vigour are most serious.

In directing attention to the limitations which such factors place on technical advances and in pointing to the contributions which can come from better education and the increased vigour arising from improved health, as well as from such capital developments as irrigation and drainage, P E P in this broadsheet tends to correct the materialistic emphasis and outlook of Sir Harold's lecture. Sir Harold seems to overlook not only the importance of this factor of education but also the demands which are made on man himself. The self-control which is demanded—particularly in those areas where population is increasing most rapidly and malnutrition is most rife—in order that the greater productivity which the wise use of science could bring is to keep pace with the needs of an increasing population is unlikely to come unless the campaign against want is accompanied by a no less vigorous campaign against ignorance. Nor is the driving force for such a campaign to be found in any view of man that takes account solely of his physical or material needs.

In Asia and Africa, as in the West, man's hope of a richer and fuller life in any sense rests ultimately on a worthy view of man himself. It is true that, in the backward areas of the world, men can only rise to their full stature and make free judgments between right and wrong when science and industry have removed want and malnutrition and the ignorance which is largely responsible for these conditions. It is true also that below a certain level of physical existence few men can have any apprehension of moral or spiritual values of life, and it is not materialistic to be concerned with devising ways and means whereby ordinary men and women may be raised above this animal level of existence.

Nevertheless, the problem is not a purely physical or materialistic one. Primarily, it is an intellectual problem—a challenge to man's intellect as well as to his self-control. Education, as already indicated, is one of its most important aspects, and this is true at the primary or secondary school level, in the colleges, in the technical colleges, and at the university level, within and without the walls. The solution of this problem involves much more than the right use of science and technology for the efficient use of man's material resources, the appropriate training of a sufficient number of scientists and technologists and technicians, and attracting able pupils to pursue such careers. It equally depends on using the new means of education which science has provided to train men and women to understand how to make use of the possibilities latent in science and technology, and the dangers inherent in the abuse of those possibilities, and to appreciate what is demanded in the way of co-operation and self-discipline in order that society may enjoy the benefits which are within its reach. It implies also that the training of the embryo scientist or technologist shall enable him to understand better the ordinary man and woman whose needs his work will serve, and whose lives will be affected by its results.

Neither education in science alone, nor education without science, will suffice, and herein lies the critical importance of an adequate number of science teachers of high quality and character. That is indeed a first step towards providing means for the solution of the hard technical and political problems that are involved in the utilization and distribution of the world's resources among its expanding population. It is an important contribution towards the taking of the right decisions and the implementation of the policies they imply, once those solutions have been found. Only education can overcome the refusal to face facts which lies at the root of the perennial difficulty of relating knowledge to action ; and in order to succeed, such an education must impart at least some understanding of the outlook and method of science.

The importance of education in this connexion is well seen in the symposium of papers on Technical Assistance Programmes contributed to a recent issue (March 1954) of the *Bulletin of the Atomic Scientists*. It is also apparent in yet another broadsheet (No. 363), in which Political and Economic Planning, discussing the use of private capital for under-developed areas, shows how serious has been the fall in the flow of such capital to these countries, due largely to the ignorance and misunderstandings which education could help to remove. The prospects of stimulating either the flow of badly needed private capital or increasing the supply of technical and managerial experience which accompanies it are slender indeed without deeper understanding on all sides.

The problem of matching the earth's resources with the needs of its expanding population is fundamentally an intellectual problem—a challenge to man's capacity to think, to improvize and to organize. If he will make the effort, there is no present reason for believing that a solution cannot be found which will enable the world's population to be fed adequately, and increasing control maintained over the pests and diseases which take toll of human life and energy, crops and animal life, while ensuring also adequate supplies of materials for industry. But there will be a price demanded in individual self-control, as in that of communities ; and it is not on education alone that we can rely to ensure that the price is paid. Whether, in fact, the nations, and the communities of which a nation is made up, will pay that price and renounce the prejudices and the customs and ways of life that endanger the efficient utilization and effective distribution of the world's resources, will not depend solely on whether an adequate supply of scientists, technologists, technicians, science teachers, and the like is forthcoming, or even on a clear apprehension on the part of the population generally of what science is and how it works. The problem of relating action to knowledge rather than prejudice is not simply an intellectual issue: it is also a moral issue, in the sense that only a worthy view of man can compel the action, and induce men and women to accept the sacrifices, which in one way or another will be demanded of the advanced and also of the more backward areas of the world.

Meanwhile, in Great Britain, no political party seems prepared to deal with the problem of education on realistic lines or to court the unpopularity which might be involved thereby. Trades unions seek to resist changes in practice that would eliminate waste. Even in education and social policy there is much that encourages the increase of the less educable or adaptable types, and tends to undermine incentive and slacken the will to work. Even some lines of research seem to be pursued rather as an excuse for delaying action on already known but unpalatable facts. As Sir Charles Darwin has commented, "the policy of paying most attention to the inferior types is the most inefficient way possible of achieving the perfectibility of the human race". When all regard is had to the possibilities of those advances in knowledge which such researches as Sir Harold Hartley suggested might bring, it should be remembered that mankind has already much knowledge which, if used effectively, could go far towards improving the balance between the demands of an increasing population and world resources. Nor will any fresh largesse which science may confer remove the fundamental need for courage and honesty in the use of present knowledge.

DEBYE'S COLLECTED PAPERS

The Collected Papers of Peter J. W. Debye

Pp. xxii+700. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1954.) 9.50 dollars.

To celebrate the seventieth birthday of Prof. Peter Debye, this volume containing a selection of his classical papers has appeared. No one during the past forty years has made so many significant contributions to modern physical chemistry as has Prof. Debye: his name will always be associated with such topics as X-ray scattering, the theory of strong electrolytes, dipole moments and, during more recent years, with the scattering of light by colloidal solutions.

In this book his classical papers on these topics are collected together under their respective headings, together with a number of miscellaneous communications, including the important one on the specific heat of solids. While the book is an important one for purposes of reference, it is most valuable in that it gives us a glimpse of the methods of attack adopted by one who, trained as a mathematician, became in turn professor of theoretical then of experimental physics and finally professor of chemistry, in which subject he received the Nobel Prize. Grouping of the papers in subjects in the volume permits us to follow the progress by which the Debye–Scherrer method of X-ray examination of powders was developed and the subsequent excursions into the exploration of liquids and gases. It is interesting to note that Debye gave an independent theory of the Compton effect, but a little later than Compton himself. The section on electrolytes is introduced by the well-known paper of Debye and Hückel, which classical paper is the basis of the present-day concepts concerning electrolytes. During the Second World War the United States Government was interested in developing the synthetic rubber industry, and Debye became interested in methods of examination of macromolecular solutions. His interest in the scattering of X-rays naturally led him to investigate the applicability of Einstein's theory of light scattering to randomly coiled molecules, and as a result a method not only for the absolute determination of the weight-average molecular weights but also of the spatial extension of the macromolecules in solution was developed, probably the most valuable tool presented to workers in the field of polymers.

The volume has, as preface, a brief account of the life of Debye, and this is followed by brief surveys of the various topics by H. Mark on X-rays and light-scattering, C. P. Smyth on dipole moments and R. M. Fuoss on the papers on electrolytes. Papers originally in the German language have been translated into English. Perhaps this is the most unsatisfactory feature of the volume: Debye's papers both in German and in English are remarkably lucid and clearly written; but the translations do not do the author justice. Eric K. Rideal

THE SINEWS OF SCIENCE

Mathematics in Action

By Prof. O. G. Sutton. Pp. viii+226. (London: G. Bell and Sons, Ltd., 1954.) 16s. net.

Prof. O. G. Sutton is to be congratulated on his book "Mathematics in Action". The publisher's simple comment on the jacket that "the book is a straight-forward account of applied mathematics and its influence on modern ideas concerning that nature of the physical universe" is a bald understatement. The story which the author tells illumines the essential features of the scientific method—the search for basic principles hidden within experimental results, and the development of pathways from basic principles to new experiments and speculations.

The writing is simple and elegant, and not without evidence of a dry humour; the author has a flair for simple exposition and has steered a masterly course between the Scylla of over-simplification and the Charybdis of over-elaboration. The book itself is a pleasure to hold and to read; the illustrations have been chosen with care and have been drawn with sympathetic understanding.

In most books on experimental physics one can scarcely see the wood for the trees. Most books on applied mathematics, on the other hand, model themselves on Euclid; after a token genuflexion in the direction of experimental physics, they develop their accounts as a series of deductions from a number of stated general principles. Contact with the world of reality is usually lost, at each new topic, after one or two introductory paragraphs. It is these brief paragraphs which Prof. Sutton has moulded, and expanded, into a book of about 225 pages. "Mathematics in Action" should be of considerable value to young mathematicians, physicists and engineers, in the upper forms of secondary schools, and also in technical colleges and universities. It should be an excellent source-book of ideas for teachers of science, and also for those students of the interpretative humanities who wish to gain some knowledge of how the ideas of physicists and engineers have been made more precise and more powerful through formulation in terms of mathematics. In passing, the book shows how mathematics in action has stimulated both the experimenter and the mathematician.

As the narrative unfolds, the author gives a very personal account of what is meant by 'theory' in physics and mathematics. The way in which ideas underlying some of the theories have evolved is briefly sketched. Empirical formulæ lead to mathematical abstractions; the world of reality leads to the worlds of the mathematician, and these lead back again to the world of reality. The most remarkable thing about this process is that there should be any correlation at all between the two types of world—but experience has shown that there is. One of the really important problems of philosophy is to explain this connexion.

Prof. Sutton traces the development of the ideas underlying classical physics and comments: 'It is a strange thought that a few symbols, 'meaningless marks on paper', have contributed so much to the shape of life as we know it to-day. A mediæval scholar, awakening in our world, would recognize such symbols as spells, magic formulæ which when properly pronounced confer power over the forces of Nature".

To lend point to his comments, Prof. Sutton talks about arithmetic, algebra, complex numbers, calculus, etc.—the tools of the mathematician's trade. Then, in the tradition of the English method of teaching mathematics and physics, he gives a series of examples, which in this case are illustrations from ballistics, waves, the problems of flight, statistics and meteorology. His examples are beautiful little essays. The topics which are discussed are all taken from subjects in which Prof. Sutton has had to work professionally from time to time, and they give some indication of the width of his interests and powers. The book deserves to be read by many people.

L. ROSENHEAD

BIRDS OF WEST AFRICA

The Birds of West and Equatorial Africa

By Dr. David Armitage Bannerman. Vol. 1: Struthionidae to Picidae. Pp. xiii+796+plates 1–37. Vol. 2: Eurylaemidae to Ploceidae. Pp. viii+797–1526+plates 38–54. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 2 volumes £6 6*s*. net.

THE author's "Birds of Tropical West Africa" in eight volumes (1928–51) will inevitably be known in future as 'the large Bannerman'. It must remain the basic work, indispensable for many purposes; but it is too bulky to be readily portable, and the earlier volumes are obtainable only with difficulty and at a high price. Now we have 'the small Bannerman' as well, complete in two volumes, and its availability and more compact form will make it most welcome to the field observer. It should be of great help to the latter, and it should stimulate further interest in the subject. There are still many gaps in knowledge which a resident in West Africa can take part in filling; and one may well follow the rule that, if an indubitable observation is 'not according to Bannerman', it is worthy of record.

The new work is essentially a condensation of the older, although the text has been wholly rewritten, and as a condensation it must be judged. The reduction in length has been achieved largely by the omission of detailed technical descriptions, synonymies, references, and separate treatment of geographical races; none of these will be missed by the field observer. On the other hand, the great abbreviation in the account of habits is less easily accepted, as it is especially in this respect that there are opportunities for filling gaps in knowledge, if one can be sure where they exist.

Rewriting has involved distribution to the proper heads of all the addenda to the larger work which were published at its end. The new book professes to be up to date as at the close of 1950, when the manuscript was completed; but one notes that some observations recorded as late as 1952 have, in fact, found a place. Apart from the repetition of the useful identification keys from the larger work, the book consists of the standard information relating to each species. One misses a more general section, giving a comprehensive account of the characteristics of the area, which ranges from arid desert to tropical rain-forest and is traversed from its highlands to its coasts by great rivers.

One welcomes again many of the excellent coloured plates from the earlier work, with a few newcomers, as well as numerous black-and-white illustrations. Turning the pages in the less sunnier clime of Great Britain, one recalls many a characteristic sight—the aerobatics of the brilliantly coloured Abyssinian roller, the trees loaded with the nests of weaver birds, the restless parties of piapiacs on the Borassus palms, the egrets among the grazing sheep, and on some up-river sandbank the crocodile bird of which Herodotus wrote.

LANDSBOROUGH THOMSON

PRINCIPLES AND APPLICATIONS OF CHROMATOGRAPHY

Chromatography

A Review of Principles and Applications. By Edgar Lederer and Michael Lederer. Pp. xviii+460. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) 60*s*.

CHROMATOGRAPHY has grown out of all recognition during the past ten years. Yet, although a number of excellent monographs have recently appeared which deal with special aspects of the subject, none has dealt with the subject as a whole. The publication of this book is therefore timely: the authors have brought together information from a formidably vast field and presented it attractively. They have themselves made distinguished contributions to chromatography, and therefore have a first-hand knowledge of much that they have written. The book is divided into five main sections. The first three deal with the general principles and techniques of the three main types of chromatogram, namely, adsorption, ion exchange and partition. Theoretical aspects are here treated simply but adequately for the purposes of the book. The fourth section is concerned with the applications of these methods to organic substances, and largely consists of chapters each devoted to a particular class. The fifth section deals with the inorganic field and is probably the most comprehensive account of this subject that has yet appeared. Finally, there follows a list of references and addenda to the various chapters which brings the literature survey up to the end of 1952. The completeness of this section is an outstanding feature.

It is remarkable how well the authors have succeeded, in a book of ordinary dimensions, in dealing so adequately with such a wide subject. The emphasis has rightly been on the newer methods, but important aspects of the older have not been ignored. There are many valuable features. For example, more than ninety tables of R_F values are given, which cover many hundreds of substances. There are many tables which give useful information at a glance, and the book is generously illustrated with diagrams and photographs of apparatus, chromatograms, elution curves, and so on. It is an achievement of the book that many of the methods are sufficiently well described to enable one to carry them out in the laboratory without having to delve through a mountain of literature beforehand. Division of the text into many subsections has made for attractiveness in presentation. A word of tribute, too, must be paid to Dr. A. T. James, who translated part of the book from the original French into good English.

In a book which provides so much information, one feels diffident in suggesting that a little more could have been given in one or two places. There might, for example, have been provided representative chemical formulæ for all the numerous classes of organic compounds—for who but the final-year chemistry honours student remembers them all ? Perhaps a more detailed explanation could have been given of how the identification of the products of partial hydrolysis of complex substances helps to provide a picture of the whole structure, and more about how some of the reagents (ninhydrin, for example) used in paper chromatography react with the substances for which they are used. There might be some justification, in view of the correspondence in *Nature* (which is cited), to have included in the historical section some account of the contributions to chromatography made by British contemporaries of Tswett. It would have been helpful if the references, which are arranged in alphabetical order, were each followed by the page number in the text.

These are, however, minor criticisms. The authors and publishers are to be congratulated on the production of an attractive book of outstanding importance. It should be in the hands of those who use chromatographic methods, those who expect to use them and those who ought to use them—that is, every chemist and biochemist.

PHYTOGEOGRAPHICAL WRITINGS OF SIR JOSEPH HOOKER

Pioneer Plant Geography

The Phytogeographical Researches of Sir Joseph Dalton Hooker. By Dr. W. B. Turrill. (Lotsya—A Biological Miscellany—Volume 4.) Pp. xii+267+21 plates. (The Hague: Martinus Nijhoff, 1953.) 19 guilders.

RARELY can Fortune have showered so many of her favours on a botanist as she did on Sir Joseph Dalton Hooker, and seldom can there have been a botanist more fitted to make the most of them. The son of Sir William Jackson Hooker, he was born in the botanical purple, and his father's distinguished career afforded him quite exceptional opportunities for his own scientific work. But his time was also propitious; born in 1817 and living until 1911, his life almost exactly spanned the longest and most complete period of tranquillity, freedom from distraction, and material prosperity that Great Britain has ever known, while his birth made him of such an age that he rode the rising tide of scientific progress at its flood and became, almost inescapably, a foundation member of the new biology. But, above all, Fortune endowed him with qualities of mind and character which enabled him to profit from all these circumstances. Fate offered him a giant's place, and he was big enough to fill it.

As with pioneers in many other walks of life, it fell to Joseph Hooker to say, for the first time, many fundamentally important things about his subject. Nowhere is this more obvious than in his phytogeographical writings, and Dr. W. B. Turrill has therefore done a very worth-while service in reminding us again of their more important passages. It is all too easy to think of such early work only in the idiom of to-day and to forget the part it has played in forging the ideas which now we think of as our own.

Some readers will doubtless be most interested in those extracts which reveal Hooker's attitude towards Darwinism and his gradual, though not very convincing, assimilation of it; but it is with plant geography that Dr. Turrill's book is almost wholly concerned. One's first feeling here is astonishment that so much was known so early in Hooker's career, and some slight chagrin that the advance since then has not been greater; but this is, for many reasons, rather unjust, although the fact seems to remain that only in the realm of palæogeography have we really passed beyond Hooker's comprehension. Many of the problems which troubled him are the problems which still perplex us, very notable among them being that of the way in which the oceanic islands and more isolated mountains of the world have become populated. These are still, as they were in his day, among the most crucial issues of plant geography.

"Pioneer Plant Geography" in the main takes the form of a series of chapters arranged in a formal geographical sequence, each consisting of long extracts from the relevant writings of Hooker, and a summary, by Dr. Turrill, of subsequent work on the same matters. The book is pleasantly produced, and there is a useful bibliography. In total it contains a great deal of information, some of it not easily come by elsewhere, and will certainly become an important source book for plant-geographers. At the same time, it does not conceal some of the exceptional difficulties inherent in a book of this sort. Of these only the author himself can be fully aware, and one hesitates, therefore, to comment on his procedure; but many will, perhaps, feel that Dr. Turrill's decision to abandon the chronological approach was an unfortunate one, since it not only threw away the most potent source of continuity in the narrative, but also deprived the reader of any opportunity of following the development of Hooker's personality and science. In consequence of this the book is somewhat lifeless, which, bearing in mind its subject, is a pity. It is also a little unfortunate that, owing to this geographical arrangement of the book, it first presents the least satisfactory of Hooker's geographical writings and leaves the consideration of his most classic (and earliest) memoirs to the end. RONALD GOOD

Algebraic Geometry

By Solomon Lefschetz. (Princeton Mathematical Series.) Pp. ix+233. (Princeton: Princeton University Press; London: Oxford University Press, 1953.) 30*s.* net.

Ideal Theory

By D. G. Northcott. (Cambridge Tracts in Mathematics and Mathematical Physics No. 42.) Pp. viii+111. (Cambridge: At the University Press, 1953.) 12*s.* 6*d.* net.

IN the volume "Algebraic Geometry", Prof. S. Lefschetz has presented, in amplified form, his lecture notes of pre-war Princeton days. A concentrated account is given in the first three chapters of the algebraic treatment of the subject. Chapter 4, on formal power series, provides a bridge linking this with the analytical treatment. In this chapter, the theories of algebroid varieties and local rings are treated briefly and applied to a study of the local properties of algebraic varieties. Four chapters are then given to the theory of algebraic curves, and this work provides examples of the preceding general theory. The final chapter treats the theory of systems of curves on a surface.

Prof. Lefschetz has certainly dealt with the 'core' of the subject, but it is a pity that the account is so brief and concentrated. It is difficult to escape the conclusion that the book is a summary rather than an exposition. The treatment in one of the main chapters (4) is "admittedly sketchy and often without proofs", and in several places it is necessary to refer the reader to other books or journals for a more detailed account. This fragmentation in the presentation of information seems to be a feature of many contemporary publications; but the publishing houses rather than the authors probably have more to answer for in this matter.

In "Ideal Theory" we have an excellent account of a subject which has developed with a burst in recent years. It is easily the most important advance in commutative algebra for a generation; and the motive for this development has come from the need of algebraic geometers for a sharper and more powerful tool with which to examine the foundations of the subject. Prof. D. G. Northcott has written a very clear self-contained account, and has emphasized the algebraic and the analytic theory of local rings, the subject-matter of which has only emerged very recently.

L. S. GODDARD

Principles of Radar

By Members of the Staff of the Radar School, Massachusetts Institute of Technology. Third edition, by Prof. J. Francis Reintjes and Godfrey T. Coate. (A publication of the Technology Press, Massachusetts Institute of Technology.) Pp. xv+986. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 55*s.* 6*d.*

ALTHOUGH this volume is described as the "third edition", it is in fact the first British publication of the work in normal printed format. In its original form, it was in duplicated typescript, prepared by members of the staff of the Massachusetts Institute of Technology and issued as a classified document in 1944 to students of the Institute's Radar School. An extensive revision of the text was carried out before the material was released for general publication.

The book is essentially a detailed descriptive treatment of the technique of radar, with particular reference to the use and operation of radar installations on wave-lengths of between 1 and 30 cm. (frequencies of 30,000–1,000 Mc./s.). No mathematics beyond trigonometry and simple differentiation and integration are used; and the text is very clearly presented together with 650 diagrams, many of which are of exceptional quality and interest. The book may be recommended as an encyclopædic work of reference for all students, scientific workers and engineers engaged in this field; and users will be greatly indebted to the small band of experts responsible for the assimilation and collection in a single volume of a large mass of technical information and experience.

Fields and Waves in Modern Radio

By Simon Ramo and Prof. John R. Whinnery. Second edition. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 70*s.* net.

THE inclusion in this edition of a chapter on microwave networks is the main change from the first edition. Introductory chapters on oscillations and electric and magnetic fields provide the basic ground for the formulation of Maxwell's equations. Circuit concepts and high-frequency effects are then developed, and lead to a study of wave propagation in guides and along transmission lines. The final chapter on radiation completes the physical picture derived from earlier chapters.

Though written mainly for engineers, there is a good deal of common ground here for the physicist. The lucidity, directness of approach, and skill in presentation make this a most valuable book on electromagnetic theory.

L. JACOB

Inorganic Chemistry

A Text-Book for Advanced Students. By Dr. E. de Barry Barnett and Dr. C. L. Wilson. Pp. xiv+512. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 35*s.* net.

THIS book is intended for students who have an elementary knowledge of inorganic and physical chemistry, and many common elements and compounds are only mentioned as "too familiar to require description". The arrangement is based on a particular periodic table, and hence many less familiar elements appear before the commoner members of their groups. The old-fashioned name "first short period" is used, though the periodic table on p. 6 shows this to be the second.

The book begins with a short discussion of nomenclature, then deals with the classification of the elements and the periodic law, the determination of atomic weights, natural radioactivity, artificial atomic breakdown, isotopes, the structure of atoms and valency, stereochemistry and crystal structure. After three pages on ore-dressing, the individual elements, beginning with the inert gases, are dealt with, the rarer elements being, of course, included. Special topics such as the hydrides of boron, the metal carbonyls, peracids and the silicates are discussed; but the treatment of polyacids is unsatisfactory, and there are surprising omissions.

Attention is given to industrial processes, and use is made of official publications on those developed in Germany. Brief, but useful, notes on analytical chemistry are given. There are some references to literature. The book contains information not easily found elsewhere and is likely to be useful to students and teachers.

NICOLAUS STENO, SEVENTEENTH-CENTURY ANATOMIST, GEOLOGIST AND ECCLESIASTIC

NICOLAUS STENO (Niels Steensen) not only ranks as one of Denmark's greatest men of science but also occupies a distinguished place within the larger group of naturalists whose activities brought about the scientific revolution in Europe that marks the close of the seventeenth century. In addition, he played a prominent part in the religious life of the period. Not surprisingly, therefore, his life and work have been much studied, particularly by his own countrymen, and their latest contribution to these studies is a record of all Steno's surviving correspondence, both scientific and theological. This occupies two large quarto volumes, which have been edited by Father Gustav Scherz, of Copenhagen, assisted by Joanne Raeder*. Much of the literature about Steno is in the Danish language, or is contained in publications not easily accessible to British readers. An appreciation of the value of his letters depends on some knowledge of his achievements, so that a brief account of his remarkable career may not be out of place here. It is based mainly on the account, written in English, by Prof. Vilhelm Maar, of Copenhagen[1].

Steno was born in Copenhagen in 1638, and commenced to study in the University of Copenhagen at the age of eighteen. One of his teachers was the famous anatomist, Thomas Bartholin, a fact that doubtless influenced the course of his career. After pursuing a medical course in Copenhagen, which was interrupted by a war with Sweden, he followed the usual custom of the times and travelled abroad, to continue his studies at foreign universities. He went first to Amsterdam, and it was here, in 1660, that he made his first important discovery, the recognition of the parotid duct (ductus Stenonianus); here also began a friendship with the naturalist Jan Swammerdam, that continued throughout the latter's lifetime. After four months at Amsterdam, Steno moved on to Leyden, where he remained four years, studying under van Horne and Franciscus Sylvius. He had as a fellow student at Leyden Sir Robert Sibbald, the Scottish physician and naturalist, who records that Steno "dissected in my chamber sometymes, and showed me there, the ductus salivalis superior, he had discovered"[2]. In Holland, Steno gained general admiration, not only for his skill as a dissector and for his capacity for making new observations and drawing sound conclusions therefrom, but also for his pleasant and modest personality. At this time he met, among other well-known men, Benedict Spinoza. His intellectual interests widened, and he studied languages, mathematics and religion. He was now free to enter into discussions with members of the Roman Catholic Church, which had not been the case in Lutheran Denmark. His inclination towards mathematics, and particularly geometry, is reflected, later on, in his method of presenting the results of his anatomical and geological researches.

Family affairs compelled a return to Copenhagen in 1664. The reputation he had by then established as an anatomist would have justified an appointment as professor in the University, but this was not made. He therefore left Denmark in the same year, proceeding this time to Paris. He had letters of introduction to a well-known patron of the sciences in that city, Melchisédec Thévenot, who received him as a guest. French scientists were accustomed to meet for discussions in Thévenot's house, and it was here that Steno delivered his famous discourse on the anatomy and physiology of the brain[3].

Steno spent nearly a year in France, during which time he visited other centres of learning. In Montpellier he met two British naturalists, John Ray and Martin Lister. It is recorded that Ray was present when Steno dissected an ox's head and demonstrated the existence of the 'ductus salivaris'[4]; and Lister describes his meeting in the following terms: "I had ye honour to assist att an Anatomie Lecteur on some particular dissections and demonstrations made by Mr Steno ye Dane himself in my Lord of Ailesburys cabinet. the demonstrations were neat and clever wherein I much [? most] admired ye ingenuitie and great modestie of ye person. . . . Afterwards I visited Mr Steno whom I found infinitely taking and agreeable in Conversation and I observed in him very much ye Galant and honest man as ye french say, as well as of ye schollar"[5]. Steno possibly met also Dr. William Croone, first secretary of the Royal Society, at Montpellier. A little later on he addressed a letter on the salamander to Croone, which was published in the *Philosophical Transactions* of the Society, in 1667[6].

From France Steno passed on to Florence, arriving in the summer of 1665. Soon the Grand Duke Ferdinand II of Tuscany attached him to his court, and thereafter encouraged him in every way to continue his scientific investigations. Ferdinand and his brother Leopold were leading spirits in the Accademia del Cimento, and in Florence Steno moved in the same circle as the members of the Accademia, meeting, among others, Vincenzo Viviani, pupil and biographer of Galileo, and the naturalist Francesco Redi. He also gained the friendship of the anatomist and microscopist, Marcello Malpighi. Meanwhile, fostered by local contacts, his interest in Roman Catholicism developed, and in December 1667 he entered that Church. It seems clear that he took this step without any thought of gaining personal advancement; it led, ultimately, however, to his abandoning science for religion.

In the same month Steno received a summons to Copenhagen from King Frederick III of Denmark, with the promise of a professorship. He delayed his return for various reasons, and when he did set out, in 1668, he travelled north by a circuitous route, reaching Amsterdam in 1670. In the interval, Frederick III had died, and he also learnt that his patron, Ferdinand II, was ill, and so he returned to Florence again. Upon the death of the Grand Duke his patronage was continued by his son, Cosimo III.

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* Nicolai Stenonis: Epistolae et Epistolae ad eum Datae. (Quas cum Prooemio ac notis Germanice Scriptis.) Edidit Gustav Scherz, adjuvante Joanne Raeder. Vol. 1: Pp. xxxii+480. Vol 2: Pp. xii+481–1028. (København: Nyt Nordisk Forlag, Arnold Busck; Freiburg i Br.: Verlag Herder, 1952.) 175 Dan. Kr., or 105 D.M.

Up to the time Steno first arrived in Italy, he seems to have devoted his life mainly to the study of anatomy and physiology, though not without other interests, as would be expected in a man with his brilliant intellect and inquiring mind. There is, however, no evidence that he had yet considered any of the geological problems which, even at this early date, before the science had gained a name, exercised the minds of not a few scientists. It may appear, at first glance, that there is no obvious link between anatomy and geology, and thus it may be wondered why Steno took up the study of the latter science. The answer is that, as with many of his anatomical studies, chance played a part, though it can scarcely be doubted that he had already discussed geological matters with his Italian friends. The problem of the origin of fossils, for example, had been considered by many Italian naturalists from the days of Leonardo da Vinci onwards. Moreover, in the same year that Steno arrived in Florence, Athanasius Kircher published a voluminous geological work, "Mundus Subterraneus", which most probably came to the notice of Steno. It appears that Steno first gave systematic consideration to the problems of geology through the circumstance that Ferdinand II placed at his disposal for dissection the carcass of a shark. His examination of the teeth led him to compare them with the fossil sharks' teeth known as 'glossopetræ', which were common objects in the Mediterranean region, and to be seen in private collections. Their true origin was still disputed, but Steno, as a skilled anatomist, could scarcely have failed to conclude that there was no essential difference between the fossil and recent varieties. This conclusion naturally raised in his mind a further question. Why are fossil organic remains found in rocks far from the sea? His first tentative views on these questions are contained in the book in which he describes his dissection of the shark[7]. To solve the problem, he did not indulge in speculation, as so many had before him, but went out into the countryside to study the rocks themselves. He published the results of his researches soon afterwards, in 1669, in a book bearing a title that gives little indication of its contents: "De Solido intra Solidum naturaliter contento Dissertationis Prodromus". The 'solids contained within solids' that Steno discusses were the fossils contained in rocks, and also certain minerals upon which, too, he made important original observations. Steno's "Prodromus" was intended only as a preliminary discussion of problems that he hoped to deal with at greater length later on, but, unfortunately, he did not do so. Even so, the importance of his book in the history of geology is outstanding. In it Steno lays down for the first time the fundamental principles of geology in a scientific manner, on the basis of field evidence. The principles stated, though somewhat crudely expressed, for the most part still hold good to-day, although not all the explanations advanced by Steno to explain observed facts were correct. Nor could this be expected at a time when geology was still a science very much in the embryo stage. It was not long before the importance of his book was realized outside Italy, and an English translation by Henry Oldenburg, secretary of the Royal Society, appeared in London in 1671. To the title of this edition Oldenburg added the significant words: "a Foundation for the Rendering a Rational Accompt both of the *Frame* and the several *Changes* of the Masse of the EARTH, as also of the various *Productions* in the same".

Physical science, too, aroused the interest of the versatile Steno, a fact to which attention has been directed by Dr. Axel Garboe[8]. The doctrine of *antiperistasis*, the current explanation of the relation between heat and cold, interested Steno, as it had other seventeenth-century scientists, including Robert Boyle. In Italy, for example, the presence of hot lava in snow-covered Etna attracted attention to the problem. Steno thought that two grottos in the remoter heights of the north Italian Alps, which were reputed to be permanently iced, might throw some light on the question; he therefore made the arduous journey to these grottos, carrying with him a Florentine thermometer, and was able to make observations showing that *antiperistasis* was not a valid explanation of the relation between heat and cold. His account of these journeys, contained in letters to Cosimo III, has been translated into English by Dr. Garboe[9].

Soon afterwards, in 1672, a second royal summons to return to Copenhagen reached Steno, and this time he obeyed it and returned to his homeland. On arrival he was created Anatomicus Regius, because, as a Roman Catholic, appointment to a university professorship was precluded. After his return, Steno made many anatomical demonstrations in the old Theatrum Anatomicum, accounts of which he published in a periodical newly established by his old master, Thomas Bartholin, the *Acta Medica et Philosophica Hafniensia*. However, though by now a somewhat more tolerant attitude towards the Catholics existed, yet his religious faith still made life difficult for Steno in Denmark, and there was, too, a serious conflict in his mind between the opposing calls of science and religion. In consequence, he returned once more to Florence, in 1674, where he became tutor to the son of Cosimo III.

Henceforwards, so far as is known, he abandoned the study of natural science, becoming increasingly interested in religious matters. He took holy orders in 1675, and was made a titular bishop in 1677, receiving the appointment of Vicar Apostolic of Northern Germany and Scandinavia. He then proceeded to Hanover and, after residing in various towns in northern Germany, he died in Schwerin in 1686. During these latter years Steno lived the life of an ascetic and devoted his energies solely to furthering the cause of the Church and the poor. After his death, his body was conveyed to Italy by Cosimo III and buried in the crypt of the church of St. Lorenzo, Florence.

Steno published many books and papers describing his anatomical and physiological researches into the glands and lymphatic system, the heart, the muscles, the brain and the reproductive system. These alone, apart from his contribution to geological science, would be sufficient to ensure for him an honoured name in the history of science. His scientific works have been published in a collected edition under the general editorship of Prof. Vilhelm Maar[1]. In this publication Maar has included a long introductory essay on the life and work of Steno, and an annotated bibliography. Both the essay and the annotations are in English and form the best source for English-speaking readers wishing to study the life and works of Steno. His theological works, too, have been issued in a collected edition[10], edited by Knud Larsen and Gustav Scherz, with an introduction and commentary in German.

Now this extensive collection of Steno's correspondence is available. A detailed review is not practicable here; but a note on the contents of the volumes, particularly in so far as they bear on the history of science, will serve to show that this is a work of importance. It has been edited with great care and erudition, and all matter complementary to the letters is in German. A brief preface indicates that it contains all the letters both from and to Steno which the editors have been able to trace after searching a large number of European libraries and archives, especially those in Denmark, Italy and Germany. Doubtless others were searched with negative results but, while it is evident that the correspondence assembled must approach completeness, its publication may lead to further finds. At all events, it does not seem that possible British sources have been examined. Through the courtesy of the Librarian of the Royal Society, I am able to record that a contemporary copy of a letter from Steno to Dr. William Croone, dealing with medical matters, is still preserved in the Society's archives (though not the original of the other letter to Croone, published in the *Philosophical Transactions*). Its contents indicate a date not long before the publication of Steno's book on the dissection of the shark (1667). The correspondence covering the period of Steno's scientific activities is not extensive, and any additions would be welcome.

In the correspondence as printed, the term 'letter' is to be understood to include everything from friendly informal notes to formal documents such as episcopal communications with Rome. These are printed in the languages in which they were written, mainly Latin and Italian, and are arranged chronologically and numbered consecutively. They total 478, and range in time from a letter written by Steno in 1661 to Thomas Bartholin about his anatomical work to that written from his death-bed in Schwerin in 1686 to the Grand Duke Cosimo III. The editors state that about one-half of the letters printed are hitherto unknown, and only about one-eighth of the total have been published previously. Some are only printed in abstract, but references are provided to sources where they are given in full. Every letter is preceded by a summary of its contents in German, a great convenience for students with special interests. As indicated above, the number of letters of scientific interest is disappointingly few, in relation to the total, and those in Vol. 2, 253 in all, covering the period 1680–86, are mainly, if not exclusively, of theological interest. Fourteen letters that passed between Steno and Bartholin have been printed in full; and among other scientists to whom Steno addressed letters that have survived are Paolo Boccone, Athanasius Kircher, G. Leibniz, Marcello Malpighi, Francesco Redi, Swammerdam, Thévenot and Viviani.

Perhaps the most valuable part of the book for students of the history of science is the long introductory essay which discusses the seventeenth-century background, especially with reference to the life and work of Steno's correspondents. This is followed by an equally valuable index of sources consulted containing upwards of seven hundred references. Vol. 2 concludes with a number of "Additamenta". These include a reproduction of parts of what is known as the "Chaos" manuscript, a document preserved in the Biblioteca Nazionale in Florence, which contains a series of disconnected notes in Steno's handwriting dating from his student days. The additional matter also includes extracts from contemporary letters containing references to Steno and his work. Finally, there is an index of persons and places mentioned in the text.

The production of these two volumes must have required much research, apart from the laborious task of preparing the material for the press. The resulting work is a valuable contribution to our knowledge of the intellectual life of the seventeenth century, and it should find a place in all important reference libraries. As the editors point out, virtually all the material necessary for the preparation of a reasoned assessment of Steno's contributions to science and the Church, and for the preparation of a definitive biography, has now been assembled. It remains only for some author or authors, competent and willing to do so, to undertake the task. Such a biography would be of the greatest interest to students of the religious and scientific history of the seventeenth century.

V. A. EYLES

[1] "Nicolai Stenonis Opera Philosophica", 2 Vols., edited by Vilhelm Maar (Copenhagen, 1910). See also the shorter, but authoritative, accounts of Steno's life in English in V. Meisen's "Prominent Danish Scientists through the Ages", pp. 36–43 (Copenhagen and London, 1932); and J. G. Winter's edition of Steno's "De Solido ... Prodromus" in Univ. Michigan Studies: Humanistic Series, 11, Contrib. Hist. Sci., Pt. 2, 175–187 (New York, 1916).

[2] "The Memoirs of Sir Robert Sibbald", edited by F. P. Hett, 57 (Oxford, 1932).

[3] Steno, N., "Discours ... sur l'anatomie du cerveau" (Paris, 1669).

[4] See Skippon, P., "A Journey through part of the Low Countries, Germany, Italy and France ... in company with the celebrated Mr. Ray, etc.", in "A Collection of Voyages and Travels", 6, 359–736 (1732). The reference is here quoted from Raven, C. E., "John Ray", first ed., pp. 132 and 137 (1942).

[5] Bodleian Library, Oxford. Lister MS. 5, Folios 224 (Verso) and 225: here quoted from Brown, H., "Scientific Organizations in Seventeenth-Century France", 211 (Baltimore, 1934).

[6] "An extract of a Letter not long since written from Rome, rectifying the Relation of Salamanders living in Fire", *Phil. Trans. Roy. Soc.*, No. 21, 377 (Jan. 21, 1666/7).

[7] "Elementorum myologiae specimen, ... Cui accedunt canis carchariae dissectum caput ..." (Florence, 1667).

[8] Garboe, A., "Niels Stensen (Steno) som Fysiker", *Fys. Tidsskrift.* 113 (Copenhagen, 1947).

[9] Garboe, A., "Niels Stensen's Grotto Letters", in "Hilsen Til J. Christian Bay", 15 (Copenhagen, 1951).

[10] "Nicolai Stenonis Opera Theologica", 2 Vols., edited by K. Larsen and G. Scherz (Copenhagen, 1941–47).

BOTANY IN THE UNIVERSITY OF GLASGOW

250TH ANNIVERSARY

AT the opening in 1901 of the present Department of Botany in the University of Glasgow, the then director of the Royal Botanic Gardens, Kew, Sir William Thiselton-Dyer, said: "Had it not been for the work of Sir William Hooker in Glasgow University I do not think that Kew would be to-day what it is; and as the University looks to Bologna, so does Kew look to Glasgow". The long connexion between the Glasgow Department of Botany and the Royal Botanic Gardens at Kew was recalled and continued when the director of the Gardens, Sir Edward J. Salisbury, delivered a discourse on "The Creation of a Botanical Tradition" at the 250th anniversary celebrations of the Department on June 15, 1954.

The actual anniversary falls in September, for it was in that month of the year 1704 that John Marshall was appointed keeper of the Physic Garden and to give instruction in botany to students. He continued to teach until his death in 1719. A dual chair of anatomy and botany was founded in 1720 and for some time botany was regarded as the leading subject, perhaps out of deference to Thomas Brisbane, the first holder of the chair, who refused to teach anatomy altogether and soon ceased to teach botany also. At this time occurs the first distinct notice of a University summer session for, in 1727, a Commission of Visitation ordained that Brisbane should teach botany from May 16 until July 1.

Brisbane died in 1742 and his successor, Robert Hamilton, is significantly described in the commission as "professor and *teacher* of Botany and Anatomy". It is doubtful, however, if Hamilton taught any botany, since William Cullen settled in Glasgow in 1744 and soon began to teach medicine, botany, materia medica and chemistry. He gave his botanical lectures in Latin and presented an account of the principles on which the different systems of botany had been founded. Cullen left for Edinburgh in 1756 and Hamilton died within three months. Joseph Black held the chair of anatomy and botany for a year and was succeeded by Thomas Hamilton, the brother of Robert. In 1781 Thomas resigned in favour of his son, William, who was to give botany a considerable share of his time until his death at the age of thirty-one in 1790. The King then appointed James Jeffray, who taught botany for some years; but after 1799 the subject was taught by Dr. Thomas Brown. Brown gave the first lectures on agriculture. After 1808 Jeffray seems to have again taught the botany class; but in 1816 the faculty agreed that Dr. Robert Graham should do it.

The College had had a Botanic Garden since 1704, although at various times it had been in danger of extinction. William Hamilton devoted much time and money to it; but, towards the end of the eighteenth century, cultivation, never easy on the stiff clay soil, became still more difficult owing to the impurity of the atmosphere. As the result of a public movement the Royal Botanic Institution of Glasgow was formed and a garden laid out at Sandyford. Graham, who was appointed first regius professor of botany in 1818, was much occupied with the laying out of the Garden until he left for Edinburgh in 1820 to superintend the formation of the new gardens in Inverleith Row.

In 1820 William Jackson Hooker was appointed with an unusual degree of swiftness to be regius professor, and he began that course of organization of public botanic gardens which continued to the day of his death. Scientific visitors to the Glasgow Garden almost invariably expressed the opinion that it would not suffer by comparison with any other similar establishment in Europe. Hooker had never lectured or even attended a course of lectures; but his tenure of the chair was remarkably successful. His lectures were attended not only by the medical students but by also the public and even by army officers. At the close of his first course the class presented him with a handsome silver vasculum chased with the design of a moss that had been named after him. He published a long series of works, illustrated by himself and by the Glasgow artist, W. Fitch, and made Glasgow a famous source of writing on descriptive botany which probably had no equal at its time. Hooker established a tradition of student excursions which has been carried on until the present day, and at the 1901 ceremony Sir Joseph Hooker described some of his father's excursions in the olden days when there were no railways, cycles, or motor-cars, and very few inns in the western Highlands. The accounts of these expeditions are often amusing, and occasionally professors and students became involved in court proceedings. In 1841 Hooker was appointed to be director of the Royal Botanic Gardens at Kew and was succeeded in Glasgow by John Hutton Balfour, who occupied the chair for only four years, passing on to Edinburgh in 1845, where he earned by his tough assiduity the title of "Woody Fibre".

The only professor of botany to have died in office was George Arnott Walker Arnott, who held the chair from 1845 until 1868. This fact had a marked effect on departmental history, for whereas his predecessors had, on leaving Glasgow, removed their collections and other effects elsewhere, Walker Arnott's library and herbarium were acquired after his death for the University. Throughout the nineteenth century the Glasgow chair of botany served as a stepping-stone to more valuable preferment elsewhere. Sir William Hooker passed on to Kew, Profs. Graham, Hutton Balfour, Dickson and Bayley Balfour (via Oxford) all moved to the chair at Edinburgh. At each step, collections, books and apparatus were removed. Those of Sir William Hooker formed the foundation of the scientific establishment at Kew, while the equipment of the others went to Edinburgh.

Arnott was followed by Alexander Dickson, who arrived just before the opening of the new University buildings in 1870. A beginning was now made in the establishment of a permanent Department of Botany, consisting of a large class-room at the top of the north-east corner tower, with a retiring room and a room for herbarium work, together with two badly lighted attics, without heat, water or gas. Dickson remained for eleven years and left the Department very much as it had been at Walker Arnott's death, except that the herbarium had become infested with beetles.

The vacancy in the chair in 1879 was filled by Isaac Bayley Balfour, a young man, full of energy, and fresh from the Continental schools. Balfour ensured the herbarium for the University. Having worked under Huxley and De Bary, practical classes seemed to him essential, and so he bartered his lecture-room for two small rooms that would serve as laboratories. These were too small for more than a fraction of the students; but they continued to be used for twenty years, first by Balfour and afterwards by Bower. Although Balfour is credited with having introduced practical classes in botany at Glasgow, it should be noted that Hooker required every student to provide himself with a pocket-lens, knife and pair of forceps, with which they followed the professor's demonstrations.

By 1840 the Sandyford site had become unsuitable for the Botanic Garden owing to the spread of the City and so the plant houses were removed to the rural area of Kelvinside in 1842. The Garden was still controlled by the Royal Botanic Institution, and the professor of botany did his teaching in the Garden until 1870. The plant houses became very dilapidated and the herbaceous ground very cramped; but with the support of Sir Joseph Hooker (by that time director of Kew), Bayley Balfour rehabilitated the Garden. His costly schemes hastened the transfer of the Garden to the Corporation, which finally took place in 1891, although the University still retained facilities for the teaching of botany in the Garden.

For forty years from 1885 Frederick Orpen Bower was regius professor, and his greatest domestic botanical achievement was undoubtedly the building of the present Department of Botany. Botany was thus the first science to have a separate building in Glasgow, and although the Department is now short of space, it seemed, in 1900, that Bower had been absurdly extravagant in his provisions. The building was opened in 1901 by Sir Joseph D. Hooker in the presence of Sir William Thiselton-Dyer, Lord Lister and Prof. Bayley Balfour. The jubilee of this event was celebrated in 1951 when the late Prof. F. E. Fritsch was the Department's guest of honour.

During Bower's professorship Robert Kidston was closely associated with the Department, and members of the staff who afterwards became well known elsewhere include J. M. F. Drummond, D. T. Gwynne-Vaughan, W. H. Lang, A. Anstruther Lawson, J. McLean Thompson and J. C. Willis.

The Department continued to grow steadily during the remainder of Bower's time and also during that of his successors, Prof. J. M. F. Drummond and Prof. John Walton (the present incumbent). The need of new laboratories for plant physiology and mycology became felt increasingly and Prof. Walton's striving to obtain these recalls the vigorous efforts of Bower at the end of last century to get a botany building. The result was the Stevenson Laboratory, which was opened by Sir Albert Seward in 1937.

The latest event in the Department's history was the celebration on June 15 of its 250th anniversary. Representatives of many university departments of botany and of the Botanical Society of the British Isles and the Botanical Society of Edinburgh were present and the guest of honour was Sir Edward Salisbury, thus maintaining the link with Kew. In his discourse, Sir Edward referred to the achievements of the Glasgow Department and showed how, through times of prosperity and adversity alike, the advancement of botanical knowledge has there been fostered and ensured. Remarking that a wise man exploits the characteristic features of his environment, Sir Edward said that the Cryptogams had continually been studied in "the perpetually humid atmosphere of Glasgow" where ferns, liverworts and mosses flourish. For Hooker, pteridology "was a major activity in a varied career, and for Bower the absorbing obsession of a lifetime". He added: "Just as the University is far more than a mere assemblage of the faculties of which it is comprised, so, too, the history of a department far transcends the mere succession of professors and teachers, however eminent. It is the good fortune of botany at Glasgow that it has had so high a proportion of those, doing it service, who have not only been gifted in their own field of study, but have been scholars with that intellectual apprehension of proportion and perspective, that is beauty".

Before the discourse (at which the vice-chancellor, Sir Hector Hetherington, presided) the guests and visitors were photographed and entertained to luncheon and tea. Afterwards an anniversary dinner was held, at which speeches were made by Prof. S. C. Harland, Prof. J. D. Mackie (representing the Vice-Chancellor), Prof. J. McLean Thompson, Dr. S. Williams, Dr. G. Bond, Sir Edward Salisbury and Prof. A. R. Gemmell. An exhibition of portraits, letters and various other documents relating to the history of the Department was on show during the day.

It was a matter of great regret to all present that illness prevented Prof. John Walton from presiding over the celebrations. A message from him was read by the Vice-Chancellor and good wishes were sent from the assembly. Prof. Walton's place was taken by Dr. Samuel Williams, the acting head of the Department.

FUNDAMENTALS OF COLOUR REPRODUCTION*

By Dr. R. W. G. HUNT

Kodak, Ltd., Wealdstone, Harrow, Middlesex

When, during the first half of the nineteenth century, certain indefatigable people strove to 'fix the images of Nature', their purpose and hopes were to fix the colours as well as the tones in their pictures, and it would no doubt have seemed to them like an idle tale if some prophet had revealed that photography was to know a hundred years of black-and-white before colour began to intrude in any measure. Yet such is the case, and this in spite of a number of early milestones which held out great promise. As early as 1810, Seebeck and others knew that if a spectrum was allowed to fall on moist silver-chloride paper many of its colours were recorded, although not with any degree of permanence. In 1853 Prof. Robert Hunt published the third edition of his "Photography", which contained a whole chapter "on the possibility of producing photographs in their natural colours"; he described seeing a number of "Heliochromes" which were "perfectly coloured; . . . but the colours soon faded, and it does not appear as yet that any successful mode of fixing the colours has been discovered". By 1890, however, Prof. Gabrielle Lippmann, of Paris, had not only perfected the technique of 'fixing' these colours (by the same methods as are used in black-and-white photography) but had also much improved the process in other ways. Moreover when, just before and just after the turn of the century, sensitizing dyes such as eosin, cyanine blue, ethyl red and (above all) pinacyanol were discovered, greatly increasing the sensitivities of photographic emulsions in the green, yellow and red parts of the spectrum, Lippmann colour photographs of very high quality, even by present-day standards, were produced.

The method, which is illustrated in Fig. 1, is an interference process. During the exposure, the emulsion is backed by mercury, so that the light is reflected back through the emulsion layer, and interference occurs between the incident and reflected beams. Standing waves are formed in the emulsion layer, and hence the latent image is formed in bands at half-wave-length intervals. The emulsion is composed of extremely fine grains so that these bands are resolved, and after development and fixing (in 'hypo' in the usual way) there remain a series of bands of silver separated by distances equal to half the wave-length of the exposing light. Since the grain-sizes are small compared with the wave-length of light, the bands of silver act as mirrors and selectively reflect light of the same wave-length as that which produced the image. It is probably true to say that, but for one fact, colour photography would have started a brilliant career at the turn of the present century by means of the Lippmann method. The one fact is that, in photographic emulsions, the finer the grain, the lower the sensitivity. Lippmann emulsions must have grain-sizes which are small compared with the wave-length of light, and the corresponding sensitivity is such that exposures of the order of half an hour in bright sunlight are

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* Based on a course of four lectures delivered at the Royal Institution, London, on November 5, 12, 26 and December 3, 1953

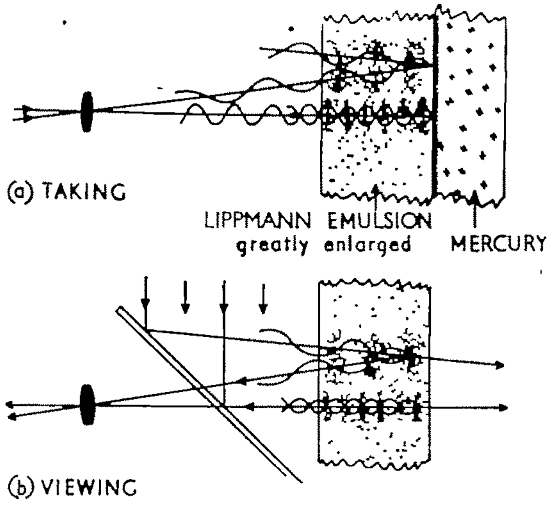

Fig. 1. The Lippmann method of colour photography. (a) Taking in this example the horizontal beam represents green light, and the oblique beam, red light (b) Viewing: the Lippmann photograph is viewed by reflexion; from the incident white light, the bands of silver selectively reflect green light in the horizontal beam and red light in the oblique beam

necessary to produce good Lippmann colour photographs.

So the early dreams of Seebeck, Hunt and others were dashed, not by the difficulty of fixation, but by low sensitivity. The Lippmann process, however, is important to any consideration of the fundamentals of colour reproduction because, apart from the micro-dispersion method (which is often described but never used), it is the only successful method in which the colours are reproduced physically. For any colour is completely defined by its spectral-energy distribution curve, and in a Lippmann colour photograph the attempt is made to reproduce, at each point on the photograph, a colour having the same spectral-energy distribution curve as in the original.

The recording and presentation of so much information in a colour reproduction, however, has long since been known to be unnecessary. For two spectral-energy distribution curves can be very dissimilar, and yet constitute colours which are visually identical; and so we find that the early pioneers were on the wrong track, and that all successful modern methods of colour reproduction, whether in photography, in printing, or in television, stem from a different source.

In 1801, Thomas Young, from physiological considerations, decided that the eye must simplify the complexity of the infinite number of variables in the spectral-energy distribution curve, and proposed that only three variables were involved. This suggestion, which was later to be much elaborated by Helmholtz, came to be known as the Young–Helmholtz, or trichromatic, theory of colour vision.

Young's original pronouncement preceded the invention of photography by about thirty years, and another thirty years were to pass before Maxwell, in his famous Friday Evening Discourse at the Royal Institution on May 17, 1861, demonstrated Young's hypothesis by trichromatic colour photography. Maxwell's thesis was that, if the eye really does analyse all colours into only three variables, 'redness', 'greenness' and 'blueness', then by preparing three negatives, one through a red filter, one through a green filter, and one through a blue filter, and making from them three positive lantern slides, then projecting them in three lanterns fitted with red, green and blue filters, respectively, and superimposing the three images thus obtained, all the colours of the original scene would be reproduced. Maxwell's work, of course, was done thirty years before sensitizing dyes became available, so that the red and green filters used in making the exposures had to be rather pale in order that any image be obtained, even when lengthy exposure-times were given. In consequence, the quality of Maxwell's colour photograph was poor, and, indeed, his purpose in showing it was only to demonstrate the truth of Young's theory of colour vision, and not to lay the foundation stone of successful colour photography. In point of fact, however, this is precisely what he did. His experiment, moreover, is not only basic to colour photography, but to colour reproduction in other media, such as printing and television. Moreover, once satisfactory sensitizing dyes had been produced, Maxwell's method became capable of a standard of excellence in colour rendering which even to-day has not been surpassed, and is seldom equalled. But the inconvenience of three separate projectors, with all the difficulties of obtaining and maintaining exact registration of the three images, has consigned the triple-projection method to the museum and the lecture bench, although in recent years it has been tried again in colour television.

The half-century following Maxwell's discourse produced a veritable spate of arm-chair inventions, and some of the leading inventors of the time showed extraordinary thoroughness; it has been said, for example, of Louis Ducos du Hauron that "there is scarcely a process which he did not foreshadow", and as early as 1869 he realized the distinction between the additive and subtractive principles (both of which derive from Maxwell's experiment in the final analysis).

In photography, the additive processes have had a long and chequered career, but are now almost entirely superseded by subtractive processes. It is very interesting to note, however, that, in colour television, methods are being used which are very similar indeed to the early methods of additive colour photography, and in this respect television is unwittingly recapitulating the history of photography with remarkable precision.

Thus triple projection has been used in colour television and, as in photography, is perhaps also in television the method capable of the highest quality, but with the same attendant difficulties of exact registration and cumbersome equipment.

One of the most attractive ways of simplifying the equipment was to view the three positive images, not simultaneously, but successively, and fifty years ago colour cinematography by means of rotating filter wheels having red, green and blue sectors raised the hopes and emptied the pockets of many an optimist. In television, this method was tried in the early 1930's by Baird, and in the form of the Columbia system was approved by the Federal Communications Commission in the United States in 1950. Unfortunately, in such a system, the blue filter is always much darker than the red and green filters, and the eye can detect the darker filter as a brightness flicker, even when the speed of the filter wheel is fast enough to remove all colour flicker. In fact, in order to remove all trace of flicker it is necessary to present the successive pictures at the rate of about 144 per second, and this requires excessive band-width in transmission. Even at this speed, however, moving objects can sometimes exhibit fringes (colour 'break-up') which are irritating to the viewer. Moreover, this high picture-frequency renders the system 'incompatible'; that is, colour pictures cannot be viewed as black-and-white pictures on existing (black-and-white) receivers, and it was perhaps as well that defence requirements prevented the widespread use of the Columbia system and made it possible for the Federal Communications Commission to approve a compatible system in 1953.

One of the most ingenious of the additive methods of colour photography was the lenticular method. The camera lens was fitted with three strips of red, green and blue filter, and the film was loaded with the emulsion facing away from the lens. The film base had furrows, or lenticulations, embossed upon it, which acted as tiny cylindrical lenses and imaged the red, green and blue strips on to the emulsion, thus analysing the picture into very fine strips exposed through red, green and blue filters. Projection was carried out in a closely analogous manner, using lenticulated films and strips of filter over the projection lens.

The counterpart to the lenticular system in colour television is the Lawrence tube. This has a large number of vertical wires fixed just behind the screen of the cathode-ray tube, and potentials are applied in such a way that a series of lenticular electron lenses is formed. Red, green and blue phosphors are deposited on the surface of the tube in vertical strips, and the potential on the wires is arranged, at one moment, so that the electrons strike only the red phosphor, say. At the next moment, by altering the potential on the wires, the electron lens is altered so that the electrons fall on the green phosphor, say. A further alteration of potential on the wires causes only the blue phosphor to be excited at the next moment. By switching the potentials at any suitable frequency above that necessary to eliminate flicker and colour break-up, a satisfactory colour picture is obtained.

In colour photography, however, the most successful additive processes were those which used mosaics of tiny red, green and blue areas, behind which the negatives were made, and through which the positives were viewed. In this system each original patch of colour is broken up into areas of red, green and blue, too small to be seen separately by the eye. The mosaic pattern was sometimes random, and sometimes regular, the latter being preferable because, in the former, random clumps of areas all of the same colour give rise to a mottled appearance. Again, it is most interesting to see that the additive method which in the end proved the most successful in colour photography is, at any rate so far, the one which has proved most successful in colour television. The type of tube originally developed by the Radio Corporation of America, which is beginning to be used in the United States, contains on its surface a regular array of triads of dots of red, green and blue phosphor. An aperture plate just behind the surface, with one aperture for each triad of dots, acts as a rough pin-hole camera, and 'images' three electron guns on to the three dots. The arrangement provides, of course, for one gun to be imaged on to all the red dots, another on to all the green dots, and a third on to all the blue dots. Mainly as a result of work carried out by the Radio Corporation of America in this field, the National Television Systems Committee of the United States obtained Federal approval at the end of 1953 for a method of transmission which was compatible, and which could be used both with the R.C.A. and with the Lawrence types of tubes.

The subtractive principle is different from the additive in that the red, green and blue components of the image are in one and the same beam of light, so that, in contrast to the additive principle, no light is wasted by the use of red, green and blue filters. Three positive dye images are made; one dye is of such a colour that it absorbs reddish light and freely transmits the rest of the spectrum; another is such that it absorbs greenish light and freely transmits the rest of the spectrum; and the third is such that it absorbs bluish light and freely transmits the rest of the spectrum. The colours of dyes having these properties are known in photography as cyan, magenta and yellow, respectively, but in printing they have for many years been termed blue, red and yellow, respectively (although the blue is slightly greenish, and the red is slightly bluish). The three dye images, when superimposed and viewed in white light, give a satisfactory trichromatic colour reproduction, because the reddish part of the white light is controlled by the cyan dye, the greenish part by the magenta dye, and the bluish part by the yellow dye. It is difficult to see at present how the subtractive principle could be profitably applied to colour television, but in colour photography it has met with very considerable success during the past two decades, particularly in the form of 'integral tripacks'; that is, systems where three emulsion layers are coated in succession, one on top of the other, on the same film base.

In printing, the number of inks used is not always confined to three. Frequently a black printing is added, and special colours—for example, a particular shade of blue—are sometimes printed in separately as well. Sometimes as many as seven or eight different inks are used, and, in this case, colorimetrically the reproduction is more analogous to painting than to photography or television.

Most methods of printing result in the inks being deposited in regular mosaics of dots, and since the mosaics of the different inks overlap in some places, but not in others, the system is partly additive and partly subtractive. Neugebauer[1] has treated the problem quite generally as an additive mixture of eight different colours: cyan, magenta, yellow, red (magenta and yellow superimposed), green (cyan and yellow superimposed), blue (cyan and magenta superimposed), black (all three dyes superimposed), and white (the colour of the paper). Hardy and Wurzburg[2] have proposed an ingenious system of scanning the original colour scene and printing arrays of dots photographically on three separate plates, such that, when these arrays of dots are printed in cyan, magenta and yellow dyes, exact colour reproduction is achieved. Clapper and Yule[3], however, have pointed out that inter-reflexions of light within the layers of ink and the paper fibres introduce errors; but the system is still capable of producing very good results and, in fact, is being increasingly used.

We have seen that a great deal of effort has been expended by many workers over a period of more than a century in the hopes of reproducing colour. Yet even to-day the vast majority of photographs, television pictures and printed reproductions are only in monochrome. The problems to-day, however, are mainly economic and not technical. Colour snap-

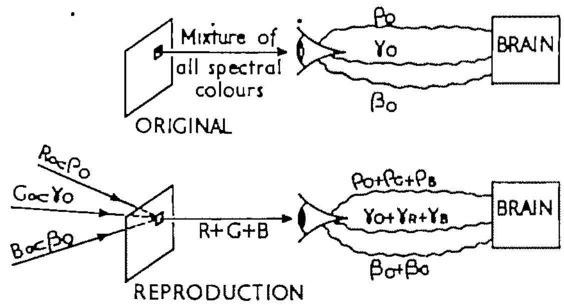

Fig. 2. Diagrammatic representation of why a trichromatic reproduction of an original scene is always inaccurate

shots, cinematograph films, lantern slides, prints, television pictures and printed reproductions have all been, and are all being, produced. Perhaps in fifty or a hundred years time the black-and-white reproduction will be a thing of the past, but only if economic and political factors allow.

There remains one question yet to be answered. How accurate can these colour reproductions be? Since Lippmann and other physical methods of colour reproduction are generally impracticable, the question is really of interest only in the case of the trichromatic methods. The situation in these methods is shown schematically in Fig. 2. The upper half of the diagram represents the situation in which the original object is viewed. Physically, the colour consists of a mixture, in certain proportions, of all the colours of the spectrum. This physical complexity is then, according to the Young–Helmholtz theory, simplified physiologically into three variables only; the magnitudes of these three variables are denoted by ρ_0, γ_0 and β_0 and, according to the theory, the sensation of colour produced by the object is a function of these variables only.

These three signals ρ_0, γ_0 and β_0 may be thought of as being produced by three types of light-sensitive cells in the retina, each having a different spectral-sensitivity curve. Since trichromatic colour reproduction depends for its success on the properties of the eye, it is clear that any system must analyse the colour of the object in the same way as the eye. Hence the three separation images must be recorded by light-sensitive receivers having the same spectral-sensitivity curves (or in certain circumstances any three linear combinations of them) as the three different types of light-sensitive cells in the retina. Although much remains unknown about the mechanism of colour vision, if the Young–Helmholtz theory is accepted these spectral sensitivity curves can be deduced from colour-matching experiments to a considerable degree of accuracy. It is thus possible to select filters for use with photographic emulsions or television camera tubes which result in sensitivity curves closely approximating those required. Three signals are thus obtained proportional to ρ_0, γ_0 and β_0, and, in television, these signals (or combinations of them) are transmitted to the receiving sets, while in photography positives are made from the negatives. Beams of red, green and blue light are then combined to form the colour picture, either additively as in colour television and additive photography, or by the independent modulation of the reddish, greenish and bluish parts of the spectrum as in subtractive photography and in printing. The intensities, R, G and B, of these beams of light are made as nearly as possible proportional to ρ_0, γ_0 and β_0, and if the red light stimulated only the ρ-type of cell, the green light only the γ-type, and the blue light only the β-type, the signals received by the brain on looking at the colour reproduction would be proportional to ρ_0, γ_0 and β_0. It would then only be necessary to adjust the overall intensity of the picture to obtain signals equal to ρ_0, γ_0 and β_0, and hence exact colour reproduction.

The essential conditions for exact colour reproduction may, therefore, be summarized thus: (*a*) analysis of the scene by sensitive elements with the correct spectral-sensitivity curves; (*b*) production of red, green and blue beams of light with intensities proportional to the analysis; (*c*) stimulation by the red, green and blue beams of light of the three types of retinal cell separately; and (*d*) correct adjustment of the overall intensity of the picture. Conditions (*a*), (*b*) and (*d*) can, at least in principle, be well enough approximated to. But condition (*c*) is impossible to realize. Even if the red, green and blue stimuli are carefully chosen monochromatic radiations, the green stimulus invariably excites not only the γ-type of cell but also the ρ- and β-types. Moreover, the use of monochromatic stimuli is precluded in practice by the difficulty of obtaining sufficient intensity, and broader bands of light have to be used. This results in the red and blue stimuli also causing unwanted excitations, and the situation arises wherein the red light gives rise to the wanted signal ρ_0 and an unwanted γ-signal γ_R. The green light results in the wanted γ_0 and in unwanted signals ρ_G and β_G; and the blue light results in the wanted β_0 and in unwanted signals ρ_B and γ_B. The situation that arises is then shown schematically in the lower half of Fig. 2. Instead of the brain receiving the signals ρ_0, γ_0 and β_0, as required, it receives signals $\rho_0 + \rho_G + \rho_B$, $\gamma_0 + \gamma_R + \gamma_B$ and $\beta_0 + \beta_G$. Now the vividness, or saturation, of colours depends on the ratios of the three signals to one another, and additions to all three signals inevitably decrease the ratios. Hence the inability to satisfy condition (*c*) results in practically all colours, but particularly greens, being reproduced too pale.

This effect is in no way dependent on the Young–Helmholtz theory and would be just as true, though more difficult to describe, even if the theory were false.

In subtractive colour photography this effect is enhanced by the fact that the red, green and blue lights have, of necessity, to be broad bands of the spectrum; and the cyan, magenta and yellow dyes also have unwanted absorptions which cause green and blue colours to be reproduced darker than in the original scene. In colour television, however, by solving linear equations electronically, the effects of the violation of condition (*c*) can be limited to those few colours which are too vivid to be matched by any mixture of the red, green and blue lights; in practice, however, this refinement is not usually worth while.

How accurate can colour reproduction be? We have shown that trichromatic colour reproduction can never be perfectly accurate, because of the inevitable violation of condition (*c*). But, in practice, trichromatic colour reproductions are often very satisfactory, and, in fact, the public sometimes feel that the colours are not too pale, but too vivid. It is probable that this feeling arises from violation of condition (*b*); by making the picture of much higher contrast than the original, some increase in the saturation of the colours can be obtained, and this device is often used to lessen the effects of violating condition (*c*). The final saturations of the colours, however, are very seldom greater than those of the original, and are usually considerably less.

Why, then, can trichromatic reproductions be so acceptable? The answer lies very largely in the fact that they are scarcely ever seen alongside the original scenes, and the quality of the reproduction is judged against a mental conception of what the scene probably looked like. But scenes vary tremendously in their colour qualities, and particularly so in colour saturation, according, for example, to the type of lighting and the atmospheric conditions. Moreover, colour reproductions are generally viewed under conditions very different from those of the original scene, and this introduces a number of complicating subjective effects, which depend on the size, brightness and surface both of the picture and its surroundings.

Of colour reproduction, it must be said that accurate methods are impracticable, and practicable methods are inaccurate; and some may be inclined to add that all methods are too expensive. But the urge to 'fix the images of Nature' is just as insistent as it was a century ago, and there are some signs that the early trickles of hope are at last becoming the full floods of success.

[1] Neugebauer, H. E. J., *Z. tech. Phys.*, 36, 22 (1937).

[2] Hardy, A. C., and Wurzburg, F. L., *J. Opt. Soc. Amer.*, 38, 300 (1948).

[3] Clapper, F. R., and Yule, J. A. C., *J. Opt. Soc. Amer.*, 43, 600 (1953).

OBITUARIES

Prof. K. N. Bahl

KARM NARAYAN BAHL, who died at Lucknow on April 21 in his sixty-fourth year, was one of the great leaders in Indian zoology, and his work is known and admired throughout the world.

He was born on February 14, 1891, at Multan, in the Punjab, and educated at the Government College, Lahore, where he graduated B.Sc. in 1911 and M.Sc. (first class) in 1913, when he was also awarded the Maclagan Gold Medal. As soon as he had taken his B.Sc. he began his university teaching career by becoming demonstrator and assistant professor at Lahore; in 1914 he was appointed professor at the St. John's College, Agra, and in 1916 at the Muir Central College, Allahabad. His first research was on the ant-like spiders of the family Attidæ; but then he turned to the study of the Indian earthworms and very soon made the outstanding discovery of a new type of nephridium. In 1919 he published the first of a series of important papers on earthworm anatomy which appeared during the next thirty years in the *Quarterly Journal of Microscopical Science*; in this first one he described three distinct kinds of nephridia—septal, pharyngeal and integumentary—which he found in the worm *Pheretima posthuma*. It was the septal nephridia which presented such an interesting novelty, for they opened not to the outside of the body, as in all other such organs, but into the intestine; he called them an enteronephric system and made the suggestion, which in later years he strongly supported by experiment, that they were an adaptation for the conservation of moisture in a dry climate. He then visited England to work for two years under Prof. Goodrich at Oxford, where he was awarded the D.Phil. for further studies on *Pheretima*, in which he worked out the blood-vascular system and the development of the enteronephric organs. His earlier discovery had in the meantime won him the D.Sc. of the University of the Punjab. On returning to India in 1921 he was made reader in zoology in the University of Lucknow and two years later became professor; here he did the greater part of his work, remaining in the chair until he retired and was appointed vice-chancellor of the University of Patna in 1951. Many more studies in earthworm anatomy, reproduction and development followed; in these he described enteronephric systems in a number of other genera and, jointly with Dr. M. B. Lal, showed the existence of a 'hepato-pancreatic' gland, with a hepatic portal system, in worms of the genus *Eutyphoeus*. His morphological work was not, however, confined to earthworms; he produced, in the *Records of the Indian Museum*, an outstanding monograph on the skull of *Varanus monitor* with its associated muscles, blood-vessels and nerves. He was awarded the D.Sc. of Oxford in 1938, and in 1942 received the Joy Gobind Law Memorial Gold Medal of the Asiatic Society of Bengal.

Bahl's leadership will continue to be felt in India and the East for many years to come through that excellent series of *Indian Zoological Memoirs* which he initiated and edited. Since he wrote the first on *Pheretima*, seven others, by different authors, have dealt in turn with selected types of the Indian fauna; they are the oriental counterparts of the well-known *Liverpool M.B.C. Memoirs* which have played so important a part in the training of English zoologists. In the words of a review which appeared in *Nature* some years ago, "zoologists in India owe a debt of gratitude to Prof. Bahl to whose enthusiasm this series of manuals is due". The debt will grow and extend through many countries as these memoirs become more widely used; there could be no better memorial to Bahl than this series of volumes. On his retirement he was made a research professor at Lucknow, but his sense of duty then compelled him to accept a pressing invitation to become vice-chancellor of Patna University; here his heavy duties proved too much for him and in 1952 he suffered a breakdown in health from which he never completely recovered. Our sympathy goes to his wife, three sons and a daughter who survive him.

A. C. HARDY

Dr. R. S. Clay

REGINALD STANLEY CLAY died on April 10, after a short illness; he was eighty-five.

Dr. Clay's interests were many and various. He was educated at Tollington Park College and St. John's College, Cambridge, becoming a Wrangler in 1892. His first professional appointment was as physics master at Mill Hill School, and in 1897 he became head of the Physics Department at Birkbeck College. In 1900 he was appointed principal of the Wandsworth Technical College and in 1902 was invited to become the principal of the Northern Polytechnic. There he found ample scope for the exercise of his professional qualifications and administrative ability, which, with his power of winning the sympathetic co-operation of his staff and the respect of his students, enabled him, during his twenty-nine years of office, to make the Institute more widely known and to bring it to a high degree of efficiency. In 1931 he retired, to the regret of all who had been associated with him either as colleagues or students.

During 1907–11 Dr. Clay was the secretary for the Association of Technical Institutions, and in 1936 he joined the board of directors of the United Kingdom Optical Co. at Mill Hill, with happy results for the firm. From 1942 he served the Company as technical consultant on many problems. He was a founder fellow of the Institute of Physics (1918), served on its Board during 1920–33, and in recent years helped to promote the education and training of laboratory technicians. For many years he did admirable work for the *Journal of Scientific Instruments*, was at one time chairman of the Advisory Committee and was himself a frequent contributor.

Throughout his life, Dr. Clay's chief interest and hobby lay in optics. He was a member of the Council of the Optical Society and its president in 1927. Having been a Fellow of the Royal Microscopical Society for some years, he became its president in 1937 and was made an honorary Fellow shortly before his death. He was also a member of the Physical Society, in the activities of which he took a keen interest.

In 1911 Dr. Clay published a "Treatise on Practical Light" which remained the standard text-book for many years. It describes many ingenious pieces of apparatus for demonstrating optical principles. He gathered a unique collection of microscopes, containing an almost complete series from 1670 to 1850. This collection, bearing his name, is now in the Museum of the History of Science, in Oxford, and is described in detail in a book published in collaboration with T. H. Court in 1932, on the "History of the Microscope"; this remains the standard work on the subject.

From 1904 to the end of his life he was closely associated with what is now the National Council for Domestic Studies, being its first treasurer and chairman of the Examination Board. During thirty-seven years he was only absent from the chair on three occasions, and he personally signed nearly thirty thousand certificates. He was particularly interested in training girls in a scientific approach to home life. One of Dr. Clay's major interests was the North London Collegiate School for Girls, now at Canons Park, where he became a governor, representing the Worshipful Company of Clothworkers, in 1929, and chairman of the governors from 1938 until his death.

During both World Wars, Dr. Clay played a part in supplying the Services with optical instruments, and during the second he was attached to the Admiralty Establishment at Teddington, acting as liaison officer between it and various aircraft depots.

On retiring from the Northern Polytechnic, he took an active interest in the Islington Antiquarian and Historical Society, becoming its president in 1948. His interests also extended to the Organ Club, the Newcomen Society, the British Society for the History of Science and the Cactus and Succulent Society. For many years he was an honorary member of the British Acetylene Association.

Dr. Clay married Theodora Tilley, and in 1947 they celebrated their golden wedding.

Dr. Clay's great gifts were consecrated to great ends. He sought to help others and to make life easier and happier for them. He had the power of inspiring respect and affection in others by his cheerful and friendly personality. To all who genuinely sought his guidance he gave freely of his time and knowledge, and he leavened his many activities with a graciousness that endeared him to all.

W. L. DOUGHTY

NEWS and VIEWS

G. S. Ohm (1787–1854)

THE German physicist, Georg Simon Ohm, whose name is immortalized in the ohm, Ohm's law and the ohmmeter, died a century ago, on July 7, 1854. Son of a master locksmith, he was born at Erlangen in Bavaria on March 16, 1787, and entered the local University at the age of sixteen, but left after eighteen months because of lack of means. After holding teaching posts in Switzerland, he returned to Erlangen in 1811, graduated and taught as *Privatdozent*. In 1817 he was appointed professor of mathematics at the Jesuit's *Gymnasium* in Cologne, where by means of experiments made with great skill and care, though with poor and deficient apparatus, he established his law of the theory of the voltaic current, which he published at Berlin in 1827 under the title "Die galvanische Kette mathematisch bearbeitet". Ohm's law, which to-day is regarded as a commonplace, was far in advance of its time, and its announcement fell on deaf ears. Deeply hurt, Ohm resigned his post and led a precarious existence until after many petitions addressed to the King of Bavaria he was made professor of mathematics at the Nuremberg Polytechnic in 1833. The Royal Society of London was the first to appreciate his work, awarding him its Copley Medal in 1841 and in the following year electing him a foreign member. In 1843 Ohm announced his law on the production of complex tones by the composition of simple vibrations. In 1852 he became professor of physics at the High School in Munich, where he died of apoplexy two years later. Small in stature, feeble in body, simple in taste, he never married and lived solely for his work.

Geography at University College, Leicester: Prof. Patrick W. Bryan

PROF. PATRICK W. BRYAN retires from the chair of geography and the vice-principalship of University College, Leicester, at the end of the present session, and has been appointed the first professor emeritus of the College. He received his early training in geography and economics at the London School of Economics under the late Sir Halford Mackinder; early in his career he spent a year at the University of Chicago, where he came under the influence of the school of geography then developing—the 'human ecology' school. The advanced text-book on North America, which was the joint work of the late Prof. Rodwell Jones and Prof. Bryan, was the first in the now well-known Methuen series, and his studies on the corn belt in particular illustrate Bryan's meticulous attention to relevant detail. He will always be associated with the development of the concept of the 'cultural landscape', elaborated in his book "Man's Adaptation of Nature". He was criticized by some for seeking an easy correlation between the features of the landscape and present human occupance; but his ideas have been absorbed in modified form in much current work. Known in later years as a great exponent of visual presentation of geographical facts, his wide circle of friends will wish him a long and profitable retirement, with leisure to follow his photographic interests.

Mr. Norman Pye

MR. NORMAN PYE, senior lecturer in the University of Manchester, is to succeed Prof. Bryan. Mr. Pye was educated at Wigan Grammar School and at the University of Manchester, where he graduated with first-class honours in geography in 1935 and obtained the diploma in education in 1936. After a period as a research student at St. Catherine's College, Cambridge, he returned to Manchester in 1938, as an assistant lecturer in geography; he served in the Hydrographic Department of the Admiralty during 1940–46. He was appointed to a lectureship at Manchester in 1946 and became senior lecturer in geography in 1953. During 1944–46 he held jointly with Dr. W. G. V. Balchin a Leverhulme Research Fellowship for climatological research in Bath and district. During 1952 he received a Fulbright travel grant for research, also with Dr. W. G. V. Balchin, in geomorphology and economic geography in the Mohave and Sonora Deserts, U.S.A. Since 1950 he has been honorary assistant editor of *Geography*. He is also a member of the Council of the Institute of British Geographers and of the Council of the Royal Meteorological Society. Mr. Pye's special research interests have been in the field of physical geography, more especially in climatology and cartography, on both of which topics he has published a number of papers and has now in the press a book on the principles of cartography and surveying. He is also much interested in, and has had considerable experience of, teaching and lecturing on both economic and regional geography. He is also a first-class man in the field and has conducted field courses both in Britain and in European countries.

Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme: Awards

AWARDS under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme have been made to the following: Prof. R. H. Common, chairman of the Department of Agricultural Chemistry, McGill University, to enable him to study avian biochemistry, principally at Reading, during July–September; Dr. D. E. Coombe, Fellow of Christ's College and University demonstrator in botany, Cambridge, to enable him to visit West Africa during 1955 to study tropical forest vegetation; Dr. J. Crossland, lecturer in physiology, University of St. Andrews, to enable him to visit Montreal during August–December 1954 in order to collaborate with Dr. K. A. C. Elliott in further studies in the behaviour of acetylcholine in the brain; Mr. J. R. Howes, lecturer in animal husbandry, Imperial College of Tropical Agriculture, Trinidad, to enable him to study problems and methods of research in African animal production, at Pretoria and in Kenya, during July–September; Dr. A. P. Subramaniam, of the Geological Survey of India, to enable him to work with Prof. C. E. Tilley at Cambridge during 1955 on a petrographic study of rocks from the type charnockite area around Madras; Mrs. Patricia M. Thomas, of Adelaide, to enable her to carry out helminthological studies at Macdonald College, Canada, during July–December. These are the first awards under the scheme which was instituted last year to provide facilities for increasing the efficiency of scientific workers of proved ability by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the British Commonwealth where the physical or personal environment, or both, are peculiarly favourable.

Royal Society Research Appointments

THE Council of the Royal Society has made the following research appointments: the Alan Johnston Lawrence and Moseley Research Fellowship to Dr. D. S. Robinson (Sir William Dunn School of Pathology, University of Oxford) for work on the biochemistry of lipid distribution and transport in plasma, and its relation to the problem of atherosclerosis; Stothert Research Fellowships to Dr. B. L. Ginsborg (University College, London) for work on neuromuscular transmission, and to Miss D. Salmony (Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London) for work on the effects of sex hormones on cell metabolism; and the John Murray Travelling Studentship in Oceanography and Limnology for 1954 to P. Hughes (University of Liverpool) for study of wind drifts in the oceans.

Atomic Energy Authority

THE Atomic Energy Act, 1954, which provides for the setting up of an Atomic Energy Authority for the United Kingdom, in accordance with the recommendations of Lord Waverley's Committee (see *Nature*, 173, 459; 1954), received Royal Assent on June 4. In the debates in Parliament, concern was freely expressed as to the position of the employees of the proposed Authority, particularly in regard to the security regulations suggested in the original first schedule. When the Bill was debated in the House of Commons, satisfactory words could not be found to define the grounds on which an employee of the Authority would be referred to the purge tribunal as a bad security risk. Such a definition was needed to write into the Bill safeguards for requiring the Lord President's consent to dismissal if the tribunal should recommend it and if the Lord President agreed with it. None of those who spoke in the debate liked the reference to a man's political associations, and in the Committee stage in the House of Lords on May 19 Lord Salisbury accepted on behalf of the Government an amendment by Lord Silkin which avoids the use of these words. In accordance with this amendment, Section 4 of the First Schedule of the Act reads: "Except with the consent of the Lord President of the Council, the Authority shall not terminate on security grounds the employment of any officer of, or person employed by, the Authority. In this sub-paragraph the expression 'security grounds' means grounds which are grounds for dismissal from the civil service of Her Majesty, in accordance with any arrangements for the time being in force relating to dismissals from that service for reasons of national security". This amendment, which puts employees of the Authority in exactly the same position as Civil servants, was afterwards welcomed by Mr. G. R. Strauss on behalf of the Opposition as perfectly satisfactory, when the Lords' amendments were considered in the House of Commons on May 31, and was accepted by the House with other amendments.

At the third reading in the House of Lords on May 27, Lord Salisbury, in reply to questions from Lord Stansgate and Lord Jowitt, explained that the Estimate to be submitted to Parliament in accordance with Clause 4 of the Bill would be in two parts. The first part would cover the expenses of the small office which will assist the Lord President to discharge his atomic energy function. The second, covering some 99 per cent or more of the total, would represent the money which the Lord President would pay over to the Authority. It would be broken down under a number of headings, though the information would be rather less detailed than is usual in regard to an ordinary departmental Vote, having regard both to the need for security and to creation of a body with freedom to run its own day-to-day affairs. The exact form of presentation, said Lord Salisbury, is still being discussed, but the breakdown will not permit a distinction to be drawn between expenditure for civil purposes and expenditure for defence. For security reasons, moreover, sums included in the Ministry of Supply and Service Department Votes for payments to the Authority for work on atomic weapons will not be shown separately, but the degree of parliamentary control provided under the clause is substantially greater than has existed in the past. Referring to the importance of a proper balance of the use of atomic energy between military and civil purposes, Lord Salisbury said that this is a major reason for transfer of responsibility from the Minister of Supply to the Authority. At present none of the energy which will be created will be allocated to private industry; it will all be in the hands of the British Electricity Authority, which ultimately will transmit the electrical power to industry.

Queen Elizabeth House: a New Centre in Oxford for Colonial Studies

A NEW centre for Colonial studies is to be established in Oxford under the joint auspices of the Colonial Office and the University, and H.M. the Queen has been graciously pleased to allow it to be named Queen Elizabeth House. For some time past it has been obvious that the cultural, economic and social life of the overseas territories of the British Commonwealth for which the United Kingdom Government is responsible has been changing very rapidly, and it is imperative that relationships between the people of these territories and those of the United Kingdom (and of the Commonwealth generally) be adjusted in harmony with these changing conditions. Much has already been done by university studies and cultural contacts promoted by government and other bodies; but what has hitherto been lacking is some recognized centre, associated with the many bodies and institutions at work in this field, but not designed to supplant or interfere with their various activities. To this centre students and visitors from overseas, together with persons in Britain concerned with the problems facing the oversea territories, could come for free discussions with others who share their interests and be put in touch with those who can help them in their studies. Such a centre, in addition to the services which it could render to individuals, could provide a setting for conferences and summer schools as well as for more formal courses arranged by government or other authorities for men and women working, or intending to work, overseas. To perform these functions effectively, the centre would have to be residential and located in suitable academic surroundings.

Recently, Sir Ernest Oppenheimer offered £100,000 to the University of Oxford for the development of Colonial and allied studies, on the understanding that a centre of the kind described above would be established in close connexion with the Institute of Colonial Studies already existing in Oxford, though not exclusively linked to it in such a way as would prevent the fullest co-operation with other interested bodies. In recognition of the important part which such a centre could play in the training of Colonial Civil servants and other cognate activities, the British Government has promised a contribution towards building costs of up to £50,000 from Colonial Development and Welfare Funds. The University of Oxford is now co-operating in securing a suitable site and in establishing the centre upon it. In order that the centre may be brought into being as soon as possible, arrangements are being made for constituting a governing body on which official, academic and other interests will be represented.

New Nature Reserves in Britain

Two further nature reserves were declared on June 15 by the Nature Conservancy. The first of these consists of the Huntspill River and Huntspill sea-wall area of about 300 acres and roughly 6,000 acres of tidal mud flats near the mouth of the River Parrett in Bridgwater Bay. Steart Island will be added by a further declaration on the expiry of the existing tenancy over it next year. The mud flats are the scene of a most successful experiment in harnessing vegetation to the work of coastal defence: the introduction of *Spartina townsendii* considerably raised the foreshore-level and gave effective protection against incursions by high tides. Further experiments are planned by the Conservancy in collaboration with the Somerset River Board. The flats are also of great ornithological interest as a roosting place for wildfowl, including wild geese, and for waders, forming the only gathering ground for moulting shelducks in Great Britain. The discontinuance of existing shooting rights will provide a large sanctuary area in which wildfowl and waders can feed and roost undisturbed and build up stocks of these species.

The second new reserve, Castor Hanglands, is in the parishes of Ailsworth and Marholm, four miles west of Peterborough. It consists of 12¼ acres of mixed woodland, known as the Blacklands, and about 93 acres of rough grassland and bushes called Ailsworth Heath, which was originally recommended as a nature reserve in 1947, particularly for the rich insect life and wide range of plant life to which the soils derived from oolitic limestones and calcareous clays give rise and of which few examples remain. There are two small pools in the reserve which support a variety of aquatic vegetation, and the heaths and woodlands harbour the rare butterflies, the black hairstreak (*Strymon pruni*), the large tortoiseshell (*Nymphalis polychloros*) and the chequered skipper (*Carterocephalus palaemon*). Access to Blacklands will be by permit; but there will be no restriction on public access to Ailsworth Heath, though permits to collect will be required.

Ethnology of Saipan in the Mariana Islands

IN Vol. 14 (anthropology) of *Fieldiana* (pp. 384; Chicago Natural History Museum, 1954; 5 dollars), Alexander Spoehr discusses Saipan in the Mariana Islands, and describes Spanish, German, Japanese and recent American rule in those islands. The

Japanese sent many immigrant settlers there and built up an extensive sugar-cane industry between the two World Wars. The destruction of industry in the Second World War was complete. Saipan was an area of intense battle in which 23,811 Japanese military were killed and 1,810 taken prisoner, while the Americans lost 3,144 killed in action and 11,000 wounded. The ethnology is a description of the changing customs and habits of some Chamorro and ex-Caroline islands natives who live in Saipan.

Symposium in Dublin on Peat

An international symposium on peat will be held in the College of Science, Merrion Street, Dublin, during July 12–17, under the auspices of the Bord na Móna, the statutory corporation set up by the Republic of Ireland to develop the peat resources of the country. On the first day, after the formal opening by the Minister for Industry and Commerce, peat resources and development in each of the following countries that will be represented at the symposium will be discussed: Canada, Denmark, England and Wales, Finland, France, Germany, Northern Ireland, Netherlands, Norway, Republic of Ireland, Scotland and Sweden. Subsequent sessions will deal with the following topics: methods of survey; general and technical classification of peats; milled peat; sod peat; dehydration; large- and small-scale plants for utilization of peat; use in gas turbines; peat coke and wax; gasification; and reclamation (afforestation, and also agriculture and soil conditioning). An excursion will be made to the Bord na Móna works. Further information can be obtained from the Bord na Móna, 28 Upper Pembroke Street, Dublin.

International Union of Geodesy and Geophysics

In connexion with the tenth General Assembly of the International Union of Geodesy and Geophysics to be held in Rome during September 14–25, the sponsoring body, the Italian National Research Council, is organizing an exhibition, to be held in the same building as the Assembly meetings, of geodetical and geophysical instruments and equipment. The exhibition will be open to the public during September 13–25. Completed application forms, which can be obtained in Britain from the Assistant Secretary, Royal Society, Burlington House, London, W.1, must be sent by July 15 to the following address: Consiglio Nazionale delle Ricerche, Mostra internazionale di geodesia e geofisica, Piazzale delle Scienze, 7 – Roma (Italia).

Announcements

Sir Frederick Brundrett, deputy scientific adviser to the Ministry of Defence, formerly chief of the Royal Naval Scientific Service, has been appointed chairman of the Defence Research Policy Committee in succession to Sir John Cockcroft, who has been appointed to the board of the new Atomic Energy Corporation as director of the Atomic Energy Research Establishment.

The President of the Board of Trade has reappointed Sir Percy Mills as chairman of the National Research Development Corporation and Prof. P. M. S. Blackett, Sir John Duncanson, and Sir Edward de Stein as members for a further period. Sir Henry Hinchliffe and Sir Alan Saunders are also appointed members in succession to Sir Edward Hodgson and Mr. W. E. P. Johnson, who are retiring.

Sir John Russell has been elected a foreign member of the Académie d'Agriculture de France in succession to the late Prof. Winogradsky.

Prof. H. R. Robinson, emeritus professor of physics at Queen Mary College, has been elected vice-chancellor of the University of London for the remainder of the present session and for the session 1954–55, in succession to Sir Roderic Hill, who has resigned on medical grounds.

Dr. S. Whitehead, director of the Electrical Research Association, has been elected chairman of the Committee of Directors of Research Associations.

The Institution of Production Engineers will be holding an exhibition and conference in London at the National Hall, Olympia, during July 7–14 (closed on July 11). Besides displays by industry on production engineering research and materials, equipment and apparatus which contribute to productivity, the exhibition will contain a number of items illustrating the work of the Department of Scientific and Industrial Research, the research associations, and government departments and other institutions. The conference will consist of morning and afternoon sessions on each day of the exhibition, except July 10, when papers on various aspects of the problems of increased productivity—technical, psychological, physiological, etc.—will be read. Applications for tickets to the exhibition or conference should be made to Andry Montgomery, Ltd., 11 Avenue Chambers, 4 Vernon Place, London, W.C.1; further details can be obtained from the Secretary, Institution of Production Engineers, 10 Chesterfield Street, London, W.1.

Mr. G. Seligman, president of the British Glaciological Society, writes: "With reference to the obituary notice of Prof. A. B. Dobrowolski in *Nature* of June 12, Mr. E. Gold mentions that his great work on ice, "The Natural History of Ice", was published in Polish. However, two of the most important chapters of this work, namely, 13 and 14, were translated into English by Prof. B. W. A. Massey, of the University of Poznan, and were published in 1948 under the title "Glaciers: Structure and Movement Theories", by the Institute of Experimental Physics, Warsaw, as Supplement No. 1 to the *Bulletin of the Polish Geophysical Society*, Part 16 (Warsaw, 1939–48)".

The directors of Griffin and Tatlock, Ltd., and of W. and J. George and Becker, Ltd., have announced the merging of their two organizations, under the name of Griffin and George, Ltd. Griffin and Tatlock, Ltd., with their associated company, Standley Belcher and Mason, Ltd., manufacture scientific apparatus and laboratory furniture in London and Birmingham, and have branch houses in Manchester, Sheffield, Glasgow and Edinburgh. Griffin and Tatlock (India), Ltd., operates from Calcutta and Bombay. The name of the firm, which originated in 1826, is widely associated with laboratory apparatus under the trade mark 'Microid'. W. and J. George and Becker, Ltd., of London and Birmingham, have manufactured laboratory equipment since 1897. The original firm of F. E. Becker and Co. was founded in 1872, and was purchased by W. and J. George, Ltd., in 1897. The company produces an extensive range of products including optical and electrical apparatus and high precision balances, which are sold under the trade mark 'Nivoc'. The chairman of the new company of Griffin and George, Ltd., is R. McKinnon Wood.

FIFTH INTERNATIONAL WEST AFRICAN CONFERENCE

SCIENTISTS working in the several territories of West Africa were long hampered by lack of opportunities for contact with one another. Contiguity of territory enabled the French to extend much of their work over the whole or greater part of French West Africa; but studies in the separate British, Spanish and Portuguese areas lacked correlation. A very important function is thus served by the International West African Conference, which meets every second year, alternating between British, French, Spanish and Portuguese territories. The fifth conference was held at Abidjan (Côte d'Ivoire) during December 7–10, 1953, followed by excursions during December 11–19. Difficulties of accommodation, not the least being space on air lines, necessitated the participation being restricted to official delegates; but those present represented a wide range of interests and regions.

The conference met under the presidency of Prof. G. Mangenot, director of the Institut de Recherche Scientifique et d'Études Tropicales of the Office de la Recherche Scientifique Outre-Mer, and most of the meetings were held at the Research Station of the Institut at Adjopodoumé some 18 km. from Abidjan. Other meetings were held at the Museum and Research Station in Abidjan of the Institut Français d'Afrique Noire, the headquarters director of which is Prof. Th. Monod (Dakar). The smooth running of the conference owed everything to the organizing ability of M. J. L. Tournier, of the Institut Français d'Afrique Noire, who acted as secretary.

Delegates included a dozen from British West African territories and two from Britain (Profs. C. Daryll Forde and L. Dudley Stamp), and the conference opened with a gathering at the Palace of the Governor, followed in the evening by a brilliant and lavish reception at Adjopodoumé attended by leading citizens, both African and European, of Abidjan.

The working sections were those of zoology, botany (including forestry), geography (including geology) and ethnology–sociology (including economics). For some sessions the last two met jointly, and papers of general interest were read to plenary meetings.

It would be difficult to speak too highly of the lavish hospitality of the French hosts. A conference where delegates have no need of money at all, their every wish being anticipated by a system of vouchers, must be almost unique. The insight given into the cultural life of a remarkable tropical city with fourteen thousand white inhabitants was a revelation to many of the delegates long familiar only with their own territories. The conference was in other ways ideal in that it gave abundant opportunities for discussion amid delightful surroundings, and local excursions arranged for all interests formed a pleasant prelude to the two long excursions. Of the latter, one studied the ecology and forestry of the coastal belt, and the other undertook the long journey across to the Liberian border and the eventual ascent of the massif of Nimba.

The conference revealed in a striking way the large volume of fundamental research now in progress in West Africa. In the French territories this is now focused by the Institutes; in the British territories the influence of the University Colleges of the Gold Coast and Ibadan is very marked. Young enthusiastic scientists, not overburdened with routine teaching, are bringing to bear on African problems techniques acquired in universities all over the world. At present, those of European descent play the leading part; but Africans are beginning to take their places in the ranks of the research workers. Detailed studies ranging from the distribution of population, so bafflingly irregular, and the ecology of disease to the measurement of evaporo-transpiration and the economics of fisheries cannot fail to throw light on the innumerable problems which at present hinder the development of tropical Africa and at the moment make nonsense of 'planning'.

L. DUDLEY STAMP

THE GOLGI APPARATUS

SYMPOSIUM OF THE ROYAL MICROSCOPICAL SOCIETY

R 302

ON May 5 the Royal Microscopical Society held a symposium on "The Golgi Apparatus". The opening address was made to a large gathering by the chairman for the morning session, Dr. L. Foulds, who directed attention to the present controversy regarding the intrinsic morphology of the Golgi apparatus.

The first speaker was Prof. J. Brontë Gatenby (Trinity College, Dublin), who expressed his gratitude to the Society for its recent award to him of an honorary fellowship. He then went on to review the various controversies which have been in vogue concerning the morphology of the Golgi apparatus. The most important controversy of all, he said, arose with the vacuome theory of the Parat school (1924–33); but this work has been discredited by many cytologists. It is significant that Parat's term 'lépidosome' instead of 'dictyosome' has not been used in the new great French text-book "Traité de Zoologie". With regard to the recent controversial views, held mainly by the Oxford school, Prof. Gatenby said that on the whole, apart from their use of Parat's word lepidosome, he is in agreement with much that they have written about the structure of the Golgi apparatus of invertebrate cells. However, he cannot accept the view that the Golgi apparatus or network of vertebrate neurones is an artefact. Both Dr. T. A. Moussa and he have seen the network in living neurones, and this has been confirmed by the vital observations of the Americans Adamstone and Taylor. Similar networks have also been seen in living cells of the epididymis by Dr. A. J. Dalton and Mrs. M. Felix. In addition, these latter workers have supplied him with some remarkable electron micrographs which agree with his conception of the networks as being a series of vacuoles, compressed spaces and canals, to the walls of which a chromophile substance is attached.

Finally, Prof. Gatenby gave seven reasons why he believes that the Golgi dictyosomes of invertebrate cells may be regarded as being homologous with the

Golgi networks seen in vertebrate cells. These inclusions occupy similar positions in the undifferentiated cell; play an important part in cell secretion; can be shown by the classical technique; have the same specific gravity when ultracentrifuged; unless dispersed are attached to the centriolar part of the amphiaster at some stage in cell division; cannot be vitally stained in neutral red and methylene blue; and both have the same dictyosome-like appearance in amphibian nerve cells.

After the long paper by Prof. Gatenby, two shorter papers were given by Dr. G. H. Bourne (Department of Histology, London Hospital Medical College) and Dr. A. L. Roque (Department of Zoology, Oxford). Dr. Bourne concentrated on some chemical and biochemical aspects of the Golgi region of certain cells, and pointed out that there is good evidence to suppose that such regions, and therefore possibly the Golgi apparatus, contain lipoidal substances and polysaccharide. Also, in some cells of the adrenal cortex there is a localization of ascorbic acid which corresponds with the position usually occupied by the Golgi apparatus. There is also good evidence to suppose that the Golgi apparatus of the epithelial cells of the small intestine contain alkaline phosphatase and some other phosphatases, including one which dephosphorylates œstrogen phosphate. The epithelial cells of the mouse prostate also contain acid-phosphatase in the Golgi region. Dr. Bourne concluded that these results indicate that the Golgi region, or Golgi apparatus, is of considerable biochemical importance.

Dr. Roque made a report on a detailed study of the form of the lepidosomes (dictyosomes) in the male germ-cells of *Helix*, as revealed by phase-contrast and interference microscopy and by the use of vital dyes. He compared these lepidosomes with the lipochondria of the nerve cells of *Helix* and showed that they are distinct morphologically.

For the afternoon session, the chair was taken by the president of the Society, Dr. T. E. Wallis. Each of the four speakers in this session were from the Department of Zoology, Oxford. The first paper was read by Mr. S. A. Shafiq, who said that in the neurones of *Locusta migratoria* Kolachev preparations reveal the Golgi apparatus as a number of curved rods (dictyosomes) scattered about the cytoplasm. When lipid preparations are made the lipid appears in the form of spheroids also scattered about the cell. In order to see if any relationship exists between the two inclusions, Kolachev preparations were made, but were osmicated for only a short time. Faintly impregnated dictyosomes were seen. On colouring these sections with sudan black it was apparent that the dictyosomes were a deposit of osmium on the curved surface of the lipoidal spheroids. Further proof for this view has been adduced by a study of the developing neurone. As a result of this work, Mr. Shafiq pointed out that the dictyosomes of these invertebrate neurones, being an artefact, cannot be homologized with the Golgi apparatus of vertebrate neurones.

The next paper was read by Dr. W. G. Bruce Casselman and dealt with the histochemistry of the sites in certain cells where osmium tetroxide or silver nitrate are reduced in classical Golgi methods. The study was based on the work of Mr. Shafiq and Dr. John R. Baker, who found that the classical methods when used on the motor neurones of *L. migratoria*, and intestinal epithelial cells and Paneth cells of the mouse, were impregnating mainly lipoidal bodies. Dr. Casselman said that in the motor neurones the lipochondria (= lipoidal bodies) consist principally of phospholipids and cerebrosides. In the intestinal epithelial cells of the mouse, the lipochondria apparently contain only neutral lipids and are embedded in a neutral mucopolysaccharide. The lipoidal bodies of the Paneth cells are embedded in what is probably a mucoprotein and, in addition, are at least partly covered by neutral lipid.

The next speaker was Dr. John R. Baker, who said that a single name can be properly given to an object in a cell if there is reason to believe that it always has essentially the same structure and always essentially the same chemical composition. This does not apply to the term 'Golgi apparatus'. Not only were the 'Golgi dictyosomes' studied by Mr. Shafiq an artefact, but also they were morphologically different from the 'Golgi networks' which Dr. Baker himself had examined in vertebrate neurones. He believed, too, that these networks are an artefact produced in neurones by the over-impregnation of lipochondria. In gland cells a similar network may be an artefact of a different kind, for it may simply result from the deposition of metals on chemically modified cytoplasm between crowded secretion granules. A special study on the intestinal epithelial cells of the mouse had shown that the 'Golgi apparatus' of these cells is an artefact formed by the deposition of osmium on to the lipochondria. Dr. Baker then emphasized the work of Dr. Casselman as showing the lack of specificity of the classical Golgi methods which may reveal 'sites' of dissimilar chemical composition. He urged the discontinuance of the term 'Golgi apparatus', for there cannot be any homology, as the term implies, between objects or regions which differ both structurally and chemically. Further emphasis was placed on the unsuitability of the term 'Golgi substance', for Dr. Baker pointed out that it means nothing to anyone with a biochemical outlook.

The last paper of the afternoon was read by Dr. A. J. Cain, who discussed mainly the concept of homology at intracellular levels. He indicated that, in view of what had already been said by other Oxford workers, objects lumped under the term 'Golgi apparatus' may have been wrongly homologized due to the imperfections of the classical technique.

The chair for the evening session was taken by Dr. R. J. Ludford, and the one paper at this session was read by Mr. Dennis Lacy (Department of Zoology, St. Bartholomew's Hospital Medical College), speaking on the Golgi apparatus of the exocrine and endocrine cells of the pancreas of the mouse. He showed that the various distorting effects which the classical fixatives are supposed to have on the lipoidal bodies are erroneous, and also that the Golgi network of these cells do not result from either the over-impregnation of lipoidal bodies or from the laying-down of metals between secretion granules. Emphasis was placed on the delicate appearance of the networks of these cells as shown by Nassanov, Morelle, Gatenby, Ludford, Hirsch, Bensley, Beams and other distinguished cytologists. None has produced gross over-impregnated structures. The network of these cells was then shown to be a net-like canalicular system, distinct from lipoidal bodies, neutral-red granules or mitochondria. These canals were shown by Mr. Lacy after the use of a variety of fixatives, in frozen-dried preparations and in living cells.

Dr. Ludford then opened up the meeting for discussion. Many interesting points were raised, among which was a question by Dr. A. J. Marshall as to whether the Oxford workers had at any time, in their numerous preparations, seen a canalicular structure. Dr. Baker said that Dr. W. S. Morgan (late of Oxford) had seen the canals in fixed preparations of acinous cells of the pancreas; but that he [Dr. Baker] could not say whether or not they existed, though he could say that they should not be called Golgi bodies.

The main issue which emerged from this symposium was whether or not the term 'Golgi apparatus' (or 'Golgi body', etc.) should be used. According to the Oxford workers it denotes homology between objects believed by these workers to be mainly artefacts, the true form of which is represented by lipoidal bodies which may differ chemically from one another. The Oxford work is, however, based mainly on the results of one invertebrate cell (the neurones of *L. migratoria*) and on two kinds of intestinal cells (epithelial and Paneth). Further, their artefact theory probably cannot be accepted in at least four very different kinds of vertebrate cells (neurones, exocrine and endocrine cells of the pancreas, and epididymis cells), where the evidence from so many sources (fixed, ultracentrifuged, frozen-dried, electron microscope studies and vital examination) leaves little doubt that the Golgi network does exist in life. This latter work shows clearly, too, that the network is not represented by lipoidal bodies, and all the Oxford studies emphasizing chemical dissimilarity are studies on the lipoidal bodies. It is clear that such lipoidal bodies may not be homologous. From the classical point of view, Prof. Gatenby has given seven reasons why he accepts homology between the Golgi dictyosomes of invertebrates and the Golgi network (or canals) of vertebrates and retains the general term Golgi apparatus. The crux of the matter is whether, as yet, there is sufficient evidence of an incontrovertible nature, on a large enough number of invertebrate and vertebrate cells, to justify a change in nomenclature which will affect some two thousand papers.

A full account of the symposium and the discussion which followed will be published in the *Journal of the Royal Microscopical Society*.

DENNIS LACY

THE IMMOBILIZATION OF MINERAL NUTRIENTS IN TROPICAL SOILS

MESSRS. W. V. Bartholomew, J. Meyer and H. Laudelout, of the Institut National pour l'Étude Agronomique du Congo Belge (I.N.E.A.C.), have published a paper which should be of considerable interest to all who are concerned with the underlying causes of fertility and infertility of tropical soils (*Publ. I.N.E.A.C.*, Sér. Sci. No. 57, 1–53, 1953; 30 f.). They have tackled the problem of the immobilization of mineral nutrients under forest and grass fallow in the Yangambi region of the Belgian Congo, and they have given some attention to the decomposition of plant debris on the forest floor. Some understanding of these matters is essential to rational agricultural practice, especially in those regions where the inherent soil fertility is not very great, where it may be of a fleeting character, or where it may indeed be almost incredibly low. In the native rain forest a large proportion of the available plant nutrients is immobilized in living organisms—mostly forest trees and vines—but large quantities of plant tissue (mainly leaves and branches) are constantly being deposited on the forest floor, where they decompose and return their nutrient content to the soil. The reabsorption of these nutrients by elements in the flora and fauna is so rapid in the rain forest that, in the case of an acid sandy soil which was studied, the available supply in the soil was found to be continually kept at an exceptionally low level. The authors consider that under a plant cover with high nutrient demands, it is unlikely that many nutrients are lost by fixation or leaching.

When a forest is felled and a crop established, the transition phase is often attended by the temporary liberation of large quantities of mineral nutrients to the soil and by an accelerated loss of nitrogen, particularly if the area is burned over, as is frequently the contemporary practice. In such instances there may be a considerable, even a high, loss of plant nutrients before the crop has grown sufficiently to re-immobilize most of them. In the usual cultivation practices, however, the new crop is typically established concurrently with the disintegration and decomposition of the forest debris; but even so the utilization of all the nutrients may not keep pace with mineralization, and excessive nutrient losses may result.

Native cropping practices in the Central Congo Basin usually permit the return of forest species within 2–3 years after the forest is felled, and the ensuing fallow or regeneration period may continue for about fifteen years, where there is government supervision; but it may be considerably less. While this kind of soil management has its defects both in terms of soil fertility and labour, it "appears to be a practical solution to the soil management problems where land is in good supply, demand is not great for agricultural products, transportation to market and supply is long and costly, and where local fertilizer resources are either non-existent or not developed".

In both forest and grass fallow the authors point to two factors as being of first importance in enhancing soil fertility, namely, the accumulation of nutrients in organic combinations and the prevention of their loss by plant immobilization, and the improvement of soil structure by rest from cultivation and by biological activity.

The use of grass fallow as an alternative for short rotations has been considered, but its value in native agriculture requires fuller exploration. The maximum usefulness of grasses as fallow crops is probably attained within a few years. It has been observed that after two to four years the rate of root formation reaches a maximum and that decomposition of the grass residues proceeds as rapidly as the new growth is formed; that is, a maximum immobilization of plant nutrients in organic form has been attained. Thereafter, the chief effects of an extension of the fallow period would be to improve the soil texture.

As the immobilization of mineral nutrients may be the most important means of evaluating the usefulness of fallow systems, an investigation was carried out to obtain some indication of the actual amounts of nutrients immobilized under forest fallow conditions after different periods of time and to compare the effects of grass and forest fallows. The sites selected for sampling in the more mature forest fallow areas were approximately 10 × 30 metres. All the vegetation of suitable and representative sub-plots was collected and weighed green at the site, leaves being separated from branches and trunks from roots. Samples of these materials were duly analysed for their water, mineral and organic contents. Litter samples, subdivided into foliar and stem materials, were similarly analysed. Grass samples were taken from replicated plots of different species representative of fallow areas. It was found that the immobilization of nutrients in the forest fallow is initially rapid: in the first five years more than half the total amount immobilized in eighteen years is accounted for. Leaf growth rapidly approaches a maximum, the later increases in total growth being chiefly due to the accumulation of woody materials, especially in the aerial parts. Roots also approach a maximum at a rather rapid rate. The data at five years show 75 per cent as much growth as at eighteen years. Litter accumulation from leaf and stem residues approaches a maximum some time between eight and twelve years.

In grass fallows, it was noted that a large part of the total harvested material consisted of litter in various stages of decomposition, this being in sharp contrast to either the quantity or proportion of litter in the forest fallow plots. The total root weight in the grass fallows was considerably less than in the forest fallow, though the small and fibrous character of grass roots must here be borne in mind.

The distribution of the nutrients in the different plant parts is important. Thus, leaves comprise only a small proportion of the total weight of plant material except during the early stages; woody tissues, of both stems and roots, account for most of the total weight. In the immobilization of nutrients, however, leaves are considerably more important than woody tissue, particularly in the uptake and release of nitrogen. The woody tissues contain the major proportion of all nutrients, except in very early stages of the fallow, and are particularly important as repositories of the cations and phosphorus.

In the grass plots, it was found that the litter contained a large proportion of the plant nutrients, the roots accounting for only 10–20 per cent. Also, grass is relatively higher in phosphorus and potassium and lower in calcium and magnesium than forest fallow. In the investigators' view, for short fallow systems, the grass fallow compares favourably with the forest fallow, in that it appears to absorb nitrogen and phosphorus at a more rapid rate in the early stages of development. It could not, however, be expected to immobilize the large total quantity of nutrients found in a mature forest fallow.

The rate of nutrient release from fallow forest residues after clearing for cultivation was not specifically studied; but estimates based on the data of decomposition experiments and on a knowledge of mineralization processes of plant materials yield some points of considerable practical importance. Burning of forest fallow or grass fallow releases the immobilized nutrients immediately, a large proportion of the bases (potassium, calcium, magnesium, etc.) and phosphorus being deposited as the oxides on the soil surface; nitrogen, on the other hand, is almost totally lost into the atmosphere, either as free nitrogen or as volatile oxides. After burning, it is, of course, the availability of nutrients that is of special interest and this may present problems of some complexity. Thus, the phosphorus may be partly fixed in relatively unavailable form before the newly planted crops can absorb it; and potassium may be fixed, or lost through drainage. The available nitrogen, on the other hand, because of its release from immobilization in the woody tissues, may be higher immediately after burning than where the vegetation is simply allowed to decay. In general, if the fallow vegetation cover is not burned, its nutrients will tend to be retained in organic combination until they are released by the action of micro-organisms. The major part of the nitrogen, phosphorus and other mineral nutrients is rapidly liberated in mineral form, but, simultaneously, these are taken up again in the synthesis of the cellular materials of the invading micro-organisms. The net difference between mineralization on one hand and this new immobilization on the other gives a measure of the nutrients available for use by crop plants. During vegetable decomposition, potassium and phosphorus are lost more rapidly than nitrogen. In plant residues and in micro-organisms, the ratio of nitrogen to phosphorus approached 7–8 : 1. In soil organic matter Pearson and Simonson found ratios ranging from 7·0 : 1 to 15·7 : 1 with a mean of about 9·3 : 1. The authors record that the litter from the forest fallow plots, and litter gathered from the native forest, had a nitrogen to phosphorus ratio of about 25 : 1. In the residue from the decomposition of the mixed forest leaves the ratio was 32 : 1, and in the decomposed litter from the grass plots it was 12 : 1. They consider that it is unlikely that nitrogen could be rapidly liberated during the initial stages of decomposition of forest or fallow vegetation, as the organisms causing decomposition will initially re-absorb a part of it. Hence, burning the fallow vegetation may actually result in a better nitrogen supply during the early stages of utilizing forest or fallow land than natural decomposition after felling but without burning.

The release of phosphorus from decomposing vegetation is likely to be more rapid than that of nitrogen; and potassium, calcium and magnesium should be rapidly released because of their relatively low utilization in the metabolism of micro-organisms. In the case of potassium this rapid loss was demonstrated experimentally. But calcium and magnesium, though they are liberated and made available, form various insoluble salts, for example, carbonates, sulphates and phosphates. They are not removed by leaching and remain as a part of the decomposed residue. This property makes difficult the measurement of mineralization. The authors conclude that mineralization of nitrogen and phosphorus from grass fallow will, in general, be more rapid than from forest fallow. Potassium from grass fallow will be similar to that from forest fallow, but in each case the rate of release would be related to the total quantity immobilized. Calcium and magnesium were found to be low in the grass samples examined and therefore are not likely to be supplied rapidly from such fallow systems. They also point out that the decay of forest residues may not provide a balanced nutrient supply for some crops and that the relative concentration of available nutrients may undergo important changes during the course of the decomposition; for example, nitrogen may be immobilized to a much greater extent than the other nutrients. The liberation of the elements through biological decomposition is a slow process and in 4–6 months forest fallow residues may yield no more than 30 to 50 per cent of the total potassium or calcium and magnesium, and 15–30 per cent of the total phosphorus, while the percentage release of nitrogen may be even smaller.

TOBACCO RESEARCH BOARD OF SOUTHERN RHODESIA

NEW HEADQUARTERS STATION AT KUTSAGA

By Dr. F. A. STINSON

Director of Tobacco Research, Southern Rhodesia

TO solve the production problems of the expanding tobacco industry in Southern Rhodesia, the growers and Government jointly established in 1950 the Tobacco Research Board. Interest and confidence of growers in results of research have been considerable, owing to their representation on the Board and to the direct financial contribution they make toward it—more than £2 for every £1 provided from general taxation.

The Board's research approach is agronomic in its broad sense, and the investigations on crop rotations serve to illustrate this. Comprehensive rotation experiments were developed owing to the inadequacy of systems of cropping used on farms in all tobacco-growing areas. Their design permits comparing the effects, on yield and quality of tobacco, of growing many different crops in various sequences with a range of fertilizer practices, management and methods of crop disposal. Study of crop nutrition, soil organic matter and methods of disease, insect and eelworm control is also an integral part of these projects.

Experiments of lattice and factorial designs are used extensively to examine effects of inter-related production factors. Simultaneous examination of the important factors bearing on a specific problem has helped to minimize the dissipation of energy which would otherwise result if, in evaluating methods of controlling a leaf spot disease, for example, such important factors as date of planting, soil fertility and the effects of cropping systems on eelworm incidence were overlooked.

The excessive drainage and excellent aeration that make Rhodesian sandvelds so suitable for flue-cured tobacco pose special problems in humus replenishment and fertility maintenance. The abundance of available nutrients required for rapid growth and economic yields, along with the sensitivity of leaf quality to changes in nutrient balance, give nutritional research—both in the field and in the laboratory—a high priority in the programme. Present fertilizer investigations include examination of rates of use and sources of nitrogen, phosphorus, potassium and magnesium. Methods of fertilizer placement and the efficiency of nitrogen and potassium when applied fractionally, as well as responses to trace elements applied singly and in combinations, are being examined. Disease, insect and eelworm control investigations occupy an important place in the Board's work. Methods of producing tobacco seedlings, as well as cultural and curing practices, receive attention. The varietal improvement work includes testing and comparing the ability of particular varieties to produce high quality and yield, as well as evaluating their resistance to various diseases and types of eelworm damage. Breeding work in progress is designed to introduce resistance or immunity while, at the same time, further improving the leaf qualities of those varieties now in common use for commercial production. By introducing improved varieties, materials and methods as standard treatment in all field experiments as soon as their superiority is indicated by research, such factors are proved on a farm scale before being offered to farmers in the form of recommendations.

The procedure in laying out field experiments has been standardized within the organization. Fields are divided into ranges and permanently benchmarked to accommodate 60-ft. rows of tobacco. Plots differ in width only; the number of rows per plot varies from one to eight, depending on the nature of the experiment. A permanent system of roadways and surface drainage is provided by placing the 60-ft. wide ranges 25 ft. apart, each intervening strip consisting of a broad-based terrace and a broad, shallow channel. The direction of ranges to field slope is adjusted so that the fall in the rows of tobacco and in the drainage channels ensures surface drainage without causing erosion. Ant-heaps up to 100 ft. in diameter and rock outcrops, common in Rhodesian tobacco-farming districts, complicate the siting of field experiments.

An important stage in the organization's development was marked by the formal opening of the Kutsaga Station on January 21 this year. This Station, which is near Salisbury, is now the headquarters of the Tobacco Research Board. Before Kutsaga was established, the Trelawney Station, opened by the Government in 1934 and leased to the Board in 1950, was the centre of tobacco research, and it will be operated in future as a branch station.

Kutsaga occupies 585 acres alongside the new national airport, ten miles south of the Federal capital. The research building provides spacious chemical and biological laboratories, a library, staff canteen and stores; the addition of two laboratory wings is anticipated. The laboratories are fitted with electricity, gas and hot and cold water. The Cape-Dutch design of the building blends with its natural surroundings of indigenous trees on a sandy slope typical of those in much of the tobacco-growing region. The slate roof, the teakwood terrazzo floor and the mukwa panels and fittings are in keeping with the importance of the country's largest industry which the Board serves. At the rear of the main building is a 100-ft. greenhouse and headhouse containing a laboratory and storage and potting room. Farm buildings for handling, curing and grading leaf from experimental plots were ready for the 1953–54 crop. Modern residences have been erected on the Station for key staff members, and substantial brick homes, with modern plumbing and sanitation, are being provided for all African employees and their families.

Staff are encouraged to obtain postgraduate experience outside Rhodesia, the Board's paid study-leave scheme being designed to facilitate this advanced training. There are also bursaries to assist above-average Rhodesian students to qualify at leading universities preparatory to employment by the Board. At present the Board has a professional staff of fifteen, including a biometrician.

The Board is aware of the importance of keeping the sponsors, especially tobacco growers, fully informed on the progress made. The frequent publication of reports of progress, bulletins and interim reports, as well as the preparation of material for the Press and radio, is regarded as an integral part of the work. The new facilities at Kutsaga will contribute to progress in all branches of the present programme.

The land and buildings at the Kutsaga and the Trelawney Stations have permitted the development of research on most phases of tobacco production. More than four thousand plots were employed in the field experiments during the 1953–54 season. Lack of research information previously retarded development of Southern Rhodesia's flue-cured tobacco industry; but already the growers are extensively adopting with advantage the results of current research.

INDUSTRIAL RESEARCH AND DEVELOPMENT IN THE UNITED STATES

A SURVEY of industrial research and development in the United States conducted in 1952 by the Research and Development Board of the Department of Defense has been issued by the United States Department of Labor*. The report is based on a questionnaire sent to private companies and non-profit research agencies (excluding colleges and universities, as well as hospitals and museums). Some ninety-six thousand research engineers and scientific workers were employed in January 1952 by the two thousand companies which replied, and nearly 75 per cent of these were working for firms engaged in the aircraft, electrical machinery, chemicals and allied products, professional and scientific instruments, machinery (except electrical) and petroleum-refining industries, more than half being employed in the first three of these industrial groups. Two out of three engineers and scientists were on the staffs of companies with five thousand or more employees; but only 1·5 per cent of the employees of the reporting companies were research engineers or scientific workers. About half of them were working on federally financed projects, almost all of which were sponsored by the Department of Defense or the Atomic Energy Commission, and the number so employed was more than 50 per cent higher in January 1952 than in January 1951, although employment on company-financed research increased in most industries during the year. On an average there were 1·5 support workers (technicians and other laboratory assistants, clerical and administrative staff) per research engineer or scientist; but the ratio varied widely between companies and industries.

The annual turnover of this research staff during the year July 1950–June 1951 was 13·9 per cent, or about one-fifth higher than during the last half of 1951, when military service only affected about 3 per cent, although one-fourth of the research staff covered by the study were in the categories most liable to military service, 19 per cent were in the Reserves or National Guard, and another 6 per cent were classified 1 *A* or 2 *A* by Selective Service as of January 1952.

Expenditure of the reporting companies on research and development in 1951 was nearly 2,000 million dollars, compared with a national expenditure on scientific and engineering research and development of about 3,750 million dollars, of which about 2,500 million dollars was for work done in laboratories and other facilities owned or operated by private industry. Of this 2,000 million dollars, more than 1,000 million was spent by the electrical machinery, aircraft and chemical industries, and nearly half of the 1951 research and development expenditure was provided by the Federal Government, ranging from 85 per cent in aircraft manufacture to 3 per cent in petroleum refining. Such research accounted for about three-fifths of the total in companies with less than five hundred employees, compared with about one-half for larger organizations. Research costs amounted to about two per cent of the total value of sales of the reporting companies in 1951, reaching 13 per cent in the aircraft industry but falling to less than 1 per cent in several others. The average cost per research scientist or engineer in 1951 was 21,900 dollars, being lowest in the chemicals and allied products industry and nearly four times as great in the motor-vehicle industry. Taking supporting workers into account, the average cost per research worker was 8,800 dollars, a ratio which varied much less among industries and companies than that for research scientists and engineers.

CAMBRIDGE OBSERVATORIES

REPORT FOR 1953

THE report of the Observatories Syndicate of the University of Cambridge for the year ending September 30, 1953, includes the following headings: reconstruction and re-equipment; solar research; stellar photometry; optics; other investigations; buildings and grounds; lectures; and published papers. The following are the more outstanding items in the report for which there is space in this short article to mention. After exhaustive tests by Drs. H. von Kluber and Z. Suemoto, the spectrograph in the new solar tunnel has been completed and put into use. The grating in the instrument, a modern one lent by the Mount Wilson Observatory primarily for the 1954 eclipse, has proved far superior in general optical quality to any other possessed by the Observatories. The installation of the new 17–24 in. Schmidt telescope which has replaced the Huggins refractor is almost complete, and the telescope is being tested and adjusted. Among the programmes of work proposed for this instrument, an immediate one is the examination and identification of radio sources. The construction of the new 36-in. reflector is continuing, and the firm of Sir Howard Grubb, Parsons and Co. estimates that delivery should take place this autumn.

Solar work is primarily concerned with the problem of the structure of the outer layers of the sun, and in the new solar tunnel Drs. von Klüber and Suemoto have applied a Fabry–Perot interferometer to the measurement of profiles of well-isolated Fraunhöfer lines (in the wave-length region 6200–6400 A.) between the centre of the solar disk and the limb, using a resolving power of about one million. Among other items mentioned, reference may be made to a solar camera of 6 in. aperture and 40 ft. focal length, weighing about 100 lb. with power supplies included, which has been designed by Drs. D. E. Blackwell and D. W. Dewhirst. It is intended to be carried by a balloon to a height of 60,000 ft. or more, and should turn automatically towards the sun, focus itself and take a series of photographs in practically perfect seeing with the theoretical resolution of a 6-in. telescope. Tests are now being carried out with the camera swinging on a rope attached to a mast, and later tests may be made with the use of a helicopter.

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* Scientific Research and Development in American Industry: a Study of Manpower and Costs. Bulletin No. 1148 of the Bureau of Labor Statistics, U.S. Department of Labor. (Washington, D.C.: Government Printing Office, 1953.) 50 cents.

The 15° Selected Areas programme of *pg* and *pv* magnitudes of 1,268 stars, measured photographically and in part also photoelectrically, has been ready for printing since early in the year; but some delay has arisen from the difficulty in finding funds for publication.

Dr. E. H. Linfoot has made an analytical determination of the optimum aberration balancing in aplanats and in astigmats when optical performance, including chromatism, is assessed on the basis of a root mean square criterion of image quality. An account of this work is appearing in his forthcoming book, "Recent Advances in Optics" (Oxford: Clarendon Press). Dr. G. Merton's trials at the Oxford University Observatory of the reconstructed two-plate Schmidt–Cassegrain camera of 8 in. aperture have proved very successful, the smallest fully exposed stellar images being about 15 μ in diameter.

During the year 119 lectures were given by the director, Prof. R. O. Redman, and four other members of the staff, and the Observatory Club held twelve colloquia. The list of published papers includes "A Comparison of the Intensities of Infra-Red and Violet Radiation from the Solar Corona at the Eclipse of 1952 February 25" (*Mon. Not. Roy. Astro. Soc.*, 112, No. 6, 652; 1952), by D. E. Blackwell; "Den Totale Solformørkelse Den 25 Februar 1952" (*Nordisk Astro. Tidsskr.*, No. 1, 1953), by H. von Klüber; and "The Continuous Spectrum of a Prominence observed at the Total Solar Eclipse of 1952 February 25" (*Proc. Kon. Ned. Ak. Wet.*, 55, 598; 1952), by R. O. Redman and H. Zanstra.

ASSAY OF TRITIUM-LABELLED SUBSTANCES: A 'COMBUSTION BOMB' METHOD OF PREPARATION OF GAS FOR COUNTING

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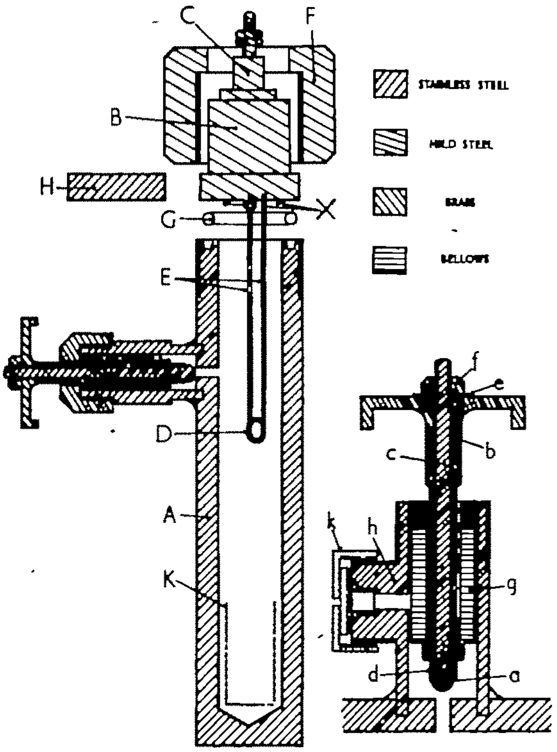
THE estimation of tritium, using the gases generated by the reaction of 'active' water with aluminium carbide as the filling for a proportional gas counter, has been described by White, Campbell and Payne[1]. A method has now been developed which enables the gas to be prepared from tritium-labelled substances in about one hour. Combustion of the samples is effected in oxygen under pressure, in a metal bomb, in which the gas mixture used for counting is afterwards generated.

The combustion bomb is illustrated in Fig. 1, and consists of a body *A* and head assembly *B*, *F*. The body is a cylindrical vessel of stainless steel ('Staybright FMB' supplied by Messrs. Firth Vickers) turned from the solid (internal diameter 0·937 in., external diameter 1·625 in. and internal length 7·125 in.).



Brazed to the body is a valve, consisting of a stainless steel ball *a*, and a seat, machined in the side of *A*. The ball is moved by the threaded brass sleeve and knob *b*. One end of *b* bears against the cup *d*, and the other against the washer *e*. A self-locking nut *f* is screwed on to the end of the non-rotating shaft *c*. The sleeve and shaft are enclosed by the metal bellows *g*, which forms a gas seal.

The valve outlet is threaded to receive a standard hand-tightened vacuum connector, and is covered by the cap *k*, when the bomb is heated in steam.

The head consists of a block *B*, into which is screwed a diesel engine heater plug *C* (*KLG* type 737). The plug filament, *D*, is mounted on two monel metal rods, *E*, 4·5 in. in length. The block *B* is brazed to the end of the heater plug at *X*, and the inner face of the unit is chromium plated. *B* is clamped to *A* by the screwed collar *F*, and the silicone-rubber ring *G* forms a gas seal. *B* is replaced by a stainless steel disk, *H*, during evacuation and gas generation.

The sample, the size of which is adjusted to yield about 300 μl. of water, is attached to the filament as described below. The body *A* is dried immediately before use in an oven at 105° C., and while it is still hot, *B* is placed in position and secured by the collar *F*. Oxygen is then introduced to a pressure of 250 lb. per sq. in. The bomb is inverted and current passed through the filament to ignite the sample. The lower part of the bomb is cooled for 5 min. in a 'dry-ice' – propanol mixture, after which the pressure is released. The head is removed, a glass tube containing 3 gm. of aluminium carbide is introduced, and the body is sealed with the disk *H*. The pressure in the bomb is reduced to less than $1 \cdot 5 \times 10^{-2}$ mm. mercury, the valve is closed, and the outlet covered by the cap *k*. The gas for counting is now generated by heating the bomb for 30 min. in a domestic pressure cooker at 20 lb. per sq. in. Finally,

Sample	Result
1. Active water standard	122 ± 0·34* counts/sec.
" " " × 1/2	62·7 ± 0·13 " "
" " " × 1/6	21·5 ± 0·16 " "
" " " × 1/12	11·0 ± 0·11 " "
" " " × 1/24	6·04 ± 0·087 " "
	1·00 ± 0·009 " "
2. Water from filter paper combustion 312 μl. + standard 20 μl.	14·1 counts/sec. (calc. 14·1)
3. Filter paper 492 mgm.: 496 mgm.	f† = 0·566 : 0·567
Cigarette papers (10) 480 mgm.: 483 mgm.	f = 0·534 : 0·535
4. Tritium labelled DL-leucine from paper chromatogram (64 μgm.)	148 ± 1·3 μc./gm.
5. Rat serum protein fractions:	
albumin	7·24 ± 0·038 counts/sec.
a globulin fraction	2·65 ± 0·10 " "
blank (519 mgm. paper)	1·02 " "
6. Rat skeletal muscle:	
462 mgm.	126 counts/sec. f = 0·619
381 mgm.	123 " " f = 0·605

* Errors shown are standard errors calculated from three determinations.

† f = isotope dilution, or water equivalent of the material.

the bomb is cooled in tap water, and the gas transferred to the counter tube[1].

Attention has been given to the assay of substances separated on filter paper by chromatography and electrophoresis, since these methods are very useful in work with small samples, such as are obtained from experimental animals.

The paper carrying the sample is folded, and wrapped around the filament *D*, and held in position by a loop of tungsten wire. Samples in powder form (for example, dried tissue) are enclosed in cigarette paper, and similarly attached to *D*. Materials ignited in this way yield clear water after combustion, with no visible traces of carbon. Similar samples held in a crucible, on the filament, were found to be incompletely oxidized.

The results of the first series of tests shown in the accompanying table are the activities of gas, generated in the manner described, from 300-μl. amounts of dilutions of standard active water. It was found that the same isotope dilution occurred when the standard was diluted with water produced by combustion of filter paper (Exp. 2). Samples of the types of paper used in assays were burned, together with added amounts (40 μl.) of standard, in order to determine their isotope dilution (*f* in Exp. 3). Whatman No. 3 *MM* filter paper was dried to constant weight in a current of hot air before combustion.

The tritium-labelled DL-leucine, used in Exp. 4, was prepared by reduction of ethyl 2-acetamido-2-carbethoxy-4-methyl-pentanoate, by adaptation of the method of Albertson and Archer[2]. It is hoped to publish details of this preparation later.

A rat (230 gm.) was given 47 mgm. (7 μc.) of the DL-leucine (dissolved in 1·2 ml. water by addition of the minimum amount of sodium carbonate) by intraperitoneal injection. The animal was killed after 16 hr., a sample of blood collected, and portions of skeletal muscle were dried in a vacuum desiccator. Serum protein fractions (Exp. 5) were obtained by electrophoresis of 97-μl. samples on Whatman 3 *MM* paper. Naphthalene black was used for locating the fractions. Results are given in the table of assays of the albumin, and the most prominent of the globulin fractions, and also a 'blank' sample of the paper immediately in front of the albumin. The skeletal muscle had a lower specific activity than the substances described above, and it was necessary to combust larger amounts. The dried tissue was enclosed in cigarette paper, as previously described. The observed count-rates of the muscle must be corrected to allow for the isotope dilution due to the small amount of paper present. If the correction is made on a weight-for-weight basis, a small error is involved (1·8 per cent and 2·3 per cent in this case), due to the unknown isotope dilution of the muscle. Accordingly, 74 mgm. of muscle was combusted with 409 mgm. of filter paper of known isotope dilution (Whatman 3 *MM*), and a count-rate of 20·9 counts/sec. was observed. This result, in conjunction with the observed count-rates of the 462-mgm. and 381-mgm. samples, respectively, led to the estimates of isotope dilution and activities given in the table.

The simplicity of this method, together with the satisfactory results from the range of materials assayed, indicates that it will be very suitable for routine use.

We would like to thank Prof. B. S. Platt for his interest in this work, and Mr. C. Brown for constructing the apparatus and for valuable suggestions as to its design. [April 12.

[1] White, D. F., Campbell, L. G., and Payne, P. R., *Nature*, 166, 628 (1950).

[2] Albertson, N. F., and Archer, S., *J. Amer. Chem. Soc.*, 67, 308 (1945).

NARCOTICS AND BRAIN RESPIRATION

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It is now well known that narcotics at low concentrations exercise much larger inhibitory effects on the respiration of stimulated nerve than on that of the unstimulated preparation. Bronk and Brink[1] have shown that the rate of oxygen uptake of resting frog nerve is reduced 15 per cent by 2 m*M* chloretone, but that the increment in the rate of oxygen uptake by nerves carrying impulses at the rate of 50 impulses/sec. is decreased 50 per cent by the same quantity of narcotic. McIlwain[2] has demonstrated that narcotics, such as the barbiturates and chloral, inhibit the respiration of electrically stimulated slices of cerebral cortex at concentrations that have but little perceptible effect on the respiration of the unstimulated tissue. He has also shown[3] that stimulation of the respiration of cerebral cortex by potassium ions and by 2 : 4-dinitrophenol renders the respiration more sensitive to the action of barbiturates and chloral. Buchel[4] has pointed out that removal of calcium ions has effects on brain cortex respiration and narcotic sensitivity similar to those due to excess potassium ions.

It is the purpose of this article to describe further results bearing on the sensitivity of brain cortex *in vitro* to narcotics, under conditions where brain metabolism has been affected by the presence of potassium ions and 2 : 4-dinitrophenol. The narcotics examined include luminal (phenylethyl barbiturate), pentothal, chloretone and ethanol.

Experimental procedure. The experimental work was carried out using the conventional Warburg manometric apparatus. Rat brain cortex was largely used in the experiments to be described; but guinea

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* On study leave from the Indian Council of Medical Research.

Table 1. EFFECTS OF POTASSIUM CHLORIDE AND 2 : 4-DINITROPHENOL ON THE SENSITIVITY OF RAT BRAIN CORTEX RESPIRATION TO LUMINAL AND CHLORETONE

Narcotic used	Without KCl		With KCl (0·1 *M*)		Without DNP		With DNP (2·5 × 10^{-4} *M*)	
	Q_{O_2}	Per cent inhibition	Q_{O_2}	Per cent inhibition	Q_{O_2}	Per cent inhibition	Q_{O_2}	Per cent inhibition
Luminal								
0	12·4		23·5		13·8		25·0	
1·7 m*M*	10·0	19·3	14·8	37·0	11·2	18·9	15·2	39·2
3·3 m*M*	7·5	39·5	10·5	55·3	8·8	36·3	10·0	60·0
Pentothal								
0	12·0		17·2		11·8		19·2	
0·1 m*M*	13·5	Nil	13·2	23·2	12·2	nil	13·8	28·1
1·0 m*M*	10·9	9·1	10·9	36·6				
Chloretone								
0	12·6		21·3		12·2		23·4	
1·4 m*M*	10·5	16·7	13·2	38·0	10·6	13·1	14·5	38·0
2·8 m*M*	8·5	32·6	9·7	54·5	8·8	27·8	10·5	55·1

Vessel contents: slices of rat brain cortex (approximately 90 mgm. fresh tissue) in 3 ml. Ringer–phosphate–glucose (0·01 *M*) medium, containing additions shown in table. The respiratory activities cited are those obtained thirty minutes after addition of the narcotic

pig cortex has also been used with similar results. The animals (body weight 150–250 gm.) were killed by decapitation, the brains removed and cortex sections cut with a Stadie–Riggs slicer. The slices were weighed wet immediately and dry weight calculated by a factor determined by drying a known quantity of wet tissue to constant weight at 110°. The slices (average 90 mgm. wet weight) were allowed to respire at 37° in oxygen in a medium of the following composition: NaCl, 128 m*M*; KCl, 5 m*M*; $CaCl_2$, 0·6 m*M*; $MgSO_4$, 1·3 m*M*; KH_2PO_4, 1·3 m*M*; Na_2HPO_4, 10 m*M*, brought to *p*H 7·4 with *N* HCl. The medium contained glucose (0·01 *M*) except when otherwise stated.

Carbon dioxide liberated during respiration was absorbed by potassium hydroxide in the centre wells of the manometric vessels.

A solution of the narcotic or of potassium chloride (or 2 : 4-dinitrophenol) or of a mixture of both was usually placed in the side tube of the manometer vessel, and was tipped into the medium containing the brain cortex slices when the respiration of the latter had obtained a constant rate, usually about thirty minutes after the commencement of the experiment. Readings of the rate of oxygen consumption were then taken every ten minutes for one hour.

Effects of luminal, pentothal and chloretone on rat brain cortex respiration in presence of added potassium ions. The considerable increase in respiratory activity of brain cortex due to the addition of 0·1 *M* potassium chloride[4] is seen in typical results given in Table 1. The presence of luminal brings about an enhanced inhibition of the rate of respiration in presence of 0·1 *M* potassium chloride, the increase of inhibition above that obtained in absence of potassium chloride amounting to more than 90 per cent at a concentration of 0·0017 *M*. A similar phenomenon is observed when chloretone is used as the narcotic. These results are in accord with those reported by McIlwain[5]. Although the percentage inhibition of the rate of respiration, in absence of the added potassium ions, is directly proportional to the amount of narcotic present, this is not the case in the presence of 0·1 *M* potassium chloride. Here, the increase of inhibition of respiration falls off as the amount of narcotic is increased. Similar conclusions apply to chloretone when this is used at low concentrations (Table 1).

As an example of a barbiturate that has been claimed[6] to exert its effects by uncoupling of phosphorylation and not by oxidative inhibition, pentothal may be cited. This narcotic, which has little or no inhibitive effect at low concentrations on the respiration of brain cortex *in vitro* and may even show a stimulation, is a potent inhibitor, at the same concentrations, when the brain cortex is stimulated by potassium ions. Typical results may be seen in Table 1. The inhibitive effect of this narcotic increases with its concentration, and it has not been observed to give a stimulation with brain cortex in presence of 0·1 *M* potassium chloride, such as may occur with brain cortex in absence of added potassium ions. Conceivably, the stimulation shown by low concentrations of pentothal with brain cortex in the absence of added potassium ions is due to an oxidation of, or a catalysis by, the thiol group of this narcotic.

While these results make it apparent that brain cortex respiration is made much more sensitive to the inhibitive action of narcotics by the presence of 0·1 *M* potassium chloride, another conclusion, not hitherto commented upon, may be drawn from them. The data of a number of representative experiments given in Table 2 make it clear that the presence of the narcotic greatly diminishes the stimulating action of added potassium ions. Thus, whereas the average increase of the respiratory rate of rat brain cortex in a glucose–phosphate medium due to the addition of 0·1 *M* potassium chloride amounts to 70 per cent during the first half-hour after addition of the salt, the increase only amounts to 12 per cent when 0·0033 *M* luminal is present. In no case has it yet been observed that the addition of luminal (or pentothal or chloretone) reduces the rate of respiration of rat brain cortex in presence of 0·1 *M* potassium chloride below that found in the absence of added 0·1 *M* potassium chloride. If the effect of added potassium ions is simply to render the brain cortex more sensitive to the action of the narcotics, it would be expected that respiratory rates *lower* than those found in the absence of added potassium would be found. We have not yet found this to occur. The results, in fact, indicate that the inhibitive action of the narcotic at low concentrations is *restricted* to that

Table 2. EFFECTS OF LUMINAL ON RAT BRAIN CORTEX RESPIRATION IN PRESENCE OF POTASSIUM CLORIDE

Additions	Q_{O_2} Without added KCl	Q_{O_2} With added KCl 0·1 *M*	Average per cent increase of Q_{O_2} due to KCl
Glucose	14·5 12·6 11·5	24·5 20·0 21·0	70
Glucose + luminal 3·3 m*M*	9·5 7·4 6·9	10·5 8·5 7·8	12

Table 3. EFFECT OF CHLORETONE ON THE KCl-STIMULATED RESPIRATION OF RAT BRAIN CORTEX SLICES IN PRESENCE OF DIFFERENT SUBSTRATES (0·01 M)

Substrates	Qo_2 No chloretone present	Qo_2 In presence of 3·3 mM chloretone	Per cent diminution in Qo_2
Glucose			
Without KCl	12·5	8·3	33·5
With KCl	20·5	9·2	55·1
Fructose			
Without KCl	12·6	8·5	32·5
With KCl	20·0	9·5	52·5
Sodium pyruvate			
Without KCl	13·2	10·0	24·2
With KCl	18·8	11·2	40·4
Sodium lactate			
Without KCl	11·8	9·5	20·0
With KCl	16·8	10·2	40·0
Sodium L-glutamate			
Without KCl	7·5	5·0	33·3
With KCl	7·0	5·0	28·5
Sodium succinate			
Without KCl	10·8	10·5	3·0
With KCl	9·0	8·5	5·5

Vessel contents: conditions as in Table 1 except that glucose is replaced by other substrates. Respiratory activities recorded are the average over the first 30 min.

aspect of brain cortex metabolism which is stimulated by potassium ions. Another way of expressing the same result is to state that the stimulating action of potassium ions mainly operates on that aspect of brain cortex metabolism which is inhibited by narcotics at low concentrations.

The stimulating effect of the presence of 0·1 M potassium chloride on brain cortex respiration is seen not only with glucose as combustible substrate but also with fructose, sodium pyruvate and sodium lactate[4]. With all these substrates, the increased effect of the narcotic in diminishing the respiration stimulated by potassium chloride is observable. Typical results with chloretone (0·0033 M) are shown in Table 3. It will also be observed that there is but little stimulating effect of the added potassium ions on the respiration of brain cortex in presence of fructose, lactate or pyruvate when the narcotic is also present.

When sodium L-glutamate is present as substrate in place of glucose, no stimulating effect of added potassium on the respiration is found[6] nor is the narcotic effect increased (Table 3). Moreover, when sodium succinate is present as substrate, neither stimulation of the rate of respiration by added potassium ions nor increased sensitivity of the respiration to the narcotic, within the experimental error of these observations, is observable (Table 3).

A fact supporting the conclusion that both the inhibitive activity of narcotics and the stimulating effect of potassium ions are directed to the same aspect of brain respiration is the observation that homogenized brain tissue in presence of glucose has a respiration which is neither stimulated by 0·1 M potassium chloride nor inhibited by low concentrations of narcotics.

A possible explanation of these results is that the presence of high concentrations of potassium ions catalyses the processes of formation of energy-rich phosphates, such as adenosine triphosphate[7], which in turn enhance the rates of oxidation of glucose or pyruvate[8]. Granting these facts, and the correctness of the conclusion that narcotics at low concentrations block oxidative synthesis in the brain of adenosine triphosphate[9] and pyruvate oxidation[10], it is apparent that, in the presence of narcotics, the stimulating effect of potassium ions will be reduced or eliminated. It follows, too, if this view is correct, from the results given in Tables 2 and 3 that a considerable fraction of the respiration of brain cortex is neither narcotic-sensitive (for low concentrations of narcotics) nor responsive to the presence of high concentrations of potassium ions.

It is of considerable interest in this connexion to recall the observations of Lipsett and Crescitelli[6], who have shown that the potassium stimulation of oxygen uptake by rat brain is inhibited by the addition of 0·01 M citrate, α-ketoglutarate, L-glutamate or succinate. The suggestion made by the authors is that these substances (the oxidation of which is not stimulated by 0·1 M of potassium chloride) yield large amounts of high-energy phosphate during their metabolic breakdown. It is, however, also possible that these substances, by competition with glucose or pyruvate for common carriers in brain respiration, may have sparing effects on the utilization of glucose or pyruvate and thus diminish the potassium stimulation. This is obviously a matter for further investigation. Reference should also be made to the work of Kimura and Niwa[11], who have shown that the potassium stimulation of brain cortex respiration is inhibited by malonate, which has relatively little effect on the unstimulated respiration. This would indicate that the narcotic-sensitive respiration is also highly malonate-sensitive, a fact which is consistent with the conclusion that the stimulated phase involves the oxidation of carbohydrate (or pyruvate) through the operation of the citric acid cycle.

Effects of luminal, pentothal and chloretone on rat brain cortex respiration in presence of 2 : 4-dinitrophenol. The increased respiration of rat brain cortex in presence of 2 : 4-dinitrophenol ($2·5 \times 10^{-5}$ M) is, like that due to excess potassium ions, highly sensitive to the inhibitory action of narcotics. Typical results are shown in Table 1 and are in agreement with the results of McIlwain[3] obtained with guinea pig brain. Again, it is clear that in the presence of small concentrations of narcotics the stimulatory effect of 2 : 4-dinitrophenol is greatly reduced. A comparison of the effects of potassium ions and of 2 : 4-dinitrophenol on rat brain cortex respiration is given in Table 4.

An explanation similar to that given for the results with 0·1 M potassium chloride may apply to those obtained with dinitrophenol. Recent evidence[11] makes it likely that the accelerative effects of 2 : 4-dinitrophenol are due to an increase in the rate of breakdown of adenosine triphosphate to adenosine diphosphate, which by acting as phosphate acceptor serves to stimulate oxygen uptake. Here again, if the narcotic blocks oxidative synthesis of adenosine

Table 4. EFFECTS OF POTASSIUM IONS AND OF 2 : 4-DINITROPHENOL ON RESPIRATION OF RAT BRAIN CORTEX IN PRESENCE OF NARCOTICS

System	Per cent increase of respiration due to KCl (0·1 M)	Per cent increase of respiration due to DNP ($2·5 \times 10^{-5}$ M)
Glucose only	55	55
Glucose + luminal 1·7 mM	10	15
Glucose + luminal 3·3 mM	5	8
Glucose + chloretone 1·4 mM	10	12 to 15
Glucose + chloretone 2·8 mM	4	10
Glucose + ethyl alcohol 0·02 M	15	10
Glucose + ethyl alcohol 0·2 M	10	8
Glucose + ethyl alcohol 0·4 M	7	Nil

The values given in this table refer to respiratory activities calculated during the 30–60 min interval of the experiment

Table 5. EFFECTS OF ETHYL ALCOHOL ON THE NORMAL AND KCl-STIMULATED RESPIRATION OF RAT BRAIN CORTEX SLICES

System	Average Q_{O_2}		
	30m.	60m.	90m.
Glucose (0·01 *M*) only	12·5	12·2	12·0
Glucose (0·01 *M*) + ethanol (0·02 *M*)	14·4	14·0	13·8
Glucose (0·01 *M*) + ethanol (0·2 *M*)	13·6	13·5	13·0
Glucose (0·01 *M*) + ethanol (0·4 *M*)	13·8	13·0	12·0
Glucose (0·01 *M*) + KCl (0·1 *M*)	21·4	20·3	18·0
Glucose (0·01 *M*) + KCl (0·1 *M*) + ethanol (0·02 *M*)	19·2	17·0	14·6
Glucose (0·01 *M*) + KCl (0·1 *M*) + ethanol (0·2 *M*)	18·0	15·0	13·0
Glucose (0·01 *M*) + KCl (0·1 *M*) + ethanol (0·4 *M*)	16·4	14·0	11·8

Table 6. EFFECTS OF ETHYL ALCOHOL ON THE NORMAL AND 2 : 4-DINITROPHENOL-STIMULATED RESPIRATION OF RAT BRAIN CORTEX SLICES

System	Average Q_{O_2}		
	20m.	40m.	60m.
Glucose (0·01 *M*) only	12·6	12·0	12·0
Glucose (0·01 *M*) + ethanol (0·02 *M*)	15·0	14·8	14·0
Glucose (0·01 *M*) + ethanol (0·2 *M*)	15·0	14·5	13·8
Glucose (0·01 *M*) + ethanol (0·4 *M*)	14·7	14·0	12·0
Glucose (0·01 *M*) + DNP ($2·5 \times 10^{-5}$ *M*)	24·0	22·8	20·8
Glucose (0·01 *M*) + DNP ($2·5 \times 10^{-5}$ *M*) + ethanol (0·02 *M*)	22·0	17·0	15·0
Glucose (0·01 *M*) + DNP ($2·5 \times 10^{-5}$ *M*) + ethanol (0·2 *M*)	20	16	13·2
Glucose (0·01 *M*) + DNP ($2·5 \times 10^{-5}$ *M*) + ethanol (0·4 *M*)	17·4	13·8	10·0

triphosphate, the stimulatory action of 2 : 4-dinitrophenol will be reduced or eliminated.

Ethanol as a narcotic. It is known[13–15] that brain tissue is capable of oxidizing ethanol when this is present in small concentrations, and possibly this fact has made it difficult to study narcotic effects of ethanol *in vitro*. Depression of brain metabolism *in vivo* by ethanol has been observed[16,17].

Results given in Table 5 and Table 6 show that the addition of ethanol at small concentrations to rat brain cortex slices respiring in a glucose–phosphate medium brings about an increase in the rate of respiration, the increase being diminished with increase of ethanol concentration (see also Buchel[3]).

Ethanol, however, even at the lowest concentration tested (0·02 *M* ≡ 92 mgm. per cent) exercises a definite inhibition of rat brain cortex respiration in presence of 0·1 *M* potassium chloride. As will be seen from the results given in Table 5, the presence of ethanol brings about inhibitions of the stimulated respiration of rat brain cortex that increase with increase of ethanol concentration. The same phenomenon holds with 2 : 4-dinitrophenol-stimulated respiration of rat brain cortex (Table 6). These observations indicate that ethanol behaves in a manner similar to luminal or pentothal or chloretone on the stimulated respiration of rat brain.

It is likely, though not yet proved, that the increase of respiration of unstimulated rat brain due to the addition of small concentrations of ethanol is due to oxidation of the ethanol itself, and that such increase is obscured by the stimulation of oxidation that occurs in a glucose medium in presence of 0·1 *M* potassium chloride or of 2 : 4-dinitrophenol.

In the light of these results it would appear that narcotics, at pharmacologically active concentrations, exercise large inhibitive effects on the total respiration of the stimulated nerve cell by suppressing that aspect of respiration capable of response to the presence of high concentrations of potassium and which is concerned with carbohydrate (or pyruvate) oxidation. With the resting, unstimulated, nerve cell the respiration is due to processes a considerable proportion of which are neither highly sensitive to narcotic nor capable of stimulation by potassium ions. It is for this reason that apparently so little effect on the respiration of the unstimulated nerve *in vitro* is seen by a narcotic at pharmacologically active concentrations. With stimulated nerve, however, the potassium-responsive, narcotic-sensitive, aspect of respiration becomes the more prominent phase.

The general conclusion that narcotics, at pharmacologically active concentrations, act on the nerve cell, where they are adsorbed, by the suppression of oxidative events, particularly those involved in glucose or pyruvate oxidation, is thus supported.

Summary

The increased respiration of rat brain cortex *in vitro*, brought about by addition of potassium ions or of 2 : 4-dinitrophenol, is suppressed or eliminated by the presence of pharmacologically active concentrations of barbiturates, such as luminal or pentothal, or of chloretone. The increased sensitivity of the respiration of stimulated brain cortex to narcotics is due to a retarding effect of the narcotics on a specific phase of nerve respiration that is potassium-sensitive and concerned with glucose (or pyruvate) oxidation. This phase is not prominent in a resting, unstimulated, nerve, the respiration of which is made up largely of processes that are unresponsive to potassium or insensitive to low concentrations of narcotics. This phase, however, becomes an important aspect of the respiration of stimulated nerve. The presence of ethanol at low concentrations (0·1 per cent) brings about a decided inhibition (20 per cent) of the respiration of rat brain cortex stimulated by potassium or by 2 : 4-dinitrophenol. The same concentration of ethanol increases the respiration of unstimulated brain cortex probably by undergoing an oxidation, which is obscured by the stimulation of respiration in a glucose medium by the addition of potassium ions or of 2 : 4-dinitrophenol.

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LETTERS TO THE EDITORS

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Fractionation of Deoxyribonucleoprotein by Successive Extraction with Constant Salt Concentration

IN recent papers Chargaff and his collaborators[1], and Brown and Watson[2], have shown the possibility of obtaining nucleic acids (DNA) of varying composition from deoxyribonucleoprotein. Chargaff's fractionation was achieved by successive extractions of nucleoprotein with salt solutions of increasing strength, after the nucleoprotein had been precipitated by a mixture of chloroform and *n*-octanol. This yielded a series of nucleic acid fractions containing progressively increasing quantities of adenine and thymine. Chargaff has suggested that this fractionation may arise from the existence of bonds of varying stability, between the protein and the nucleic acid, which are broken progressively with increasing salt concentration. It may be noted that in the observations quoted, although fractions of differing composition were undoubtedly obtained, there were marked irregularities in the way in which the composition of the fractions varied with the salt concentration used in extraction. This suggested to us that some other variable may have had a significant effect on the results obtained.

Attempts were made to fractionate nucleoprotein directly, without prior chloroform treatment; and by slowly adding or removing salt by dialysis, to obtain fractional solution and precipitation respectively of the nucleoprotein. Though the nucleoprotein was fractionated into soluble and insoluble material at salt concentrations of both 0·65 *M* and 0·75 *M* by this means, the nucleic acids thus obtained showed no significant differences in composition.

We then investigated the result of extracting the chloroform-denatured nucleoprotein successively with the same salt solution. Fresh, minced calf thymus glands were washed five times with 0·9 per cent sodium chloride, homogenized in water, and then mixed with an equal volume of chloroform (35 parts) and amyl alcohol (10 parts) for five minutes in a Waring blendor. The gel obtained on centrifugation at 20,000 *g* was blended into excess 0·6 *M* sodium chloride for one minute, and the extract stirred slowly overnight. After centrifugation at 32,000 *g* for three hours, the viscous supernatant liquid was decanted, precipitated with alcohol, and protein removed from the material to yield the nucleic acid. The residue, partly compact and partly gel-like, was then extracted further with 0·6 *M* salt solution as above. All operations, except deproteinization, were performed at temperatures below 5° C. In experiment I, protein was removed by treatment with chloroform and amyl alcohol in 10 per cent salt solution[3], whereas in experiment II protein was removed by a detergent method[4]. A small dilution of the sodium chloride by the water present in the gel occurs in the first extraction; but in subsequent extractions this is negligible.

We are able to extract successive nucleoprotein fractions by the above procedure, and the deoxyribonucleic acids obtained in these extractions have been found to vary progressively in composition, as can be seen from the results of the two experiments given in Table 1. In experiment II, more than 50 per cent of the total salt-soluble phosphorus was extracted in five successive extractions.

Each value of (adenine + thymine)/(guanine + cytosine) is the mean of three determinations on one perchloric acid hydrolysate of the substance[5]. No individual value differed from the mean of the three by more than 3 per cent (except fraction II 1), and the average difference from the mean value was less than 2 per cent. Fractions I 2 and II 2 were hydrolysed in duplicate and the mean values differed by only 1 per cent in each pair of hydrolysates.

In the first two extracts of both I and II, the nucleoprotein as precipitated by alcohol was largely non-fibrous, and precipitation required several hours at about 4° C., whereas the later extracts immediately gave the usual fibrous precipitate. The specific viscosities of the isolated nucleic acid fractions did not vary greatly, though all were lower than that of thymus deoxyribonucleic acid ($\eta_{sp}(P) = 1,045$), in which protein had been removed with chloroform/amyl alcohol in 10 per cent salt solution.

There is no doubt that the chloroform-treated nucleoprotein is in a different state from the native material. Extracts of the denatured material in 0·6 *M* salt solution after precipitation with alcohol yield nucleoprotein soluble in 10 per cent salt solution, whereas material extracted similarly from the native nucleoprotein and precipitated with alcohol is insoluble in 10 per cent salt solution[6].

Table 1. COMPOSITION OF CALF THYMUS DEOXYRIBONUCLEIC ACID FRACTIONS

Experiments	Fraction	Sodium chloride molarity	% of total[b] soluble phosphorus	N/P[b]	$\eta_{sp}(P)$[c]	$\frac{\text{Adenine}}{\text{Thymine}}$	$\frac{\text{Guanine}}{\text{Cytosine}}$	$\frac{A+T}{G+C}$
I	1	0·6				1·08	1·14	0·88
	2					1·24	1·17	0·88
	3					1·05	1·10	1·16
	4					1·07	1·12	1·21
II	1	0·6	2·5	25·0	—	0·99	1·13	0·76[d]
	2		4·6	5·4	727	1·09	1·18	0·85
	3		12·9	4·2	880	1·07	1·14	1·06
	4		18·0	3·8	984	1·06	1·11	1·20
	5		18·5	3·8	898	1·04	1·08	1·30
	Residue[a]		43·5	3·5	955	1·03	1·13	1·31
Unfractionated deoxyribonucleic acid (chloroform deproteinization, ref. 3)						1·07	1·06	1·20
Unfractionated deoxyribonucleic acid (detergent deproteinization, ref. 4)						1·01	1·18	1·22

a, The residue in II was extracted in 10 per cent sodium chloride solution.
b, Total phosphorus and nitrogen was determined in each salt extract.
c, $\eta_{sp}(P)$ is the specific viscosity (Ostwald type viscometer) of the deoxyribonucleic acid divided by the molarity of the solution with respect to phosphorus. Solutions were 0·1 per cent deoxyribonucleic acid in 0·1 *M* sodium chloride. Outflow time for 0·1 *M* sodium chloride was 13·2 sec. at 25° C.
d, Fraction II 1 accurate to within 5 per cent.

It can be concluded that whatever is the actual process that gives rise to the fractionation, the essential variable is not the concentration of sodium chloride in the extracting solution. The nitrogen/phosphorus ratios of the extracted nucleoprotein fractions given in Table 1 show that the ratio protein/nucleic acid decreased in the successive extractions. But the excess of protein extracted in the early fractions may have been extraneous, and not closely associated with the deoxyribonucleic acid. However, the fractionation of the deoxyribonucleic acid might possibly be a consequence of the fact that a high protein/deoxyribonucleic acid ratio occurs in those fractions which are richer in guanine and cytosine.

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Effect of Hæm-linked and Other Ionizations on Hæmoprotein Reactions

THE ionization of a proton from a 'hæm-linked' acidic group, generally believed to be on the amino-acid residue to which the hæm is attached, is known to alter the affinity of the iron atom for a ligand, as in the combination of the ferrous hæmoprotein, hæmoglobin, with oxygen (Bohr effect)[1]. If a similar effect operates in the formation of ferric hæmoprotein complexes, then it may be very difficult to decide, from the variation with *p*H of equilibrium or of velocity constants, or from determinations of the *p*H changes which accompany complex formation in unbuffered solutions, whether complexes formed with ligands possessing acid-base properties contain the undissociated ligand, HX, or its anion, X^-, bonded to the iron atom[2]. However, a knowledge of the acid strengths of hæm-linked groups, obtained from reactions where the effect of *p*H comes entirely from their ionizations, such as the oxygenation and electrode reactions, does enable a definite choice to be made. In this way we have recently shown[3] that the fluoride and cyanide complexes of the ferric hæmoprotein, metmyoglobin, involve bonding of fluoride and cyanide ions.

But in the case of the hæmoprotein enzymes, catalase and peroxidase, the simplest interpretation of the scanty data on the variation of equilibrium and velocity constants with *p*H suggests bonding of the undissociated ligands HF, HCN, HN_3, etc.[4]. Yet the physical properties of the complexes, particularly absorption spectra and magnetic susceptibilities, resemble so closely those of metmyoglobin and methæmoglobin that on these considerations alone anion bonding has long been accepted[4]. One explanation of the apparent contradiction could be that anions are bonded in all the complexes, but in metmyoglobin reactions the ionization of a hæm-linked group only slightly modifies the *p*H variation of equilibrium and velocity constants indicative of anion bonding, whereas the *pK* values of the linked ionizations in catalase and peroxidase are such as to alter it completely.

In addition to the effect of a hæm-linked group, the ionization of other acidic groups on the hæmoprotein would be expected to influence the reactivity of the iron atom by altering the 'ionic strength charge' (Z)[5]. Such an effect should be most readily detectable at very low ionic strengths (I), where the magnitude of the charge could be obtained from the variation of an equilibrium or velocity constant with $\sqrt{I}$. The effect would probably be a composite one since every charged group would exert an influence depending, among other factors, upon its distance from the iron atom and upon the dielectric constant of the medium between (which might be low like that of the backbone chain of a polypeptide, or high like that of polar side-chains or solvent water molecules). On the same basis, the charge on a hæm-linked group should also contribute to the value of Z.

We have obtained values for the changes in Z for three metmyoglobin reactions[6,7]. In the table these values are given to the nearest whole number, together with the corresponding changes in the 'formal charge' on the iron atom, which is usually taken as + 1 in metmyoglobin on the grounds that two of the three positive charges are neutralized by negative charges on pyrrollic nitrogen atoms of the porphyrin ring. The table shows that at *p*H values between 6·6 and 7·5, where the hæm-linked group[3] is predominantly ionized in metmyoglobin ($pK \sim 6{\cdot}0$) and in its fluoride complex ($pK \sim 6{\cdot}4$), the change in both quantities is from + 1 to zero as the complex forms. Determinations of the *pK* of the linked group on the fluoride complex, from the slight increase in the intensities of its absorption bands over the *p*H range 5·8–6·7, also indicate that Z changes from + 1 to zero in this reaction[7]. Although this ionization does not involve any change in the formal charge on the iron atom, provided the hæmatin group and its linked acidic group are considered as one unit, this result is consistent with the previous one, and can be readily accounted for by the ionization of a cationic acid, for example, the glyoxalinium NH^+ of histidine.

CHANGES IN CHARGE ACCOMPANYING METMYOGLOBIN REACTIONS. $Fe^+(H_2O)$ represents the ferric iron atom in metmyoglobin with its co-ordinated water molecule. H^+Y and Y represent, respectively, the conjugate acidic and basic forms of a hæm-linked group with the charge assigned arbitrarily

Metmyoglobin reaction	Formal charge on Fe	Ionic strength charge (Z) (nearest whole number)
$Y.Fe^+(H_2O) + F^- \rightleftharpoons Y.FeF + H_2O$ at *p*H values between 6·6 and 7·5 (ref. 7)	+ 1 → 0	+ 1 → 0 in range of $I = 0{\cdot}01$–$0{\cdot}10$
$H^+Y.FeF \rightleftharpoons Y.FeF + H^+$ from *p*H 5·8 to 6·7 (ref. 7)	0 → 0	+ 1 → 0 in range of $I = 0{\cdot}025$–$0{\cdot}10$
$Y.Fe^+(H_2O) \rightleftharpoons Y.FeOH + H^+$ from *p*H 8·5 to 9·4 (ref. 6)	+ 1 → 0	− 2 → − 3 in range of $I = 0{\cdot}002$–$0{\cdot}010$

But a more complicated co-operative effect cannot be excluded. For example, the ionization may be that of a carboxylic acid where the influence of the negative charge of the carboxylate ion is compensated for by the positive charge of a cationic acid. In this connexion the ionization of the two propionate side-chains of the ferriprotoporphyrin merit consideration, particularly in view of J. Keilin's observations on copper uroporphyrin[8], where a $pK \sim 5 \cdot 7$ was obtained from the change in absorption spectrum with pH, a probable consequence of the ionization of the acetate and propionate side-chains. Preliminary estimates[7] of the heat and entropy of ionization of the hæm-linked group in metmyoglobin, obtained from the variation of pK with temperature at $I = 0 \cdot 10$, give $\Delta H^{\circ} = 2 \pm 2$ kcal.mole^{-1} and ΔS° about -20 e.u., which more closely resemble the thermodynamic constants for the ionization of a carboxylic acid than those for the NH$^+$ of histidine.

Whereas in the pH range 6·6–7·5, which spans the isoelectric point, it is not apparently necessary to invoke a charge contribution from acidic groups other than the hæm-linked group, this is no longer so in the pH range 8·5–9·4, where the ionization occurs of the water molecule co-ordinated to the iron. Here the change in formal charge is again $+1$ to 0, but the corresponding values of Z are -2 and -3 (see table). This suggests that between pH 7·5 and 8·5 the equivalent of three negative charges has been produced, and as carboxyl groups are unlikely to become ionized in this range, the effect is probably due to the ionization of cationic acids the positive charges of which otherwise compensate for the effect of the negatively charged carboxylate ions. Depending on the extent to which the two propionate side-chains of the ferriprotoporphyrin contribute to this charge, the equivalent of between one and three acidic amino-acid residues (aspartic or glutamic[9]) will also be needed. The cationic acids may include glyoxalinium NH$^+$ groups of histidine, or the α-NH$_3{}^+$ of the terminal glycine in metmyoglobin[10].

It is significant that although these three negative charges contribute to the value of Z, and as a consequence influence the reactivity of the hæmatin iron atom, the ionization of the groups concerned does not apparently alter the affinity of the iron for fluoride at high ionic strengths[7]. In this respect, the ionizations can be differentiated from the hæm-linked ionizations with which the Bohr effect is associated, and the contrast in behaviour substantiates the idea that some special structural or configurational feature must be present before an ionization can have the properties which characterize a hæm-linked ionization.

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Biosynthesis of Hæmin in Soy-bean Nodule Homogenates

IT has been shown that root nodules of leguminous plants contain a hæmoprotein with a prosthetic group indistinguishable from protohæmin IX of hæmoglobin[1]. Elucidation of the mechanism of formation of this pigment in plant material should broaden our knowledge of biosynthetic reactions leading to the formation of porphyrins, and make it possible to compare hæmin synthesis in plant and animal tissues.

The work to be reported was carried out with soy-bean root nodules harvested from plants approximately six weeks of age. 5-gm. portions of nodules were homogenized with a Waring blendor in 30 ml. of 0·2 molar phosphate buffer, pH 7·1. The ability of these preparations to incorporate the carbon atoms of glycine and acetate into hæmin was investigated by incubating the homogenates for three and a half hours in modified Warburg vessels at temperatures ranging from 18° to 37° C. in the presence of various substrates. Hæmin was isolated and purified by chromatography on a 'Celite' column, and identified spectroscopically as the pyridine hæmochromogen of protohæmin IX. In a few cases the pyridine hæmochromogen was converted to its corresponding porphyrin ester according to Grinstein[2] and found to be indistinguishable spectroscopically and by means of column chromatography from that isolated from hæmin IX. Table 1 shows some typical results.

Table 1. INCORPORATION OF THE CARBON ATOMS OF GLYCINE AND ACETATE INTO HÆMIN IN SOY-BEAN ROOT NODULE HOMOGENATES

Test substance	Radioactivity in hæmin*
2-^{14}C-Glycine	38×10^3
1-^{14}C-Glycine	4×10^3
2-^{14}C-Acetate	45×10^3
1-^{14}C-Acetate	38×10^3

* Expressed as disintegrations per mM/min./5 gm. wet weight of nodules/μc. of test substance.

As can be seen from the table, soy-bean root nodule homogenates, like animal tissues[3], are able to incorporate the alpha carbon atom of glycine and the carbon atoms of acetate into hæmin.

Differences between nodule homogenates and animal tissues in their ability to incorporate glycine and acetate into hæmin are presented in Table 2.

The differences between root nodules and bone marrow in their ability to incorporate 1-^{14}C-glycine

Table 2. DIFFERENCES BETWEEN SOY-BEAN ROOT NODULES AND BONE MARROW IN THEIR ABILITY TO INCORPORATE GLYCINE AND ACETATE INTO HÆMIN

Variable observed	Soy-bean root nodules	Bone marrow
Incorporation of 1-^{14}C-glycine	Slight incorporation (approx. 10 per cent)*	No detectable incorporation
Incorporation of 1-^{14}C-acetate	About the same incorporation as of 2-^{14}C-acetate	Less incorporation than of 2-^{14}C-acetate (approx. 60 per cent)†
Effect of 0·01 M sodium fluoride on incorporation of the carbon atoms of glycine into hæmin	Stimulatory (approx. 400 per cent for 1-^{14}C-glycine; approx. 190 per cent for 2-^{14}C-glycine)	Inhibitory (approx. 50 per cent for 2-^{14}C-glycine)
Temperature	Optimum, 25° C.	Optimum, 37° C.

* Expressed as per cent incorporation of 2-^{14}C-glycine.
† Expressed as per cent incorporation of 2-^{14}C-acetate.

and in their response to the presence of fluoride warrant further investigations which are now being undertaken in this laboratory.

This work was performed under contract with the United States Atomic Energy Commission at the University of Rochester Atomic Energy Project, Rochester, New York. One of us (S. C.) wishes to thank the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service, for partial support for this investigation.

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Hæmoglobin in *Heterakis gallinae*

A NUMBER of helminths and especially parasitic nematodes are known to possess a hæmoglobin-like pigment[1-4]. In some instances, a detailed study has been made of the pigment after extraction and purification[2,4]. From the discussion in the literature, it is apparent that no general conclusion as to the physiological significance of the hæmoglobin of parasites can be made.

The present investigation adds another nematode, *Heterakis gallinae*, from the cæca of the fowl, to the list of parasites containing hæmoglobin. The following observations were made on adult worms with a reversion spectroscope (Beck–Hartridge): wavelengths in millimicrons.

	Oxyhæmoglobin		Carboxyhæmoglobin		Hæmoglobin	Pyridine hæmochromogen	
	α-band	β-band	α-band	β-band		α-band	β-band
Heterakis	578·2	542	570·0	c. 530	555	557	525
Fowl blood*	578·0	541	571·8	537	556		

* There is a slight difference between our results and those of Anson *et al.*[5]: they give 576·4 as the position of the α-band in man and 576·9 in the fowl. We found, with our spectroscope, in man 577·2 and in the fowl 578·0.

It was noted that the hæmoglobin was rapidly deoxygenated by the respiratory activity of the worm, a fact which is in accordance with the high values of oxygen uptake found by Glocklin and Fairbairn[6].

It appears that there is little difference between the position of the bands of *Heterakis* hæmoglobin and those of the blood of the host.

Nevertheless, the hæmoglobin of *Heterakis* is probably an autochtonous pigment because (1) the absorption bands remained in the same position over a period of 24 hr. in washed parasites which were placed in an incubator at 37° C.; (2) adult *Heterakis* feed on the cæcal content and not on tissues or blood, as is possibly the case in the larval stage since there exists a tissue phase in the developmental cycle[7].

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Biological Value of Proteins as Influenced by Dietary Vitamin B_{12}

IT has been shown by Frölich[1] that chicks, fed underheated, low-quality soy bean oil meal, were depleted of their vitamin B_{12} reserves and consequently required the supply of dietary vitamin B_{12}, probably due to the antiproteolytic activity[2] or soyin content[3] of the underheated meal. Baliga and Rajagopalan[4] have reported that vitamin B_{12} at 50 μgm. per kilo of the diet containing 10 per cent raw soy bean protein (without any heat treatment) enhanced the biological value of the protein (the biological values for the raw and vitamin B_{12} supplemented soy bean protein being 48·6 ± 0·9 and 77·6 ± 1·8 respectively). This would suggest that vitamin B_{12} has overcome the adverse effect of the proteolytic inhibitor and soyin. These studies were extended to determine the effect of vitamin B_{12} on the biological value of autoclaved soy bean meal. These observations are presented here.

Cold defatted and autoclaved (at 15 lb. pressure for 30 min.) soy bean meal, at 10 per cent protein-level in the diet, was used for the determination of biological value by the method of Mitchell[5]. There were three comparable groups of albino rats, containing six rats in each group and each rat weighing 80–100 gm. After determining the endogenous nitrogen with 4 per cent egg protein, one group (*A*) was given the basal diet[4] containing the autoclaved soy bean meal, the second group (*B*) was given the same basal diet with vitamin B_{12} at 50 μgm. per kilo of the diet and the third group (*C*) received the basal diet with aureomycin at 200 mgm. per kilo of the diet. The figures for the biological values for the *A*, *B* and *C* groups were 78·30 ± 0·3, 85·40 ± 1·0 and 86·43 ± 1·40 respectively. These data clearly show that vitamin B_{12} has a definite function in increasing the utilization of soy bean protein irrespective of the extent of heat treatment. This observation is contradictory to that of Frölich (*loc. cit.*) who, using chicks, did not find vitamin B_{12} to have any beneficial influence on growth with adequately heated soy bean meal. Our results also indicate that aureomycin exerts a significant increase in the biological value of autoclaved soy bean meal.

It was of interest to find out whether an animal protein, like casein, would respond to vitamin B_{12} in the presence of proteolytic inhibitor and soyin. Each of three more groups of rats received 10 per cent casein in the basal diet in place of soy bean meal. Three lots of crude and active inhibitor preparation were made[6] from soy bean the quantity of which was the same as that which formed the 10 per cent protein-level in the original basal diet. One lot of the inhibitor preparation was inactivated by heat and added to the control group of rats. The other two groups received the active inhibitor preparation. To one of these two groups, vitamin B_{12} was added at a level of 50 μgm. per kgm. of the diet. The following biological values were obtained: casein plus inactivated inhibitor, 86·6 ± 1·14, casein plus active inhibitor, 76·67 ± 0·82, casein plus active inhibitor plus vitamin B_{12}, 85·19 ± 0·98.

In the above case, vitamin B_{12} has just counteracted the influence of the inhibitor and has not shown any extra benefit. Whereas with raw soy bean, elimination of the adverse effects of the inhibitors automatically improves the biological value as evidenced by autoclaving the raw soy bean meal, in the case of the casein inhibitor the removal of the inhibitor effect by vitamin B_{12} has resulted in the restoration of the normal biological value. With a higher concentration of vitamin B_{12} in the diet than used in the present studies, it might be possible to get a higher biological value for casein as reported by Kon and Henry[7]. This aspect is being verified.

Studies on the rate of release of certain amino-acids from raw soy bean under the influence of vitamin B_{12}, and nitrogen balance and growth studies with different levels of autoclaved soy protein with and without vitamin B_{12} and aureomycin, are in progress.

Our thanks are due to Prof. K. V. Giri for his interest in the investigation.

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Enzymatic Conversion of Salicylhydroxamic Acid to Salicylamide

After the administration of salicylhydroxamic acid to rats, we have been able to isolate conjugates of salicylhydroxamic acid and salicylamide from the urine[1]. In the intact animal, salicylhydroxamic acid is therefore partly metabolized to salicylamide. In the present communication, the enzymatic transformation of salicylhydroxamic acid to salicylamide *in vitro* is reported.

Rat liver extract (1 ml.), prepared according to Bray *et al.*[2], was incubated with sodium salicylhydroxamate (1 ml., 0·02 *M* in 0·2 phosphate buffer, *p*H 7·4) at 35° C. for various periods. The reaction was stopped by immersing the mixture for exactly three minutes in boiling water, the coagulated protein thrown down by centrifugation and the supernatant investigated by paper chromatography. A descending method, using Whatman No. 1 filter paper and 1·5 *N* ammonium hydroxide : *n*-butanol (1 : 1) as the solvent system, was employed. With this solvent, good separation of salicylhydroxamic acid, salicylic acid, and salicylamide was obtained with R_F values for the three compounds approximately 0·24, 0·41 and 0·52 respectively. When viewed under ultra-violet light, salicylic acid and salicylamide show light blue, while salicylhydroxamic acid shows dark blue, fluorescence. The compounds also give characteristic colours when sprayed with ferric ion. In addition, control spots of the above three compounds were always placed on the paper, since the R_F values tended to vary with changes in temperature.

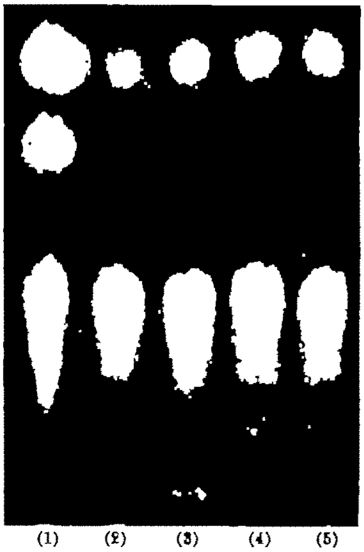

Fig. 1. Chromatogram showing the formation of salicylamide, from salicylhydroxamic acid. 1 : Control spot of salicylhydroxamic acid, salicylic acid and salicylamide; 2, 3, 4 and 5: liver extract and salicylhydroxamic acid incubated for 30, 60, 120 and 240 minutes respectively

The enzymatic transformation of salicylhydroxamic acid to salicylamide could be definitely established by the identification of the latter on the chromatogram (Fig. 1). Samples of liver extract incubated without salicylhydroxamic acid did not show the presence of salicylamide. There was no hydrolysis of salicylhydroxamic acid to salicylic acid, as indicated by the failure to detect the latter by chromatography. Activity was abolished by placing the enzyme extract for ten minutes in boiling water or by dialysis, but in the latter case was restored by the addition of the concentrated dialysate.

The transformation of salicylhydroxamic acid to salicylamide may be brought about either by a direct enzymatic reduction of the hydroxylamino group or by an exchange reaction in which the hydroxylamino group is exchanged with ammonia or the amide group of glutamine, leading to the formation of salicylamide and hydroxylamine or glutamohydroxamic acid respectively. Virtanen and Berg[3] have reported the enzymatic formation of benzhydroxamic acid from benzoic acid or benzamide and hydroxylamine, and the role of glutamine in certain exchange reactions of this type has been reviewed by Waelsch[4]. In our experiments, no evidence for the formation of hydroxylamine or glutamohydroxamic acid could be obtained. Furthermore, with salicylamide and hydroxylamine or glutamohydroxamic acid as substrates, no formation of salicylhydroxamic acid was observed. On the other hand, while the intermediate formation of hydroxylamines in the enzymatic reduction of aromatic nitro compounds has been demonstrated previously[5], a similar enzymatic reduction of the hydroxylamino group of hydroxamic acids does not seem to have been reported.

This work is being extended, and a detailed report will be published at a later date.

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Effect of Posterior Pituitary Hormone on the Release of Adrenocorticotrophic Hormone

WE have recently found that the decrease of ascorbic acid concentration of rats' adrenals due to epinephrine is smaller in rats to which pituitrin has been administered and in dehydrated rats than in normal rats[1]. This suggests that the posterior pituitary hormone depresses the adrenal cortical activity. The questions arise, whether the posterior pituitary hormone acts directly on the adrenal or indirectly through the depression of the anterior pituitary secretion, and which fraction of the posterior pituitary hormone, pressor or oxytocic, is responsible for this effect. The present work was undertaken to clarify these points.

Male adult rats were used. Ascorbic acid concentration was determined by the method of Roe and Kuether[2]. Adrenal ascorbic acid concentration of normal rats was 401 ± 16·4 mgm. per cent. When 0·02 mgm. of epinephrine per 100 gm. of body-weight was injected, this concentration decreased to 257 ± 9·8 mgm. per cent; and it remained at a value of 360 ± 22·1 mgm. per cent after injection of the same amount of epinephrine following that of 20 m.u. of pituitrin. When, in place of epinephrine, adrenocorticotrophic hormone (1 u. per 100 gm. body-weight) was administered, the adrenal ascorbic acid concentration was 258 ± 10·9 mgm. per cent, and in this case pituitrin did not alter the value (264 ± 20·1 mgm. per cent). If pituitrin inhibited the adrenocortical secretion directly, it would be expected to suppress the decrease of the ascorbic acid concentration both after epinephrine and after adrenocorticotrophic hormone. As, however, the effect of pituitrin is only seen when epinephrine is used, it may be inferred that the exogenous posterior pituitary hormone inhibits the release of adrenocorticotrophic hormone from the anterior pituitary gland.

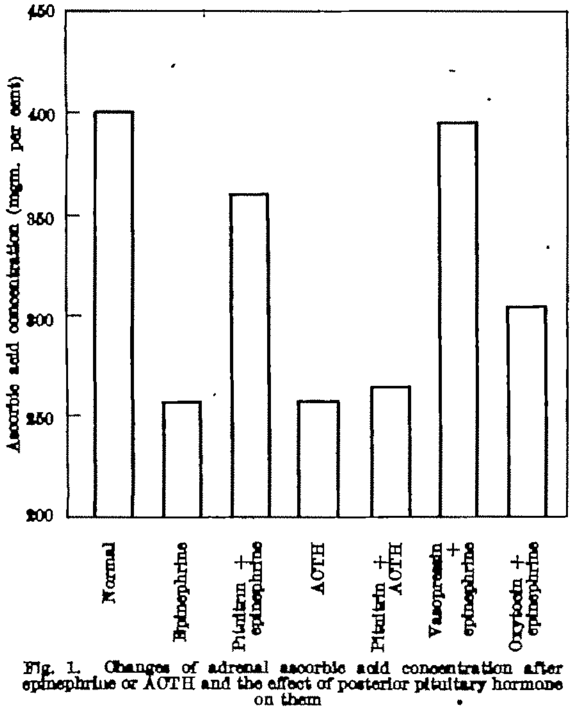

Fig. 1. Changes of adrenal ascorbic acid concentration after epinephrine or ACTH and the effect of posterior pituitary hormone on them

Pressor and oxytocic fractions were separately administered to rats, 20 m.u. per 100 gm. body-weight each, and epinephrine (0·02 mgm. per 100 gm.) was injected, while the adrenal ascorbic acid concentration was determined as in the above experiment. The mean value of ascorbic acid was 395 ± 24·2 mgm. per cent for the pressor fraction and 305 ± 15·8 mgm. per cent for the oxytocic fraction. That is, the former fraction alone shows the above effect.

Details of the experiments will be published in the *Japanese Journal of Physiology*.

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Oxidative Dissimilation of Glycerol studied with Variants of *Bacillus subtilis*

COMPARING the quantitative aspect of growths of two parent strains of *B. subtilis*, we concluded[1] that, in one of them (S_1^-), the glycerol is oxidized through the tricarboxylic acid cycle, whereas in the other strain (M_2^-) the glycerol, although actively oxidized, does not reach the tricarboxylic acid cycle.

It has already been shown that, in animal tissues[2] and in bacteria[3], the oxidation of glycerol goes through the two following steps:

$$\text{Glycerol} + \text{ATP} \rightarrow \text{glycerol-phosphate} + \text{ADP}$$

$$\text{Glycerol phosphate} \xrightarrow{-2H} \text{dihydroxyacetone-phosphate or glyceraldehyde-phosphate}$$

This mechanism cannot explain the results we have recently obtained; and we have been able to show the existence of an alternative pathway consisting of the two reactions:

(1) $\text{Glycerol} + \text{DNP}^+ \rightleftharpoons \text{dihydroxyacetone} + \text{DPNH} + \text{H}^+$.

(2) $\text{Dihydroxyacetone} + \text{ATP} \rightarrow \text{dihydroxyacetone-phosphate} + \text{ADP}$.

We have observed activity due to both the enzymes, glyceroldehydrogenase and triokinase, in cell-free

Table 1. Metabolic products of resting cells of the two strains M_2^- and S_1^- tested in Warburg apparatus, each vessel containing in the main cup 2 ml. of bacteria, optical density 3·0 in phosphate buffer pH 6·4, M/20. The first side-arm has or has not glycerol, the second side-arm 0·3 ml. of 5 N sulphuric acid to release carbon dioxide at the end of reaction. All results expressed on the total material by vessel

	Strain M_2^-		Strain S_1^-	
	without glycerol	0·2 ml. M/2 glycerol	without glycerol	0·2 ml. M/2 glycerol
Oxygen absorbed (µl.)	74	226	30	384
Carbon dioxide released (µl.)	75	88	22	227
Respiratory quotient	1·02	0·08*	0·73	0·58*
Dihydroxyacetone (µM)	traces	12·8	0	0·25
Dihydroxyacetone/oxygen (µM)*	0	1·9	0	~ 0

* Corrected for endorespiration.

extracts of *B. subtilis*. Reaction (1) has been reported recently in *Aerobacter aerogenes*[4] and *Escherichia coli*[5]. Although reaction (2) is not known to occur in bacteria, it is present in animal tissues[6].

In *B. subtilis*, these reactions lead to triosephosphate and eventually to pyruvate and the Krebs cycle; or, by condensation, to hexose derivatives. The difference between the two strains of bacteria is the absence of triokinase in strain M_2^-.

These conclusions have been reached by the successive use of cultures, resting cells and cell-free enzymatic extracts.

In aerated cultures[7] in a medium containing mineral salts and glutamate, the glycerol does not affect the growth of M_2^-, but it enhances actively the growth of S_1^-; with both strains, however, it leads to the formation of reducing substances. With strain M_2^-, 90 per cent of these substances is dihydroxyacetone; S_1^- accumulates less reducing substances, which are a mixture of dihydroxyacetone and acetylmethylcarbinol. The latter is known to arise from the condensation of pyruvate. This finding suggests a metabolic block between glycerol and pyruvate in M_2^-.

Resting cells of M_2^- oxidize glycerol quantitatively to dihydroxyacetone (Table 1); the respiratory quotient is almost nil, and two moles are formed for every mole of oxygen consumed. Cells of strain S_1^- oxidize the glycerol further ($R.Q.$ = 0·58) and dihydroxyacetone does not accumulate. Moreover, dihydroxyacetone is oxidized by S_1^- and not by M_2^-; this suggests that it is on the oxidative pathway of glycerol.

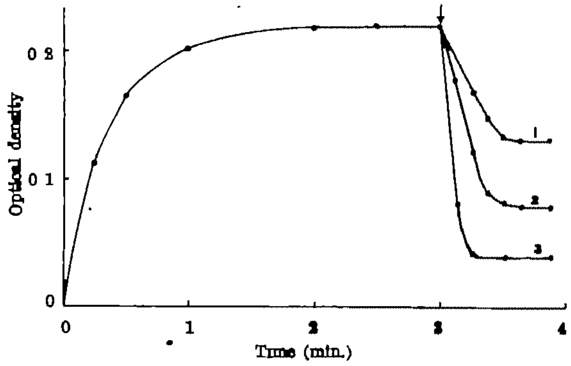

Fig. 1. Glycerol dehydrogenation followed by change in optical density of diphosphopyridine nucleotide at 340 mµ, with a Beckman model *DU* spectrophotometer at room temperature. The reaction mixture at pH 8·7 contained: 0·2 ml. cell-free extract; 0·8 ml. water; 1·5 ml. of M/10 sodium pyrophosphate; 0·2 ml. of 2·5 M glycerol.
At zero time, 0·3 ml. of M/1,000 diphosphopyridine nucleotide was added
At the arrow, dihydroxyacetone added. curve 1, 3 µM. curve 2, 5 µM, curve 3, 10 µM. Points are corrected for dilution due to addition of diphosphopyridine nucleotide

Table 2. Test for kinase activities with extracts of two different strains of *B. subtilis*: µl. carbon dioxide released after 30 min. in bicarbonate buffer pH 7·7, M/30, in Warburg apparatus; gas 5 per cent carbon dioxide in nitrogen. In each vessel, 10 µM adenosine triphosphate, 20 µM dihydroxyacetone, 2 ml. of cell-free extract corresponding to 100 mgm. of lyophilized bacteria, 0·1 ml. of M/5 sodium fluoride, 0·1 ml. of M/5 magnesium chloride

	M_2^-	S_1^-
Adenosine triphosphate	120	65
Dihydroxyacetone	26	18
Adenosine triphosphate + dihydroxyacetone	118	160

Table 3. Same conditions as in Table 2, except 15 µM adenosine triphosphate. Fructose expressed as fructose 6 phosphate (Roe, ref. 9). Total triose (free + phosphorylated) by conversion to methylglyoxal (to be published elsewhere)

Time (min.)	Alkali-labile phosphate (µM)	Total triose (µM)	Fructose (µM)
0	0	37·5	0
5	2·8	36·0	0
10	4·0	36·2	0·52
30	3·6	30·6	1·98
100	2·4	21·6	2·75

Cell-free extracts were prepared from 0·5 gm. lyophilized bacteria treated with 10 mgm. lysozyme in 30 ml. of M/30 bicarbonate buffer, pH 7·7, plus 1 ml. of M/2 citrate. The clear supernatant from the centrifugation at 12,000 r.p.m. is precipitated with ammonium sulphate at saturation. The precipitate is redissolved in 10 ml. bicarbonate buffer. The extracts of both strains contain a glyceroldehydrogenase linked with diphosphopyridine nucleotide (Fig. 1).

The fate of the dihydroxyacetone can be explained by the presence of a triokinase in extracts of S_1^-, which is absent in M_2^-. The kinase activity has been followed by the method of Colowick and Kalckar[8] (Table 2) and by the formation of triosephosphate (alkali-labile phosphate) (Table 3).

It is apparent that the triosephosphate is a transient compound, which disappears partly from the mixture. It is probably condensed to a fructose derivative, which is also further transformed, leading to a net disappearance of the total triose (free and phosphorylated) (Table 3).

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Isolation of *n*-Heptadecanoic Acid from Hydrogenated Mutton Fat

In the course of investigations on hydrogenated mutton fat[1], a fraction with saponification equivalent approximating to that of methyl heptadecanoate has been obtained by fractional distillation *in vacuo* in a packed 490 cm. × 3·9 cm. stainless steel column.

Refractionation of an aliquot of this material in a smaller efficient column provided a series of fractions the middle ones of which had saponification equivalents about 284, and these, when converted to acids and submitted to low-temperature crystallization, yielded several grams of a purified acid, of which the saponification equivalent (270·2), melting point (61·2–61·4°) and X-ray analysis (long spacing, 40·8 A.) were all consistent with it being *n*-heptadecanoic acid.

Although other investigators have reported the occurrence of *n*-heptadecanoic acid (margaric acid) in natural fats, Ralston[2] summarizes their work as follows: "All the naturally occurring heptadecanoic acids which have been described and subsequently investigated have been shown to consist of mixtures of palmitic and stearic acids". In the present investigation, however, the characteristics of the fractions preclude the possibility of its being a mixture of palmitic and stearic acids and establish the presence of *n*-heptadecanoic in hydrogenated mutton fat. Further work on the occurrence of *n*-heptadecanoic acid in this and other fats (hydrogenated and unhydrogenated) is in progress and will be published elsewhere.

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Short-range Electrical Forces between Charged Colloid Particles

In a previous communication in *Nature*[1], I suggested that the short-range equilibria which have been proved to occur between montmorillonite lamellæ might be ascribed to electrical attractive forces due to a 'crystalline' layer of interlamellar cations, these forces being balanced by repulsive forces due to adsorbed layers of oriented molecules. The phenomenon is unlikely to be confined to montmorillonite. It is therefore of general interest to consider how such an arrangement might pass into the normal diffuse Gouy layer distribution as the separation between the lamellæ increases.

The first modification to be expected in the 'crystalline' layer of ions is that, as more space becomes available, it should separate into two layers, one attached to each of the facing surfaces. We may reasonably suppose that each of the two layers thus formed will arrange itself so as to make the separation between the ions as great as possible, that is, in a hexagonal lattice. The two lattices of ions will adjust their relative position so as to make the mutual potential energy a minimum. This leads to an attractive force between the lamellæ.

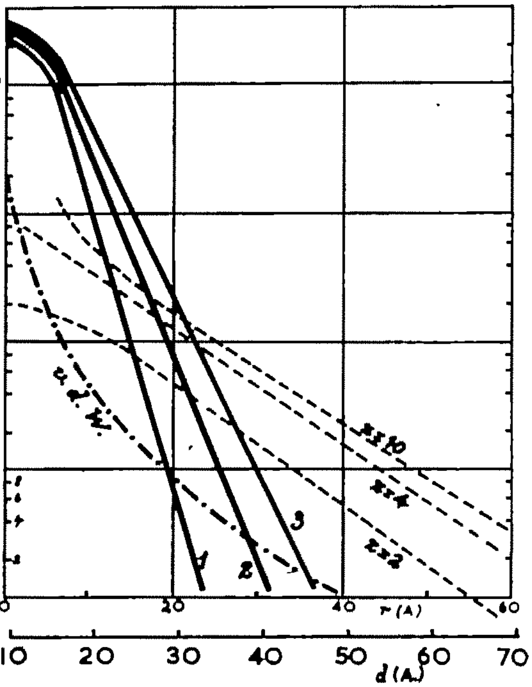

Fig. 1. Potential energy curves for montmorillonite layers. ——, Stern-layer interaction energy (attractive) calculated as described: 1, monovalent cations; 2, divalent; 3, trivalent. — · —, van der Waals energy (attractive) calculated using Verwey and Overbeek's formula (ref. 3), with $A = 5 \times 10^{-12}$. - - -, Gouy-layer interaction energy (repulsive), from Fig. 30 of Verwey and Overbeek's book, with $\kappa = 10^7$. The discontinuous expansion on Norrish's curves (ref. 4) occurs at about 0 27 *N*, corresponding to $\kappa = 10^{7.2}$

For the sake of simplicity of calculation, square lattices rather than hexagonal were postulated. The mutual potential energy of the two lattices of ions may then be evaluated by Madelung's method[2]. The full expression is complicated, involving a double sum of exponential terms, but the following approximate expression will serve as a basis of discussion:

$$V \simeq \frac{2\sqrt{\sigma^3 ev}}{\varepsilon} \exp\left(-2\pi r\sqrt{\frac{\sigma}{ev}}\right)$$

where e is electronic charge, ε is dielectric constant of medium, σ is surface charge density, v is valency of ions, and r is separation between the two layers of ions. The value of σ is given by the known structural charge of the montmorillonite lamellæ, but some assumptions must be made to fix values for ε and r.

For Fig. 1 these assumptions essentially were: (*a*) each ion is surrounded by a hydration shell one molecule thick; (*b*) the dielectric in these shells is saturated ($\varepsilon = 3$); and (*c*) outside the shells the dielectric is normal liquid water ($\varepsilon = 81$). An increase or a decrease in the extent of the saturated dielectric would result, respectively, in a raising or lowering of these curves without change of shape. A shift of the ionic layers towards or away from the lamellæ would result in a bodily shift of the curves to left or right, respectively, again without change of shape.

The same figure shows some of the curves deduced by Verwey and Overbeek[3] for the Gouy-layer repulsive potential, and the van der Waals attractive potential (with $A = 5 \times 10^{-13}$). The following features are noteworthy: (1) Up to about 30 A. interlamellar spacings (d), the electrical attractive potential is everywhere greater than the van der Waals potential. (2) Beyond 30–45 A., the electrical potential rapidly becomes unimportant in comparison with the van der Waals potential. (3) At about 20–25 A. spacing, the Gouy-layer repulsion becomes comparable with the electrical attraction, and rapidly outbalances it as the spacing increases.

Norrish's recent observations on montmorillonite gels[4] have shown that it is just in this region that a discontinuity occurs in the curve of spacing against electrolyte concentration. It may be supposed, therefore, that if the potential minimum described in my previous communication[1] occurs in this region—as it does for the sodium–montmorillonite–water system—lowering of the electrolyte concentration may eliminate it altogether, causing the system to disintegrate. Norrish observed a further series of equilibrium spacings above 35 A., showing a continuous shift with electrolyte concentration; the potential minimum in this region is not explicable on the basis of the electrical forces considered here.

Divalent ions[4] such as calcium apparently do not give spacings greater than 20 A. One factor preventing expansion may be the higher electrostatic interaction potential for such ions (see Fig. 1); but the phenomenon is a complex one, and other possible factors involved are: (*a*) the increased radius of saturation of the dielectric; (*b*) the influence of the ions on the energy of sorption of water; and (*c*) their lower degree of dissociation.

It may appear that there is a contradiction involved in postulating simultaneous action of the electrical forces considered here, and of Gouy-layer repulsion, since a layer of ions cannot be both crystalline and diffused. However, at very small separations most of the ions are forced into the Stern layer, only a few 'floating' freely in the interlamellar space. It is the interaction of the Stern layer ions that gives rise to the attractive potential.

A fuller account of this theory will appear elsewhere. I am indebted to Dr. P. M. Grundy and Mr. G. M. Jolly for advice on the mathematical aspects of this work.

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X-Ray and Differential Thermal Studies of some Indian Montmorillonites

IT is well known that members of the montmorillonite group may be classified into a number of subgroups which differ in isomorphous substitution, having varying proportions of different cations[1]. Theoretically, a continuous substitution is possible. But although a wide range of substitution is known in clay minerals, a continuous series has not yet been found.

X-ray and differential thermal studies of some Indian bentonites and soils have yielded interesting results in this connexion. The samples studied are bentonites from (i) Kashmir, (ii) Nimlinadi and (iii) Barme, and black cotton soils from (iv) Satara and (v) Indore.

The X-ray pattern of the clay fraction ($< 2\mu$) of these samples in the glycerol-treated form shows the basal spacing 17·7 A., which agrees with that of standard glycerol-montmorillonite[2]. Only sample (ii) shows, in addition to montmorillonite lines, two others at 7·1 A. and 3·5 A., indicating the presence of kaolinite.

The base exchange capacities of samples (i), (ii) and (iii) are 100, 50 and 90 m.equiv./100 gm. respectively. The lower base exchange capacity of sample (ii) compared to montmorillonite is evidently due to the presence of kaolinite.

The differential thermal curve of sample (i), showing endothermic peaks at 200°, 680° and 880° C., agrees with the standard curve of montmorillonite, except for the exothermic peak at 1,000° C., instead of the usual peak at 950° C. This is possibly due to the high magnesium substitution in the octahedral layer. The chemical analysis is: H_2O, 8·4; SiO_2, 63·18; Al_2O_3, 25·26; Fe_2O_3, trace; MgO, 4·15 per cent.

Differential thermal curves of the other four samples show some deviation from the standard for montmorillonite. The first endothermic peaks, for samples (ii) to (v), occur close to 150° C.; but the second ones corresponding to loss of hydroxyl appear at about 570° C., which is lower by about 100 deg. than that of montmorillonite. The 570° C. peak is close to that of nontronite, which has the same peak near 500° C.[3,4]. The exothermic peak lies between 900° and 950° C., as in montmorillonite; but the endothermic peak corresponding to the final breakdown of the lattice, almost invariably present in montmorillonite, is absent. The differential thermal curve of sample (ii) does not indicate the presence of kaolinite.

All the samples reported on here thus belong to the montmorillonite group on the basis of X-ray data; but differential thermal analysis reveals significant deviations, and indicates that the samples (ii), (iii), (iv) and (v) constitute a subgroup intermediate between montmorillonite and nontronite. This probably means a proportionately smaller amount of iron in the lattice than in nontronite. Complete chemical analysis of the samples after removal of free iron oxide is being carried out in order to verify the above assumption.

Two nontronite samples from (vi) Garfield, Washington, and (vii) Sandy Ridge, North Carolina, have also been analysed to study the features distinguishing the present subgroup from nontronite. They show the same basal spacing, namely, 17·7 A. The exothermic peak in both appears at 850° C., which is characteristic of nontronite. The characteristic endothermic peak was found to be at 500° C. in (vi) and 570° C. in (vii). The curve obtained with (vi) agrees with that of standard nontronite. The OH-binding energy in sample (vii) appears to be definitely greater than in standard nontronite, and corresponds to that of the subgroup formed by samples (ii), (iii), (iv) and (v); but its exothermic peak retains the characteristics of the typical nontronite.

The above information, therefore, suggests that samples (ii), (iii), (iv), (v) and (vi) form a more or less continuous link in the montmorillonite – nontronite series.

We are indebted to Prof. S. N. Bose for his many suggestions. Thanks are also due to the Assam Oil

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Heat Transfer in Pulsating Flow

When pulsations are imposed on a flowing fluid, it may normally be expected that heat transfer to or from it would be changed because the pulsations would alter the thickness of the boundary layer and hence the thermal resistance. In the laminar region, this view is also supported by the fact shown by Richardson[1] that the velocity profile for pulsating flow is steeper near the wall than for smooth flow. It follows from a consideration of the Reynolds analogy that the heat transfer should increase under such conditions. A similar process might occur for turbulent flow also, but the equations are too cumbersome for analytical solution.

Experimental information about the process, however, is meagre and sometimes conflicting. In the turbulent region, Martinelli *et al.*[2,3] and Marchant[4] found no difference in heat transfer between steady unidirectional flow and pulsating flow, but West and Taylor[5] reported an increase of 60–70 per cent. In the laminar region, Marchant[4] noted a slight increase, whereas Morris[6] and Webb[7] found no change. All these investigations were carried out at low pulsation frequencies by heating flowing water. Working with oil, Linke[8] found an increase in heat transfer of up to 4 times in the laminar region and up to 1·35 times in the turbulent region. In air, Stanton *et al.*[9] found no difference between a static and a vibrating finned engine-cylinder, whereas Kubanskii[10] obtained an increase of 50 per cent at acoustic frequencies. Andreas[11] advocated the mechanical vibration of the entire heat exchanger to improve heat transfer.

We have carried out investigations under the auspices of the Council for Scientific and Industrial Research, New Delhi, on the heat transfer to pulsating air. These investigations have been carried out by the external heating, by steam, of air at or near atmospheric pressure, flowing in a horizontal pipe of 1 in. inside diameter and 6 ft. 10 in. effective heating length. The heat transfer coefficients were measured first with steady unidirectional flow and then with pulsations imposed on the flow by means of a poppet valve operating in the path of the air. The wave-form and amplitude were measured by an instrument based on an idea of Schweitzer[12]. Reynolds number was varied from 5,000 to 35,000 and frequency of pressure pulsations from 5 to 33 c./s. The experiments were repeated with different wave-forms and amplitudes.

The Reynolds and Nusselt numbers were calculated at the mean temperature of the air, and the velocity used was that obtained by dividing the total volume flow by the cross-sectional area of the pipe. It was found that the Nusselt number changed up to about 30 per cent in a rather uneven but defined manner under different conditions of frequency, amplitude, wave-form and Reynolds number. In general, the change was negative below a certain frequency and positive above it, in the range of frequencies investigated. This critical frequency was a function of the wave-form and to a lesser extent of the Reynolds number. The magnitude of the change increased slightly with Reynolds number, the negative part of the curve increasing at lower Reynolds numbers and the positive part at higher Reynolds numbers. Only a negligible change could be detected when the amplitude of the pulsation was very low, thus corroborating the negative results of Stanton[9]. With higher amplitudes, the change was not directly proportional to the amplitude but depended on a function which combined the frequency, amplitude and Reynolds number. The exact nature of this function is now being investigated. It seems likely that not only the total magnitude of the pressure amplitude but also the steepness of the wave (or the rate of change of pressure in the wave) plays an important part in the mechanism of forced convective heat transfer under pulsating flow conditions.

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Ageing of Quartz Crystal Vibrators

It is probable that in the field of use of quartz crystal vibrators there are no requirements more exacting than those imposed on the quartz vibrator which is used to control the time-keeping of a quartz clock. The British Post Office has had considerable experience in fabricating 100 kc./s. quartz vibrators and incorporating them in suitable oscillator circuits to maintain clocks or frequency standards. It is the general experience that these oscillators have a slow frequency change even after several months of uninterrupted operation. This change is extremely small, being of the order of one part in 10^9 a day for a good clock to one part in 10^{11} for the best clock. Recent tests have shown that the frequency-change or 'ageing' can be reduced by using the crystal vibrator at a temperature which is lower than the normal 50° C.

Fig. 1 shows the results of some tests on a 100 kc./s. *GT*-cut quartz crystal operating at two different temperatures, one within a few millidegrees of a nominal 50° C. and the other of a nominal − 10° C.

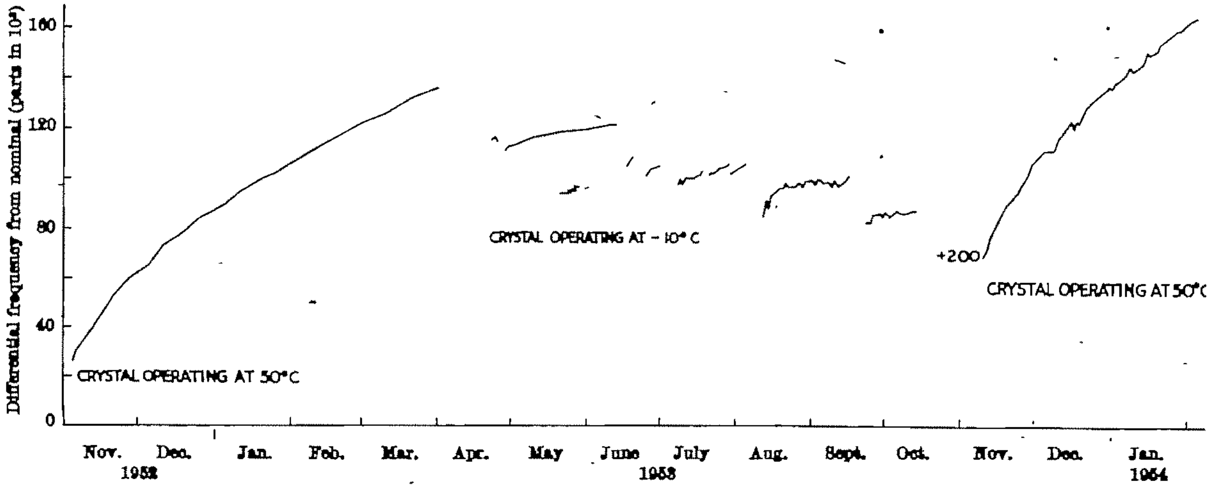

Fig. 1. *GT*-cut quartz resonators. Performance curves for crystal No. 5423

It will be seen that the ageing rates were of the order of:

50 parts in 10^{10} a day at 50° C.
10 parts in 10^{10} a day at – 10° C., and
80 parts in 10^{10} a day when operated again at 50° C.

The crystal used in these tests was gold-plated and was mounted in a clamp in an evacuated copper container. No satisfactory explanation of its ageing or of the reduction of ageing at the lower temperature is known.

A somewhat novel method was used for obtaining the stable – 10° C. condition. The crystal is normally housed in an oven maintained at 50° C. by a bridge-controlled unit. The temperature at which such an arrangement controls depends upon making the bridge balance at the desired temperature and ensuring that the ambient temperature does not approach too closely the desired operating temperature. For the cold tests, the control bridge was made to balance at – 10° C. and the ambient was reduced to – 20° C. by putting the oven in a domestic refrigerator of the deep-freeze type. Some slight difficulties were experienced when the leads from the oscillator to the crystal iced up, and though these were fairly readily cleared, they account for the intermittent nature of the – 10° C. curve.

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Cadmium in Sea-water

ALTHOUGH cadmium has been detected in a number of marine animals in amounts ranging from 0·03 to 11 mgm. per kgm. of the dried organism[1,2], its presence in the sea has not so far been established except by inference[3]. Thus Baidet *et al.*[4], who were able to identify spectrographically fourteen trace metals in a concentrate from 60 l. of sea-water from Roscoff (Brittany), were not able to detect cadmium. Noddack and Noddack[2] consider that the concentration of cadmium in the sea is less than 0·5 µgm./l.

In the present investigation, cadmium was extracted from 1-litre samples of sea-water from the Irish Sea by means of a chloroform solution of dithizone in the presence of cyanide at *p*H 8·8. The cadmium in the extracts was determined spectrophotometrically by a modification of Saltzman's[5] dithizone method (detection limit 0·006 µgm. cadmium).

The unequivocal detection of cadmium was carried out by evaporation of the dithizone extracts on spectrographically pure calcium carbonate (cf. Wark[6]). The products were examined spectrographically by means of a d.c. arc taking 5·5 amp., between pure graphite electrodes. Blank determinations revealed the absence of cadmium in the reagents. In all the spectrograms of sea-water samples the *raies ultimes* of cadmium at 2288·018 A. and 2265·017 A. were strong, and in some a further line at 3261·057 A. was visible. No other elements could be detected in the dithizone extracts. Tests on known amounts of cadmium showed that the 2288·018 A. line was just visible when 5 mµgm. of cadmium was present. This is a considerably greater sensitivity than can be attained by means of the copper spark method[7], or using sodium fluoride as a carrier[8]. Five samples of surface water from the Irish Sea contained amounts of cadmium ranging from 0·032 to 0·075 µgm./kgm. (mean 0·055 ± 0·012 µgm./kgm. or 0·49 µgm.-atoms/ton). This is lower than the concentrations of either zinc or mercury in the sea (*c.* 80[9] and 1·5[10] µgm.-atoms/ton respectively) and is somewhat less than was predicted by Buljan[11].

Further work is proceeding on the seasonal variation of cadmium in the sea and on its concentration by marine algae.

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Succinoxidase Activity of the Flight Muscles of the Wasp, *Sceliphron cementarium*

In insects, succinoxidase activity has been studied in the milkweed bug[1], in the embryonic cells of the grasshopper *Melanoplus differentialis*[2], in the thoracic muscles of the American cockroach *Periplaneta americana*[3], and in the thoracic muscles of the woodroach *Leucophaea maderae*[4]. Harvey and Beck[3] reported a sex difference in the thoracic muscles of the American cockroach, the males showing three times as much activity as the females. This difference was confirmed by McShan *et al.*[4], who also showed that in the woodroach the male and female thoracic muscles have approximately equivalent succinoxidase activity (see Table 1).

Table 1. SUCCINOXIDASE ACTIVITY IN INSECT THORACIC MUSCLES, AFTER VARIOUS AUTHORS

Insect		Average Q_{O_2} values	Author
Periplaneta americana	♂	275	Harvey and Beck, 1953
" "	♂	167	Kramer and McShan (unpublished MS.)
" "	♀	38·1	
Leucophaea maderae	♂	156	McShan *et al.*, 1954
" "	♀	153	
Sceliphron cementarium	♀	128	Present paper

In the latter paper it was pointed out that a much higher concentration of succinate (0·20 *M*) is required for optimum activity of the succinoxidase system of woodroach muscle than for this system in mammalian tissues such as rat liver, which requires only 0·05 *M* succinate[5]. Harvey and Beck[3] found 0·11 *M* succinate optimum for American cockroach muscle. These results suggest that tissues such as roach muscle, which are high in succinoxidase activity, require higher concentrations of succinate for maximum activity than do tissues comparatively low in succinoxidase activity.

With this in mind a study of succinoxidase in the indirect flight muscles of the wasp, *Sceliphron cementarium*, was undertaken, using identical concentrations of reagents and co-factors worked out by McShan *et al.* for the woodroach. Individual wasps (these were all females collecting mud from the margin of an excavation pool) were brought in from the field during late June, dissected, remnants of the gut and tracheal tubes were cleaned away and the large indirect flight muscles were removed. The tissue was weighed, placed in ground-glass homogenizing tubes contained in an ice bath and homogenized within 8–10 minutes after the wasps were killed. Sufficient water was added to give a 2·5 per cent homogenate.

The enzyme determinations were made by use of the conventional Warburg apparatus. Runs were made using 0·05 ml., 0·1 ml. and 0·15 ml. of homogenate together with the required co-factors and reagents as worked out for woodroach muscle. The final concentrations of co-factors and reagents used n the flasks were 0·2 *M* succinate; 0·05 *M* phosphate buffer *p*H 7·3; 1·6 × 10^{-3} *M* each of calcium and aluminium chlorides; and 2 × 10^{-5} *M* cytochrome c. Sufficient water was added to each flask o give a total volume of 3·0 ml. Flasks were placed n the bath at 38° C., ten minutes were allowed for equilibration, and readings of oxygen consumption were taken at ten-minute intervals for forty minutes. The average value for the number of ten-minute periods, during which oxygen consumption was constant, was used as a basis for calculating the Q_{O_2} values.

Table 2. OXYGEN UPTAKE IN CU.MM. FOR 0·05, 0·1 AND 0·15 ML. OF WASP MUSCLE HOMOGENATE

Run	Amount of tissue homogenate in ml.			
	0·05	0·1	0·15	Q_{O_2}
1	6·5	14·15	20·3	106
2	7·9	17·9	24·8	130
3	9·8	18·9	26·8	147
Average	8·1	17·0	24·0	128

The results of these runs are shown in Table 2. As indicated in Fig. 1, the average oxygen consumption for three wasps, each taken from the field and run on three successive days, gave almost perfect linearity from 0·05 ml., 0·1 ml. and 0·15 ml. of tissue homogenate. The average dry weight of this muscle on the basis of three wasps was 30·6 per cent, and using this dry weight for all calculations, the average Q_{O_2} for the three runs was 128.

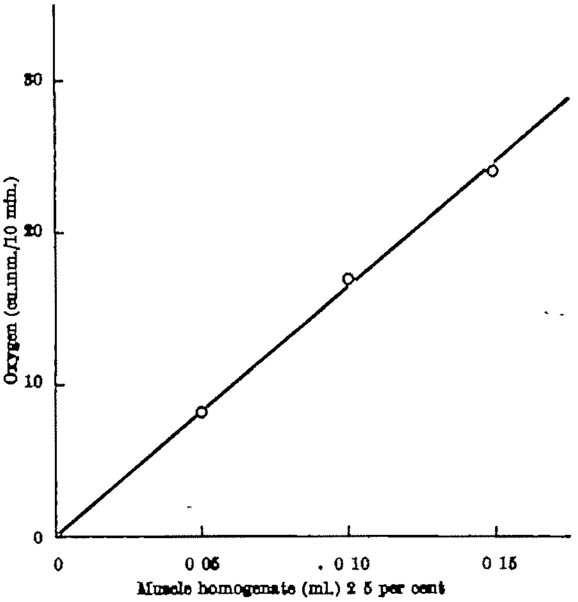

Fig. 1. Relationship between amount of wasp muscle reacting and average amount of oxygen consumed per 10 min.

It is apparent that optimum conditions for the determination of succinoxidase activity of the indirect flight muscles of the wasp *Sceliphron cementarium* are the same as those reported previously for woodroach thoracic muscle.

I am indebted to Prof. W. H. McShan for assistance with this study.

SOL KRAMER

Department of Zoology,
University of Wisconsin,
Madison.
Feb. 9.

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Thermal Reactions of Kenya Cattle vaccinated with Lapinized Rinderpest Virus

Many workers[1] have recorded thermal reactions in cattle following vaccination with lapinized rinderpest virus. In Kenya, thermal reactions are notable by their absence in vaccinated zebu, high- and low-grade European-zebu crosses and pure-bred European cattle[2]. In an attempt to clarify the position, an analysis of 5,295 morning temperatures from 444 cattle, including 113 uninoculated controls, was made. The cattle had been used for the testing of batches of lapinized rinderpest virus vaccine between August 30, 1950, and March 10, 1952. All the vaccinated cattle were found to be immune on challenge with virulent virus and all the control cattle proved to be susceptible.

Table 1. Fifth Day Post-inoculation: the Difference between the Temperatures of Vaccinated and Control Cattle which were Housed Together

	$\bar{x} \pm t_{05} s_{\bar{x}}$		P
	$\bar{x}$	t	
Control	100·7 ± 0·09		
1 : 10	101·0 ± 0·10	2·308*	<0·05 >0·01
1 : 2,000	101·0 ± 0·12	2·383*	<0·05 >0·01
1 : 4,000	100·8 ± 0·10	0·929	>0·05
1 : 10,000	100·8 ± 0·10	0·769	>0·05

* Significant

Table 2. Sixth Day Post-inoculation: the Difference between the Temperatures of Vaccinated and Control Cattle which were Housed Together

	$\bar{x} \pm t_{05} s_{\bar{x}}$		P
	$\bar{x}$	t	
Control	100·6 ± 0·08		
1 : 10	101·0 ± 0·11	2·857†	<0·01
1 : 2,000	101·2 ± 0·13	3·667†	<0·001
1 : 4,000	101·0 ± 0·12	2·429*	<0·05 >0·01
1 : 10,000	101·1 ± 0·10	3·846†	<0·001

* Significant † Highly significant.

Table 3. Seventh Day Post-inoculation: the Difference between the Temperatures of Vaccinated and Control Cattle which were Housed Together

	$\bar{x} \pm t_{05} s_{\bar{x}}$		P
	$\bar{x}$	t	
Control	100·6 ± 0·09		
1 : 10	100·8 ± 0·10	1·429	>0·05
1 : 2,000	101·3 ± 0·14	3·762†	<0·001
1 : 4,000	100·9 ± 0·10	2·528*	<0·05 >0·01
1 : 10,000	101·0 ± 0·09	3·077†	<0·01 >0·001

* Significant † Highly significant.

Pertinent data are recorded in Tables 1, 2 and 3. The normal morning bovine rectal temperature at the Rinderpest Isolation Laboratory, Kabete, altitude 6,000 ft., and situated between the 65° F. and 70° F. isotherms, was 100·63° F. (± 0·02° F.) with a coefficient of variation of 1 per cent. The temperature curves of the uninoculated and the vaccinated cattle were identical except on the fifth, sixth and seventh days after inoculation. Over this period the temperatures of the vaccinated animals were significantly higher and, as might be expected, the rise began earlier in the cattle which had received the higher concentration of the virus.

The thermal reaction in cattle, after inoculation with caprinized rinderpest virus, occurs on the fifth–seventh days, and it is suggested that a similar syndrome is associated with the administration of lapinized rinderpest virus, except that the reaction cannot be detected by an examination of a few animals. Thus the dictum 'no reaction no immunity' might be held to be fulfilled with this, as with other types of live rinderpest virus vaccination.

It is noteworthy that the mean rectal temperature of grade steers was 100·63° F. (± 0·02° F.). This figure is lower than that reported from Europe[3] and India[4].

I am indebted to the Director of Veterinary Services, Kenya, for permission to publish these findings.

G. R. Scott

Veterinary Research Laboratory,
Kabete, Kenya.
Feb. 24.

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A Polarographic Method for the determination of the Gamma Isomer of Benzene Hexachloride in Cattle Dips

One serious practical difficulty in the use of benzene hexachloride in cattle dips is that of loss of biological efficiency.

The accurate biological testing of dip-washes is a difficult and lengthy process; but recently Downing *et al.*[1] have shown that loss of biological efficiency is accompanied by a corresponding diminution in the ratio gamma isomer/total benzene hexachloride. These workers used partition chromatography of the extracted benzene hexachloride for the determination of the gamma isomer; but because this method is not well adapted to routine examination of large numbers of samples, a polarographic approach was attempted.

Under the conditions of high altitude and ambient temperature prevailing at these laboratories, Dragt's[2] method is inconvenient due to the use of acetone as a solvent, and the method of Ingam and Southern[3] gave unsatisfactory results in our hands when applied to the analysis of gamma concentrates containing relatively high concentrations of the interfering[4] heptachlorocyclohexane.

The following method was found satisfactory. A Cambridge voltamoscope was used at sensitivity 1/20 and moderate damping, the midpoint of the galvo oscillations being measured.

The following reagents were used: concentrated hydrochloric acid; 95 per cent ethyl alcohol, redistilled from silver nitrate to remove reducible impurities; 0·5 per cent gelatin solution, prepared daily; 0·2 *M* potassium chloride.

To a volume of the well-mixed sample, containing about 40 mgm. gamma isomer, add one-quarter its volume concentrated hydrochloric acid. Filter, and wash the solids with cold distilled water until free from acid. Dry in a desiccator over solid sodium hydroxide, and when dry, extract the solids with purified alcohol in a Soxhlet. Dilute the extract to 100 ml. with alcohol. Pipette a 25-ml. aliquot into a 50-ml. volumetric flask, add 0·5 ml. 0·5 per cent gelatin and dilute to volume with 0·2 *M* potassium chloride. Filter a portion into a polarographic cell, de-gas with hydrogen or nitrogen, and record the wave between − 0·5 V. and − 1·8 V. versus saturated calomel electrode at 30° C. (This temperature was used because of the high ambient temperature.) To measure the wave-height draw a straight line through the curve at $-0\cdot6$ V. and $-1\cdot0$ V. and extend to meet the $-1\cdot3$ V. perpendicular. The vertical distance between this intersection and the wave at $-1\cdot7$ V. gives the wave-height.

The gamma isomer concentration is read from a standard curve prepared using pure gamma isomer. A convenient range for this curve is 3–15 mgm. gamma isomer, this yielding a straight line, not passing through the origin.

Further aliquots of the alcohol extract are analysed for total benzene hexachloride by normal dehydrohalogenation methods, and the ratio gamma isomer/total benzene hexachloride calculated.

The method of extracting the benzene hexachloride is essentially that of Hitchcock *et al.*, as briefly described by Mackerras[4], while the empirical method of wave measurement is similar to that of Dragt[2].

I wish to thank the Chief Veterinary Research Officer, Tanganyika, for the constant interest he has shown during the development of this method, and the Director of Veterinary Services, Tanganyika, for permission to publish this account.

G. W. Walker

Veterinary Research Laboratories,
Mpwapwa, Tanganyika.
March 2.

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Isolation from the Lower Respiratory Tract of Chickens of Bacteria administered by Mouth

It is generally assumed that bacteria ingested in food or water do not enter the trachea but that all of them pass down the œsophagus. One interesting observation in this respect was made by White and Minett[1], who noted that when calves were fed milk containing *Mycobacterium tuberculosis* primary lesions of tuberculosis were sometimes found in the lungs, indicating that some of the bacteria administered may have been aspirated into the lungs. More direct evidence that this may occur was obtained as a result of some experiments that were designed to trace the route by which *Salmonella gallinarum* enters the body following its administration to chickens by mouth.

In the initial studies large numbers of *Salm. gallinarum* bacteria were mixed in a commercial mash and fed to chickens which were then killed at different times and selected organs cultured. *Salm. gallinarum* was isolated from the lungs of an unexpectedly high proportion of chickens, in some after an interval of time so short as to preclude them having reached this organ via the intestine.

In view of this, four groups each consisting of fifteen nine-week-old chickens were taken. The first group was fasted for 12 hr. and then fed on a commercial mash into which had been mixed an 18-hr. broth culture of *Salm. gallinarum*, 1 ml. per 10 gm. of mash. The culture contained approximately 50×10^7 bacteria per ml. Water was withheld from the second group for 12 hr. This group was then provided with drinking water, every 10 ml. of which contained 1 ml. of the broth culture. 1 ml. of the culture was placed carefully into the mouth of the chickens in the third group by means of a pipette. A similar amount of culture was given to the fourth group by means of a pipette introduced via the mouth into the œsophagus, care being taken to avoid touching the epiglottis.

The chickens were killed ½ hr. later by dislocation of the neck, and, at the same time, a pair of strong artery forceps was fixed, through the skin, around the upper portion of the trachea so as to occlude its orifice. A post-mortem examination was then carried out using aseptic precautions. Cultures were made from the mucous membrane of the lower end of the trachea on to deoxycholate–citrate agar[2] and a portion about 1 in. long of this part of the trachea placed in a tube of selenite-F medium[3]. Most of the left lung was removed, ground in sterile sand and one loopful of this streaked on to a plate of deoxycholate–citrate agar; the remainder was placed in a tube of selenite-F medium. The selenite-F cultures were incubated at 37° C. for 24 hr. and plated on to deoxycholate–citrate agar. All plates of the latter medium were incubated at 37° C. for 24 hr. and then examined for the presence of *Salm. gallinarum*. The results are shown in Table 1.

Table 1

Method of administering *Salm. gallinarum*	No. of 15 chickens in which *Salm. gallinarum* was isolated from: Trachea	Lung	Trachea and/or lung
In food	4	10	12
In drinking water	4	5	7
Into mouth by pipette	9	3	10
Into œsophagus by pipette	0	0	0

Salm. gallinarum was not isolated from the lower respiratory tract of any of the fifteen chickens to which it was given by means of a pipette into the œsophagus. Quite different results were obtained when it was administered by the other three methods, *Salm. gallinarum* being recovered from the trachea or lungs of a considerable proportion of these chickens. It is noteworthy that *Salm. gallinarum* was isolated more frequently from the trachea than from the lungs of the chickens to which it was given by pipette into the mouth (9–3); the reverse was true in the case of the chickens fed infected food (4–10).

Salm. gallinarum was only isolated by direct culture in one case, from the trachea of a chicken given this organism by pipette into the mouth. The other isolations were made through selenite-F medium. It is therefore probable that infection via the lower respiratory tract would be of little significance under natural conditions since chickens would not be exposed to such large numbers of bacteria. However, it is a point to be borne in mind when the production of experimental infections is under consideration.

H. Williams Smith

Animal Health Trust,
Houghton Grange,
Huntingdon.
Feb. 26.

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Tape for Microsectioning of Very Large, Hard or Brittle Specimens

DURING the last decades of the nineteenth century several methods were introduced to make sectioning possible of such hard or brittle specimens as eggs, containing large amounts of yolk granules, and arthropods with a skeleton of chitin, where the usual paraffin technique failed.

The section-surface of the paraffin block was coated with a thin film of collodion, paraffin, shellac or mastic, and this procedure was repeated after each section made.

Sometimes such methods are still used, in case of emergency; but they are rather difficult to handle and very often quite unsatisfactory.

Against these methods a ribbon of cellulose tape applied over and firmly pressed to the section surface of a paraffin block or of a specimen in the freezing microtome serves admirably for the purpose.

The section is very firmly attached to the sticky substance of the tape, and hence it cannot be wrinkled or shattered by the sectioning. Sections ranging from one micron or less in thickness to several hundred microns are always quite even. In fact, there is no trouble at all in sectioning specimens from which it would seem to be impossible to get useful sections with any other method. (For example, with the tape method whole adult mice have been sectioned (for autoradiograms) in a freezing microtome without fixation or decalcification.)

The sticky substance on the tape is soluble in benzene, toluene and xylene. Hence, the paraffin (of paraffin sections attached to tape) cannot be dissolved in the usual manner in benzene. However, the paraffin can be slowly removed in warm amyl alcohol, the sticky substance being insoluble in alcohols.

The cellulose tape is stainable, therefore drops of stain solutions should be applied to the section only. Glycerol can be used as mounting medium.

However, from a histological point of view it is preferable to transfer the section to a glass slide by the following technique.

(1) Mount the section on the tape, with the section turned upwards, on a glass slide with small strips of tape (applied so that they do not cover any part of the section itself). This is in order to get the section on a horizontal level.

(2) Spread out, using a glass rod, ½ per cent solution of celloidin in absolute alcohol and ether, equal parts, to a thin layer all over the section (but not all over the tape). Let the celloidin film perfectly dry in the air.

(3) Transfer the preparation to benzene (or toluene or xylene) in a shallow wide glass dish (for example, a Petri dish) and leave it until (within a few minutes) the collodion film, including the section, can easily be loosened from the tape. Leave the section for a while in benzene, so that all the remaining sticky substance is dissolved.

(4) Smear a cleaned slide rather liberally with egg albumen all over, dip the slide, with the smeared surface upwards, in the benzene and float the section, the previous 'tape-side' down, to the slide. Mount the section on the slide and press and blot it dry with a piece of filter paper.

(5) Transfer, at once, the slide to absolute alcohol and ether in equal parts, and leave it until the collodion is dissolved. In my experience the section is now firmly cemented to the slide.

(6) Transfer the slide to 95 per cent alcohol. Now the section can be treated as an ordinary deparaffinized section fixed on a glass slide, thus suitably stained and finally mounted in the usual manner.

Frozen sections fixed on tape must either be dried (for example, for autoradiograms of water-soluble radioactive substances) or, from a histological point of view, better, of course, be transferred from water to alcohol and to absolute alcohol before the collodion film is applied as described above.

The section can (for photographic registration of radioactivity) be attached directly to the photographic film without egg albumen, but preferably after moistening the film.

The tape method may be useful whenever the ordinary micro-sectioning technique fails and also for cutting very thin sections and for reconstructions. Sections made with the tape technique are even and are uniform from the beginning and never require any deforming treatment.

Series of sections can be made by cutting sections, border to border, on one and the same ribbon of tape, which is held rolled up on each side of the paraffin block above the level of the microtome knife during the sectioning, so that the knife does not cut the tape itself.

AXEL PALMGREN

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Feb. 20.

Zoological Nomenclature

NOTICE is hereby given that, as from November 11, 1954, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full particulars of these cases were published on May 11, 1954, in the *Bulletin of Zoological Nomenclature* in Parts 6, 7 and 8 of Volume 9. (1) *immigrans* Sturtevant, 1921 (*Drosophila*) (Cl. Insecta, Order Diptera), validation of; (2) *pruni* Geoffroy, 1762 (*Aphis*) (Cl. Insecta, Order Hemiptera), validation of; (3) *Lachnus* Burmeister, 1835, and *Cinara* Westwood, 1835 (Cl. Insecta, Order Hemiptera), designation of type species for; (4) *Stentor* Oken, 1815 (Cl. Ciliophera), validation of, and designation of type species for; (5) *Melanargia* Meigen, 1828 (Cl. Insecta, Order Lepidoptera), validation of; (6) Geoffroy, 1762, *Hist. abrégé*; validation of six generic names (*Stratiomys*, *Stomoxys*, *Volucella*, *Nemotelus*, *Scatopse*, *Bibio*) in the Order Diptera, published in; (7) *Palmatotriton* Smith, 1945 (Cl. Amphibia), suppression of; (8) *Ammonites mammillatus* Schlotheim, 1813, designation of neotype for, and *Douvilleiceras* de Grossouvre, 1893, designation of type species for (Cl. Cephalopoda, Order Ammonoidea).

Comments on the above cases should be sent to me as soon as possible.

FRANCIS HEMMING
(Secretary to the International
Commission on Zoological Nomenclature)

28 Park Village East,
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London, N.W.1.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, July 5—Saturday, July 10

Society for Applied Bacteriology (in the Agriculture Lecture Room, The University Department of Agriculture, 10 George Square, Edinburgh)—Annual Meeting and Summer Conference.

Tuesday, July 6

Association for the Study of Animal Behaviour (in the Psychology Department, Birkbeck College, Malet Street, London, W.C.1), at 10.30 a.m.—Scientific Papers on "Some Aspects of Social Behaviour".

Wednesday, July 7

Physical Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4.30 p.m.—Prof. J. A. Wheeler (Princeton University): "Fields and Particles"*.

Royal Meteorological Society (at the National Institute of Oceanography, Wormley, near Godalming, Surrey)—Summer Meeting*.

Wednesday, July 7—Saturday, July 10

Institute of Physics, Non-Destructive Testing Group (at Chancellor's Hall, The University, Birmingham)—Summer Meeting.

Thursday, July 8

At 9.15 a.m.—Annual General Meeting.

Wednesday, July 7—Wednesday, July 14

Institution of Production Engineers (in the National Hall, Olympia, London, W.14)—Production Exhibition and Conference.

Wednesday, July 7—Friday, July 16

Commonwealth Institute of Entomology (in the Large Chemistry Lecture Theatre, Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7)—Sixth Commonwealth Entomological Conference*.

Thursday, July 8—Monday, July 12

British Institution of Radio Engineers (at the University of Oxford)—Convention on "Industrial Electronics".

Friday, July 9

Physical Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4.30 p.m.—Prof. E. Amaldi (Rome): "The European Organization for Nuclear Research"*.

Friday, July 9—Saturday, July 10

Physical Society, Optical Group (at the University, Reading)—Summer Meeting.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant, Grade B (with a good degree and able to teach inorganic and physical chemistry to degree standard) in Chemistry—The Secretary, Norwood Technical College, Knights Hill, London, S.E.27 (July 8).

Agricultural Economist and an Assistant Agricultural Economist (with a degree in economics, agricultural economics or agriculture); and a Lecturer or Assistant Lecturer in Agricultural Economics—The Registrar, University College of Wales, Aberystwyth (July 9).

Assistant Lecturer in Physics—The Registrar, University College of North Staffordshire (July 10).

Lecturer in Physiology—The Registrar, King's College (University of London), Strand, London, W.C.2 (July 10).

Lecturer (with a good honours degree in mathematics and sound teaching experience) in the Mathematics Department—The Registrar, Technical College, Sunderland (July 10).

Physical Chemist (preferably with experience in ultra-violet absorption spectroscopy), to apply spectroscopic techniques to problems of organic chemistry and biology—The Secretary, Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (July 10).

Physicists and Engineers (Scientific Officer and Experimental Officer grade) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for the design and testing of high temperature electronic components for use under severe vibration and climatic conditions—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.161/54A (July 10).

Scientific Officer (with first- or second-class honours degree in chemistry or equivalent, with special emphasis on inorganic chemistry, and an interest in, and a sound knowledge of, mineral analysis), in the Mineral Resources Division, Colonial Geological Surveys, for work in laboratories at Imperial Institute Building, London, S.W.7, on the analysis and examination of minerals and their products, rocks, soils, etc., and the development of methods of analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.382/54A (July 10).

Scientific Officer (with first- or second-class honours degree or equivalent in physics, electrical engineering or mathematics, and preferably with research experience in electronics or aerodynamics, or flying experience with the R.A.F.), at the Royal Aircraft Establishment Experimental Unit, Martlesham Heath, for work on all weather and rapid landing problems of civil and military aircraft, involving co-operation in design and assessment of full scale flight experiments in marshalling, blind approach and landing, and liaison with civil and military aviation authorities—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.160/54A (July 10).

Senior Lecturer (preferably with an interest in the physics of the ionosphere) in Physics, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 10).

Assistant Analyst (with either a university degree or A.R.I.C., and preferably with experience in the analysis of food and drugs)—The County Medical Officer of Health, East Cliff County Offices, Preston, quoting "Assistant Analyst" (July 12).

Scientific Officer (with an honours degree in plant physiology) in the Irrigation Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (July 12).

Lecturer in Moral Philosophy—The Secretary, The University, Aberdeen (July 13).

Assistant Lecturer and Demonstrator (graduate in science or technology, with subsidiary qualifications in biochemistry or physics) to lecture on the pure sciences on which leather technology is based, and to supervise laboratory work—The Registrar, National Leathersellers College, 176 Tower Bridge Road, London, S.E.1 (July 16).

Research Demonstrator in Physics—The Registrar, University College, Leicester (July 16).

Research Officer (with a university honours degree in science with mathematics as major subject, preferably with physics also to a high standard or equivalent qualifications) in the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Sydney, N.S.W., Australia, to organize and take charge of a group which will be responsible for the analysis of the results of cloud seeding experiments, of rainfall and other singularities, and the possible effects of meteoritic dust, and allied problems—The Chief Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2, quoting 780/123 (July 16).

Research Scholar (graduate in science or technology, or other suitable qualification), to carry out research on some problems of interest to the leather industry, and to take part in teaching—The Registrar, National Leathersellers College, 176 Tower Bridge Road, London, S.E.1 (July 16).

Applied Geneticist (Scientific, Senior Scientific or Principal Scientific Officer grade) to work on the problems of fruit and vegetable breeding in Scotland, and a Crop Physiologist (Scientific, Senior Scientific or Principal Scientific Officer grade), to study effect of environment and climatic complex on horticultural crops in Scotland—The Secretary, Scottish Horticultural Research Institute, Mylnefield, Invergowrie, by Dundee (July 20).

Research Scholar (with a good honours degree in chemistry)—The Registrar, The University, Reading (July 24).

Assistant Lecturer (with an honours degree in agricultural chemistry or chemistry) in Agricultural Chemistry—The Registrar, The University, Reading (July 31).

Lecturer in the Department of Botany of the University of Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

Senior Lecturer in Applied Mathematics at the University of Natal, Durban, a Senior Lecturer in Applied Mathematics and a Lecturer in Mathematics, at the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

Senior Research Fellow (with research experience in virology) in the Department of Micro-Biology, John Curtin School of Medical Research—The Registrar, Australian National University, Box 4, G.P.O., Canberra, A.C.T., Australia (July 31).

Administrative Officer (preferably with technical experience appropriate to an organic chemical laboratory), for duties which will include buying, accounting and laboratory management under the Head of the Department—The Secretary, Dyson Perrins Laboratory (Oxford University), South Parks Road, Oxford.

Allen and Hanburys Research Fellowship tenable in the Department of Pharmacology—The Clerk to the Council, School of Pharmacy, University of London, 17 Bloomsbury Square, London, W.C.1.

Assistant (medically qualified, and preferably with experience in bacteriology) for teaching and research—The Secretary, University College Hospital Medical School, University Street, London, W.C.1.

Biochemist (preferably with experience in hospital biochemistry)—The Secretary, Stepney Group Hospital Management Committee, Raine Street, Wapping, London, E.1.

Crop Ecologist (with either a good honours degree in botany with postgraduate training in agriculture or agricultural botany and a sound grasp of statistics, particularly those concerning crop sampling, or a degree in mathematics with experience of statistical techniques and some knowledge of and interest in biometry or botany) in the Department of Soil and Land-Use Survey, Gold Coast Local Civil Service, to collect field data for the various crops grown on different soils—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.79/13/03.

Demonstrator in Botany—The Registrar, Wye College (University of London), near Ashford, Kent.

Design Engineers (with recognized engineering apprenticeship with A.M.I.Mech.E. or equivalent, and experience of special purpose machinery or chemical plant design) in the Department of Atomic Energy, to undertake duties of project engineers, including design and layout of special plant and equipment—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 614.

Graduate Chemist or Metallurgist for work which involves laboratory and field trial studies of the causes and prevention of corrosion of iron and steel and the application of results obtained to practical causes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Corrosion".

Honours Graduate (qualified bacteriologist, or chemist with a sound bacteriological training) in the Bacteriology Department, for work on disinfection involving a study of methods of evaluating chemical sterilizers—The Secretary, National Institute for Research in Dairying (University of Reading), Shinfield, near Reading, quoting 54/6.

LECTURER (with a good honours degree, teaching experience, and preferably other postgraduate, industrial or research experience) IN PHYSICAL CHEMISTRY at Leeds College of Technology—The Chief Education Officer, Education Offices, Leeds 1.

MASTER or MISTRESS to teach biology throughout the school up to university entrance standard—The Headmaster, School House, Keswick, Cumberland

MINERALOGIST CHEMIST (with a first- or good second-class honours degree in geology or chemistry, and experience in the analysis, identification, study, etc., of mineral species) in Tanganyika (Her Majesty's Colonial Service)—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.105/8/04.

PETROLEUM CHEMIST (graduate of a recognized university in chemistry or chemical engineering), to supervise analyses and tests of petroleum products used in aircraft, such as gasoline, jet fuels, engine lubricants, coolants and hydraulic oils—National Research Council, Scientific Liaison Office, Africa House, Kingsway, London, W.C.2.

PROFESSOR (with a degree in chemistry, and teaching experience, preferably in a medical school) OF GENERAL CHEMISTRY, at the Royal College of Medicine, Baghdad—A.S. 12, Almack House, 26–28 King Street, London, S.W.1, quoting A.12/MH/546/IRQ.

RESEARCH ASSISTANTS IN THE DEPARTMENTS OF BOTANY AND ZOOLOGY, CHEMISTRY, MATHEMATICS, METALLURGY (including GEOLOGY) and PHYSICS—The Secretary, Sir John Cass College, Jewry Street, Aldgate, London, E.C.3.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree or equivalent, in mathematics or physics), in London and the provinces, for operational research on a wide variety of problems, under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 285/52/A.

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HUMAN RELATIONS IN INDUSTRY

THE Committee on Human Relations in Industry was appointed in March 1953, following the disbanding in 1951 of the Human Factors Panel of the Committee of Industrial Productivity. It was appointed by the Medical Research Council and the Department of Scientific and Industrial Research, "to examine current activities concerning the study of human relations in industry and to call attention to problems of special timeliness and promise on which research, including applied research and field study, might be undertaken or supported by the Department of Scientific and Industrial Research, the Medical Research Council or other bodies". The first report of this Committee (London : H.M.S.O. 1*s*. net) covers its work for the period March 1953–March 1954, and records approval of twelve projects out of seventy-eight applications received, for which funds totalling £89,000 have been committed. Only two of these projects—Prof. O. L. Zangwill's inquiry in the Psychological Research Laboratory at the University of Cambridge and that under Prof. R. M. Titmuss in the Department of Social Science and Administration at the London School of Economics, on the employment of married women as part-time workers in a London factory—are financed by United Kingdom funds. The remaining projects are being financed by funds made available under the Conditional Aid Programme and derived from United States economic aid.

When the Committee was appointed, it was intended that a programme of research should be built up progressively over several years, and in anticipation of a wide programme of work sub-committees were set up for five broad fields of research: incentives; management organization; promotion and training ; technological change ; and special groups in industry. By critical examination of research proposals prior to discussion on the main committee, these sub-committees have permitted a much more thorough and detailed consideration of such proposals than would otherwise have been feasible in the time available. They have also facilitated informal discussions, both before and after the approval of projects, with members of research groups, and sometimes with members of organizations interested in the results of research in the human relations field. The Committee rightly believes that such direct contacts and informal discussions should contribute to the speedy application of results of research. They could also prevent the initiation of sterile projects or those unlikely to yield information which could not be better obtained by other means. Some scepticism may well be felt as to the value of a pilot research scheme into incentives for management or of a study of the flow of information in industrial organizations, with special reference to the making of decisions relating to production.

It is difficult to comment at this early stage on the value of the initial programme in the light of the information given in the present report. The examination of factors affecting the utilization of university graduates in industry, to be carried out by Political and Economic Planning with Conditional Aid Funds, may well go far beyond what university appointments boards, even when generously staffed, could be expected to do in their day-to-day activities. One part of this inquiry, for example, will endeavour to establish what proportion of arts and science graduates are entering defined sectors in industry, why they are doing so, and what use is being made of them. Another part is concerned rather with the technical colleges, and will seek to indicate ways in which the management needs of local industry can best be met by a technical college.

The one common feature of the projects thus initiated with financial assistance available through Conditional Aid Funds appears to be that the projects can be expected to show some tangible result of practical importance to productivity and industrial efficiency fairly soon, at least by the end of the Conditional Aid programme. Such a condition at once suggests the danger that the Committee's work may be planned too much with the view of short-term rather than long-term needs. Moreover, it is in precisely such conditions that there is the gravest risk of promoting projects of dubious value. Short-term needs are those of which industry itself is most aware and ready to finance itself. Further, where industry has borne no direct responsibility for the financial support of such research, it is apt to be slow in utilizing the results.

That risk may well be inherent in the financing of research in this field generally by Conditional Aid Funds; but the extent of that risk will depend somewhat on the conception of the relation between productivity and human relations in industry which guides the Committee. Wisely, the Committee has rejected any narrow approach to welfare in industry in the sense of merely improving the amenities of work. Its consideration and choice of projects has, on the contrary, been based on the broad conviction that greater satisfaction in work is both compatible with, and essential to, increased efficiency and productivity.

That conviction derives a good deal of support from the work of Elton Mayo and from the studies in management by J. F. Scott and R. P. Lynton for the British Institute of Management and by Dr. W. H. Scott, of the Department of Social Science in the University of Liverpool, on human relations in Merseyside firms; and it probably provides the justification for associating the Medical Research Council with the work of the Committee. Apart from this, the Committee has attempted to base its research programme on matters of direct concern to industrialists and trade unionists, and has taken every step to ensure that its projects have been properly discussed by the research workers with the managements and trade unions concerned. Research into the human relations problems of industry is relatively undeveloped in Britain, and there is a great need over the next few years to raise scientific standards and to improve research methods and the quality of work in this field generally from the scientific point of view. The practical value to industry of research in this field has yet to be demonstrated convincingly in Britain, and the Committee recognizes that a major and sustained effort will be needed to relate the researches to the needs of industry and to ensure that the results are applied to the maximum extent possible.

That being so, caution in the approval of projects is amply justified. The Committee itself recognizes that supply and training of research workers in this field set limits to what is practicable in the way of projects; and it indicates its intention of considering these questions and also the careers available for such workers, particularly from the point of view of combining competence in research with industrial experience. It also proposes to examine further the means of assessing research needs and of co-ordinating research projects; and on what is set forth in this report, the Committee's scrutiny and approval of research projects would appear likely to be increasingly realistic and sensible, provided only due regard is had to the danger inherent in the initiation of projects which industry could fairly be expected to undertake for itself, and to that of assuming that some formula or scientific prescription can be found which will solve any human problem in industry. No narrowing of the field within which decisions can be based on factual knowledge will eliminate the decisive importance of personal judgment.

There is, however, one broad field, in which the Committee has already approved some four projects which should repay all the study it can receive. In this field—the study of the human factors facilitating and restricting the introduction of new production techniques and methods—the project under Prof. Zangwill, being financed by United Kingdom funds, has already been mentioned. Besides this, a study, under Prof. T. S. Simey at the Department of Social Science, University of Liverpool, of technological change and social organization in industry, one of change and adaptation in industry, under Mr. T. Burns at the Social Sciences Research Centre, University of Edinburgh, and a comparative study of some production systems in mining by Dr. A. T. M. Wilson at the Tavistock Institute of Human Relations, London, have also been approved and are being supported by Conditional Aid Funds.

Human problems may readily retard or prevent changes that are necessary to enable the community or industry to reap the benefit of some technical advance, and the Committee rightly stresses the extent to which the competitive position of British industry in the world's market depends on the more rapid and effective introduction of new techniques, new materials or new methods of production. The projects already approved do not cover all the important aspects of this problem, and the Committee is well aware that many of its elements cannot be isolated. While it is endeavouring to commission research which covers both the economic and the social factors involved in the adoption of technical innovations, a joint Science and Industry Committee has been established by the Royal Society of Arts, the British Association for the Advancement of Science and the Nuffield Foundation to investigate the possibility of speeding up the application to industry of the results of research. This Committee, which also has received a grant from Conditional Aid Funds, is to survey research already under way elsewhere in order to see what further study is needed. Its terms of reference include also the identification and assessment of those factors which determine the speed of adoption of particular technical innovations and the correlation of those factors with the characteristics of the firm or industry; the collection of evidence on the effectiveness of measures already taken to expedite the application of science in industry or to remove hindrances to such application; and examination of the possible results of other proposed measures.

It is disturbing to find that even in this field, with a single exception, the projects so far initiated depend for support upon Conditional Aid Funds. The Committee appears to recognize that this position is not sound, but its remark that over the next few years its major task will be to build around the Conditional Aid researches a balanced programme of social science research related to the needs of industry in Britain and financed from British Government funds would be more reassuring without the qualification "as and when these are made available". Even if we accept it as proper that such work of industrial importance should be financed entirely from Government funds without industrial contributions, such an attitude is too acquiescent in a position which can scarcely be regarded as wholly consistent with British self-respect. The generosity of the United States would be more fittingly acknowledged by some immediate and substantial appropriation from our own resources for research.

It is clear from the present report that the Committee is already concerned to determine the correct balance of effort between projects designed to assist the assimilation by industry of existing knowledge, short-term applied research and such fundamental studies as have just been stressed. The Committee may well require the clearly and firmly expressed support of industry and the world of science if it is to succeed in inducing the Government to make available at an early date the funds required to remove the present dependence on external resources. Meanwhile, its commendable caution in the approval of projects should keep those actually initiated well within the capacity of the trained research workers already available, and it appears that there is no intention of excessive expansion before that supply is appropriately increased. Further, the steps already taken to secure the effective co-operation, not only of research workers but also of research institutions, industry and other organizations interested in this field, should ensure that no spurious projects are promoted, but that the investigations set on foot have due regard to the limits as well as to the possibilities of a scientific approach. Attention must also be given to alternative methods which may sometimes provide a speedier, cheaper and pragmatic solution to problems in which scientific or technical factors are only two of the aspects to be considered, and judgment and personality may be the determinants.

FELLOWS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND, 1930–51

Lives of the Fellows of the Royal College of Surgeons of England 1930–1951

By the late Sir D'Arcy Power, K.B.E., F.R.C.S., and continued by W. R. Le Fanu. Pp. xii+889. (London: Royal College of Surgeons of England, 1953.) 42*s*.

THIS work is a continuation of the two volumes entitled Plarr's "Lives of the Fellows", which were published in 1930 and constituted a biographical record of the Fellows of the Royal College of Surgeons of England who died between 1843 (when an order of Fellows of the College was established by charter) and 1930. It was proposed at the latter date to issue a supplement every ten years; but the exigencies of the Second World War and a paucity of funds led to the postponement of publication of this recent volume until now—indeed, it was only the generosity of that distinguished surgeon, the late George Grey Turner, that enabled the publication to be undertaken. Once again the remarkable bibliographic gifts of Sir D'Arcy Power were at the service of the Council, as they had been when the first two biographical volumes saw the light of day, and Power wrote for this volume the lives of all those Fellows who died between 1930 and 1940, only giving up the task on his eighty-fifth birthday, when he presented a typed copy of his work to the President and Council. By a happy chance, also, the names of W. R. Le Fanu and Samuel Wood appear in the introduction to both the 1930 and 1953 works, so that a continuity of the same high standard has been achieved. W. R. Le Fanu has himself been responsible for all the memoirs of those Fellows dying after October 31, 1940; but he has also edited the whole of the recent volume, securing uniformity of presentation without altering the text of the senior author's memoirs already in typescript.

The book is attractively produced, and he who 'reads may run' with those who have made and advanced, and those who have practised, the surgery of the first half of the nineteenth century, since many of the great surgeons of international repute have lived on into the fourth and fifth decades with which this volume deals. The notes are biographical; in the introduction, Power states that the cardinal principles of short memorials are the verification of references, accuracy and the presentation of facts, and that "from Canon Ainger, once Master of the Temple, he had learned that in this type of writing the warning often inserted in obituary notices should be strictly followed: No flowers by request". This good advice has also been scrupulously followed by the present learned and courteous librarian of the Royal College of Surgeons.

Some of the notices, especially the earlier ones, may not seem to emphasize sufficiently the transcendental operative gifts of certain surgeons; but D'Arcy Power's chief interests were never so markedly centred on the art and craftsmanship of surgery although, in fact, at the Bolingbroke Hospital he was one of the very earliest operators to resect successfully a gangrenous intussusception in an infant, while the comparative appraisal of the operative skill of various surgeons was obviously beyond the orbit of Le Fanu. I am profoundly impressed with the vast amount of information collected by the authors about those names that figure in the text, nor is it only concerning surgeons who practised in Britain that the accuracy of the information can be vouched for from personal knowledge: the memoirs dealing with surgeons who practised in the Commonwealth countries furnish a wondrously accurate account and recall to me happy memories of lost friends.

Memory has been said to be an inspiration and incentive to those who labour in similar causes to-day: the perusal of the biographical notes in this volume cannot fail to be of profound interest and perchance inspiration to present-day surgeons and to others outside the surgical profession who find distraction in the stories of those who loyally and devotedly pursue "*Quae prosunt omnibus artes*".

GORDON GORDON-TAYLOR

DETERMINATION OF ADRENOCORTICAL STEROIDS

Memoirs of the Society for Endocrinology

No. 2: The Determination of Adrenocortical Steroids and their Metabolites. (Proceedings of a conference held by the Society for Endocrinology, at the Medical Society of London, on 21 May, 1953.) Edited by P. Eckstein and S. Zuckerman. Pp. vii+92. (London: Dennis Dobson, Ltd., 1953.) 12*s*. 6*d*. net.

THE second memoir of the Society for Endocrinology deals with factors influencing the estimation of adrenocortical steroids by means of their formaldehydogenic properties, with applications of paper chromatographic methods to adrenocortical steroid assays, with the use of sodium bismuthate to convert certain 17-hydroxycorticosteroids into 17-ketosteroids and with improved methods for the extraction of steroid conjugates from urine. In addition, the detection of a previously unidentified adrenal hormone is reported, and a study of the dehydroepiandrosterone output in adrenal virilism presented.

In the first two communications the formaldehyde-retaining properties of urinary extracts are described, a method for overcoming this obstacle to analysis introduced, and a study of the excretion of acid-labile and acid-stable formaldehydogenic steroids, as measured by this improved technique, reported.

Three of the communications are primarily devoted to methods of paper chromatographic analysis. In these the importance of tetrahydrocortisone as a metabolic product the excretion of which reflects the intensity of adrenocortical steroid metabolism is emphasized, and semi-quantitative developments of the paper chromatographic methods described. A useful account of some recent developments of technique in this field is included.

The use of sodium bismuthate in the estimation of 17-ketogenic steroids is described. This technique should prove of great value in that it avoids the large and variable losses inherent in those methods of estimation of the 17-hydroxycorticosteroids which require preliminary acid hydrolysis followed by extraction and estimation of formaldehydogenic or reducing properties. Improved methods are given for the quantitative extraction of steroid glucuronides and sulphates.

The isolation of weighable amounts of a new adrenal hormone 'electrocortin' is described in a communication which undoubtedly constitutes an important advance in the biochemistry of the adrenal cortex. This steroid has an activity some ninety times that of deoxycorticosterone. Indications of its chemical structure have already been obtained.

A method is given for the difficult estimation of 17-hydroxycorticosteroids in plasma, based upon separation on a magnesium trisilicate column and colour development with a phenylhydrazine – sulphuric acid mixture. Measurements of the output of dehydroepiandrosterone and related substances in the urine of patients suffering from adrenal virilism are reported. Such cases appear to be separable into two distinct groups upon the basis of the levels of urinary excretion of 17-ketosteroids and of substances which are chromogenic with the phenylhydrazine – sulphuric acid technique.

The discussions which follow the communications and conclude the sessions materially add to the interest of this volume, which will be valuable alike to the research worker interested in the adrenocortical steroids and to those who follow the rapid developments in this field with the view of their application to clinical problems.

N. R. LAWRIE

THEORY OF SYNTHETIC POLYMERS

Fundamental Principles of Polymerization

Rubbers, Plastics and Fibers. By Dr. G. F. D'Alelio. Pp. x+517. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 80*s*. net.

THE number of volumes on the fundamentals of polymers and polymerization is increasing rapidly. Each is usually addressed to a defined reader, for the subject is not only of purely academic interest but is also important for those who have to deal in the industrial field with plastics, rubbers and synthetic fibres. The author is well known for his practical manuals on the preparation of synthetic polymers, and this volume, being theoretical, is complementary to the other books. It is addressed to those in industry who have to deal with the more fundamental aspects of polymers, and not so much to a physical chemist interested in the development of any particular branch of physical chemistry to polymer systems themselves. The arrangement of the book is somewhat unusual; but it is in conformity with the author's intentions in regard to his potential readers.

First of all there is a very general chapter, its object being to show the place that polymers occupy in relation to other kinds of matter, and the further sub-division of high polymers into plastics, rubbers and fibres. Then follows a chapter dealing in a descriptive way with polymerization reactions in general. Rather strangely the next chapter is devoted to a discussion of the evidence for the existence of macromolecules, a matter which was of interest but is now to a large extent of historical importance only. The properties of polymers in general are treated in one long comprehensive chapter in which the structure of the polymer molecule and the behaviour of the polymer substance are discussed in close relationship to each other. Having thus dealt with matters in general, the author then proceeds in the remaining two-thirds of the volume to examine in detail the processes of polymerization. Polycondensation and addition, reactions have chapters to themselves, and logically there is a chapter on the determination of molecular weights of polymers. Much is necessarily compressed into this chapter, and the intending experimentalist would need to refer to the original works for more detailed instructions on the use of the more complicated methods. Methods of following polymerization and a detailed discussion of the kinetics of free radical and to a lesser extent of carbonium ion reactions receive their proper place in the volume. The final chapter deals in considerable detail with the phenomenon of emulsion polymerization, which is, of course, of very considerable technical importance.

As will be seen from the above remarks, the order of presentation is in a way scientifically illogical; but for those who are interested in the more applied side of polymer chemistry the arrangement is more likely to be acceptable. Polymerization is an open field for nomenclature enthusiasts, and the author brings forward a number of definitions throughout the book. About the time of publication the High Polymer Commission of the International Union of Pure and Applied Chemistry published a recommended system as a result of prolonged discussion, and it is perhaps a little unfortunate that it was not possible for the author to see this document and adopt some of the suggestions. The book was completed in May 1952; but in some of the discussions, particularly on the mechanism of polymerization, the treatment is not quite so up to date as would be expected from the date on the preface. The volume is well printed and bound. Its price is on the high side for purchasers on the eastern side of the Atlantic.

H. W. Melville

BIRDS OF BURMA

The Birds of Burma

By Bertram E. Smythies. Second (revised) edition. Pp. xliii + 668 + 31 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 84*s*. net.

SEVENTY years ago, E. W. Oates published his "Birds of Burma", but the Burma of those days was restricted to that part of the country from Arakan and Pegu southwards. Shortly after the beginning of the present century the whole of Burma came under British rule, and the army officers, civilian officials and others took a great interest in birds. A new book has for a long time been needed, but it was not until a few years before the Second World War that Mr. H. C. Smith, a senior forest officer, planned the present work—or rather the original edition. Mr. J. K. Stanford undertook to prepare the letterpress, and the services of Commander A. M. Hughes, who was at that time stationed in Rangoon, were secured to draw the plates. Then the War came; Hughes and Stanford were recalled home, and though the plates were completed the manuscript was not ready. The present author, Mr. B. E. Smythies, came to the rescue, and by the year 1941 the book was published.

Owing to the War, few copies found their way out of the country, and before the end of the year the book was out of print. Shortly before orders were issued to evacuate Rangoon, Smythies rescued twenty-one of the thirty blocks for the plates and sent them to Calcutta. The original plates were saved by Mrs. Smith, but only through her sacrificing some of her personal belongings so as to keep within the 30-lb. allowance to evacuees flown out of Rangoon. When the Japanese arrived, they collected all the copies of the book they could find in Rangoon and elsewhere and sent them to Tokyo, only to be destroyed later when the building in which they were housed was struck by a bomb.

The new edition has been very considerably enlarged, re-written to a great extent, and brought up to date by Mr. Smythies when home on leave from Borneo, where he is now stationed. The climate and topography of Burma vary a great deal, and in the coastal region the annual rainfall is as much as 250 in., while in the dry zone—which covers much of the centre of the country—it may not be higher than 50 in. The author divides Burma into ten distribution areas, which are more-or-less the same as the civil divisions as shown on a map. As regards vertical zones of distribution, he defines the plains as from sea-level to 3,000 ft., the higher hills from the last elevation to 6,000 ft. and finally the mountains which in some cases go well above 7,000 ft., the highest peak being Loe Long (8,771 ft.) in the Shan States. The vegetation naturally varies according to the rainfall and elevation, and all this is clearly and concisely described in the introduction.

Owing to the geographical position of the country, the birds are of exceptional interest. In the north-west there are species from the Indian region, in the east there is a Sino-Himalayan element above 5,000 ft., and farther south there is a meeting with Indo-Chinese avifauna, while in the Tenasserim peninsula many Malaysian species are found. But taking the country as a whole, the fauna is made up of Assamese birds plus indigenous species; although many species from the adjoining regions penetrate far into the interior, on the whole the avifauna seems so far to have been little affected with the development of the country. It is true that the Burmese, or green, peafowl and some of the silver pheasants have decreased, from shooting and trapping, in the more populous parts of the country. The draining and clearing of a large dismal swamp area in southern Burma to grow rice have banished the spotted-billed pelicans and adjutants which used to breed there in great numbers, and now it is not known whether they nest anywhere in Burma. Writing of the adjutant in the early eighties, Oates described how each October they visited Pegu in great armies, and on first arrival could be seen all over the flat country in groups of fifty close together. In February and March they departed. But these great numbers are a thing of the past, as Mr. Smythies tells us, and though the bird appears to be widespread it is not common in most districts.

There is a short description given of each bird which, together with the plates, should be sufficient to name most of them. There are paragraphs on habits, food, nest and eggs, status and distribution. At the end of the book there is a systematic list with parallel columns showing the distribution of each species in the ten different areas. The thirty coloured plates, with a number of species on each, are a great asset to the book, and Commander Hughes is to be congratulated.

At the present time Burma is closed to ornithologists—which is unfortunate, since so much remains to be done. However, what we do know about Burmese birds has been ably brought together by Mr. Smythies, and the present edition is a great improvement on the first.

N. B. Kinnear

Bertrand Russell's Theories of Causation

By Erik Götlind. Pp. 164. (Uppsala: Almqvist and Wiksells Boktryckeri AB, 1952.) 16 Swedish kronor.

THIS clearly written manual is a good example of a type of composition the primary purpose of which seems to have been the clarification of the author's own mind on the complex subject of Bertrand Russell's treatment of causation. In fact, students of this theme will be grateful to Dr. Erik Götlind for committing his thoughts to print.

Dr. Gotlind begins by remarking that Russell's concepts have changed periodically in consequence of the fundamental upheavals which have occurred in physics during this century. It is this 'functional' relation between the more theoretical aspects of natural science and philosophy which these pages are designed to emphasize. Thus, the plan of the book is to take Russell's major works *seriatim*, and to elucidate his view of causation as events unfold. For example, in 1912, he is still, in the main, anchored to classical mechanics, but seems to be contemplating an abstract form of action at a distance, in which acceleration is dependent upon configuration, at a given instant. By 1914, however, causal connexions can bring events into relation with one another, implying finite temporal extension, a property previously excluded. Again, it is interesting to recall Russell's reluctance to admit (in 1936) Heisenberg's principle; by 1948, much of it had been accepted.

In numerous ways such as these, we gain a valuable insight into the progress over the years of the notion of causal laws. F. I. G. Rawlins

Selected Values of Physical and Thermodynamic Properties of Hydrocarbons and Related Compounds

Comprising the Tables of the American Petroleum Institute Project 44, Extant as of December 31, 1952. By Prof. Frederick D. Rossini, Prof. Kenneth S. Pitzer, Raymond L. Arnett, Rita M. Braun and Prof. George C. Pimentel. Pp. ix+1050. (Pittsburgh: Carnegie Press, 1953.) 7 dollars.

THIS massive progeny of "A.P.I. Research Project 44", a central agency of the American Petroleum Institute concerned with "collecting, calculating, and compiling data of interest to the petroleum industry, covering physical, thermodynamic, and infra-red, ultraviolet, Raman, and mass spectral properties of hydrocarbons and all related compounds", is, as its title reveals, a bench and office reference work—"tables of data . . . of greatest usefulness to engineers as well as chemists and physicists". It may be added that appeal is both to academic and industrial spheres concerned with petroleum and allied hydrocarbons. Components of this volume were obtainable on loose-leaf data sheets as distributed, once or more each year, when ready (the bound work is issued at five-yearly intervals), and this copy embraces all material on physical and thermodynamic properties up to December 1952.

The scope comprises an introduction containing constants, conversion factors and molecular weights of hydrocarbons. This is followed by tables of physical and thermodynamic properties; specific references for tables of properties; general references; index of properties; index of compounds; and finally publications of the A.P.I. Research Project 44. This is indeed scientific reference on the big scale, and it reflects unbounded credit on the team responsible for its achievement. Even if the reader in Britain is unaccustomed to, or troubled by, the small, neat but reduced type in which the contents are displayed, he may be consoled by the fact that, had normal type been employed, this thousand-page volume would have been doubled or even trebled in size, with corresponding increase in cost. H. B. Milner

Annual Report on the Progress of Rubber Technology

Institution of the Rubber Industry. Vol. 17. Pp. xii+174. (Cambridge: Heffer and Sons, Ltd., 1954.) 21*s*.

THE annual reports on the progress of rubber technology, issued by the Institution of the Rubber Industry, have established a reputation as a comprehensive source of information on current developments in every branch of the industry. The 1953 volume follows familiar lines. There are twenty-four sections, which include, in addition to the more obvious classes of manufactured goods, the problems of the plantation industry, the physics and chemistry of rubber, synthetic rubbers, textile fibres and fabrics used in conjunction with rubber, and the use of rubber in roads. Each of the sections is written by an expert in his field and contains a large amount of information in a highly condensed form.

Those sections which deal with the more scientific aspects of the subject are perhaps the least satisfying. The separate treatment, by different authors, of the chemistry and physics of raw rubber and the chemistry and physics of vulcanized rubber reflects an archaic outlook, and might with advantage give place to sections dealing with the chemistry of rubber and with the physics of rubber. This, however, is a minor criticism of a work which on the whole is well balanced, and which provides an excellent survey of present trends of technical development in the industry. L. R. G. Treloar

Wild Flowers of the Ceylon Hills

Some Familiar Plants of the Up-country Districts. By Thomas E. T. Bond. (London: Oxford University Press, 1953.) 17*s*. 6*d*. net.

THE purpose of this little book is to enable the non-botanist to identify, with the least possible trouble, the attractive flowering plants of the hill districts of Ceylon. To this end it contains an elementary key to a hundred and twenty species, mainly based on flower colour, supplemented by sketches of the plants themselves. The sketches are extremely important, since the preliminary subdivisions based on flower colour often involve the inspection of several—in one instance, no less than eleven—sketches in order to determine the identity of the plant.

On the line drawings, therefore, will depend the success of the book. These seem to be adequate for the purpose for which they were intended. The scale of the sketch is indicated by "the average size of the flowers (generally their diameter) in inches"; but there is no indication on the drawing whether the length or the diameter is meant, and it would have been better to have shown the reduction by a simple multiplying factor. The coloured frontispiece is poor: the colours are not correct, and there is no indication of size.

The letterpress is excellent, and a great deal of information about the plant illustrated, and often of other species, is given. The book can be recommended with confidence; it will very greatly add to the pleasure of visitors to the Ceylon hills. N. L. Bor

X-RAY STUDIES OF BIOLOGICAL MOLECULES*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

THE diffraction of X-rays by protein molecules has been studied in the Cavendish Laboratory, Cambridge, for the past fifteen years. The first promising diffraction pictures of hæmoglobin crystals were obtained by J. D. Bernal, I. Fankuchen and M. Perutz in 1938. Previous attempts had met with little success, and the positive results of these three workers were due to the inspiration of keeping these fragile and collapsible crystals in their mother-liquor while taking the photographs, thus avoiding their turning into an amorphous state. Except for interruptions due to the Second World War, Perutz and his colleagues have continued to follow this line of investigation, and I have collaborated in the work owing to my interest in the X-ray diffraction problems it presents. The investigation has, during recent years, been financed by the Medical Research Council, and the generous support of the project by Sir Edward Mellanby and Sir Harold Himsworth has made it possible to build up a research team of chemists, physicists, biochemists and physiologists. One main interest has continued to be the hæmoglobin molecule. It is not uncommon for a student to spend a year or more in attempting to solve the structure of a crystal which contains some atomic arrangement of particular interest, but I can recall no other instance of an attack on one type of molecule which has been continued for so long as it has in this case; and indeed, it is clear that it must be continued for many years to come if all the secrets of its structure are to be revealed. I propose to describe here the difficulties of the problem, and to indicate the exciting possibilities of a deeper insight into the structure of living matter which ultimate success would seem to promise us, possibilities which have lured research workers in the Cavendish and in other laboratories to spend so much time and thought on the X-ray diffraction by protein molecules.

Protein crystals irradiated by X-rays give very perfect diffraction photographs, with an immense wealth of character shown by the positions and intensities of the various diffracted beams. A typical photograph is shown in Fig. 1. We have for many years looked at these pictures much as archæologists must have looked at the Egyptian hieroglyphics, longing for the clue which would enable them to be read. During the past two years Perutz and I have seen some pieces of the puzzle falling into place, and fitting together into fragments of an ordered scheme. During the past six months a line of attack developed by Perutz and his collaborators has shown the relation of these fragments to each other, and has enabled the pattern to be interpreted. It has been like the discovery of the Rosetta stone with its parallel inscriptions in hieroglyphics and known languages, which provided a starting-point for interpreting the hieroglyphics. It must be emphasized at once how very partial and restricted this success is. We only have the picture of the hæmoglobin molecule as seen from one direction, and to a low power of resolution still far from showing up individual atoms. The molecules are not completely separated from each other, since they overlap somewhat in a continuous row. There is still a very long way to go before a model of the molecule can be made with all the atoms in their right places, such as can be done when advanced X-ray analysis has been successfully applied to such molecules as sugar, strychnine or penicillin.

The difficulties which X-ray analysis encounters in studying complex bodies, and the rewards which are gained in the way of a deeper understanding when it is successful must now be briefly mentioned. In the early days of crystal analysis, the structures were solved by a process of trial and error. If we postulate an arrangement of the atoms in a crystal, it is always possible to calculate how this arrangement would scatter the X-rays and to compare these calculations with what is actually observed. If the structure has been guessed correctly, the intensities of the diffracted spots can be explained. In the earliest crystals to be analysed, like sodium chloride, the positions of the atoms were fixed by symmetry. One had only to choose between one possible scheme or another quite different one, and it was in this way that the simple chess-board-like pattern of sodium chloride was found to be the only alternative compatible with the observations. But a greater complexity arose in the case of another of the early crystals to be analysed, iron pyrites. Here the sulphur atoms were in pairs, and the symmetry alone did not tell us the distance between them. This distance was a variable which could have any value and still be consistent with the symmetry. In a recent review of the progress of X-ray analysis, Prof. P. P. Ewald quoted a letter which I sent him in 1914, in which I said that I had got the structure of iron pyrites but that it was "terribly complicated". Solving it meant that one had to try all positions for the sulphur atoms and see which fitted best. It is not really hard to do this for one variable or even two or three; but the difficulties increase very rapidly when there are several variables. It is like one of those combination locks on which there are a number of rings, each with

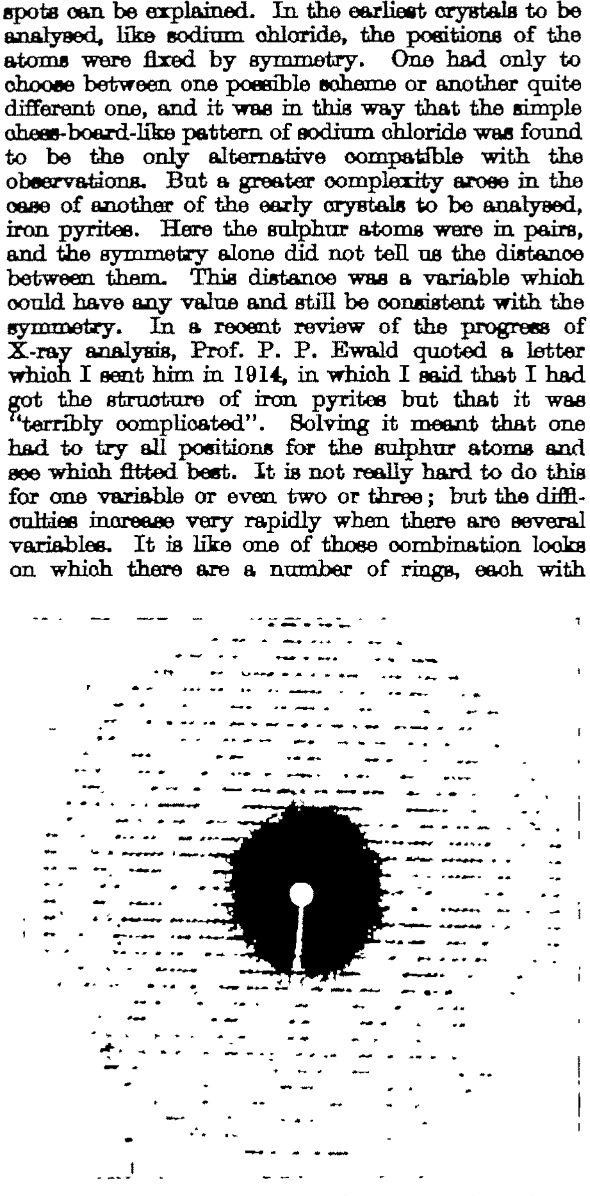

Fig. 1. X-ray diffraction photograph of a form of myoglobin (J. C. Kendrew)

several letters or numbers; every ring must be set at the right point before the lock will open. It would be easy to pick the lock if there were only one ring to try, or even two; but when there are half a dozen the possibilities are so numerous that the lock is proof against anyone who does not know the combination. After the First World War my research school at Manchester set itself the task of solving more complex crystals, and, when we claimed to have found the answer in cases with half a dozen variables, I still remember the scepticism with which our results were received. Our German colleagues, in particular, were very certain that one could not trust the answer when there were so many variables.

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* Friday evening discourse delivered at the Royal Institution on January 29.

Since those days, there has been a very great advance in the art of X-ray analysis. Complicated molecules such as those of the sugars, the alkaloids, the sterols or penicillin have been analysed, although they depend on a hundred or more variables. Success in analysis is possible because guessing has become more clever, as the knowledge of the way atoms build together has increased. However, the process remains essentially one of trial and error. We try various positions for the atoms, like a burglar attempting to open a combination lock, and we know when we have picked it successfully because, generally quite suddenly, everything falls into place, and the hundreds of diffracted spots are completely explained.

What is the reward? It comes because X-ray analysis adds something of vital importance to what the chemists have already discovered about molecules. They have found what atoms enter into the composition of these molecules and in many cases which atoms are attached to which. X-ray analysis goes further in providing a working drawing or blueprint of the molecule, showing the precise position of the atoms in it, the distance between them and the angles between their bonds. It is this element of precision which is so important and gives a far deeper understanding of the physical properties of the bodies which these molecules build up, and the way the molecules can react with each other. Perhaps the most striking example of this was the analysis of the minerals which compose by far the greatest part of the earth's crust—the silicates such as asbestos, mica or felspar and, of course, quartz itself. The mineralogists who studied these substances had divided them into families with unknown relationships between their forms and a bewildering range of compositions. X-ray analysis showed a common pattern running through them all, the element of which was a tetrahedral arrangement of four oxygen atoms around a silicon atom. It is possible for the oxygen of one tetrahedron to be also a part of a neighbouring one so that the silicates can be thought of as made of tetrahedra which can be joined at their corners. Given this clue, the whole mineral world fell into place. One could see that the great families of minerals were the only ones geometrically possible and explain their precise form. The general scheme of the main substances which compose the earth's solid crust could be sketched on the back of an envelope—one of those glorious generalizations which provide such a scientific thrill.

What are the corresponding difficulties and the hoped-for rewards in the case of the biological molecules? The major difficulty is, of course, their complexity. It has been a remarkable X-ray triumph to solve the structure of organic molecules containing some fifty atoms; the molecule of hæmoglobin contains ten thousand. Nature would seem to need molecules of this vast complexity to do the very specialized tasks of living matter. Further, in the case of a sugar or a sterol, one can make a good guess from the start as to what it should look like, basing it on the findings of the chemists and on previous experience with similar molecules. In the case of a protein molecule we are still very largely in the dark. The chemists have told us something about its structure, but its organization is a complete mystery. To attack by X-ray analysis structures which have this complexity of quite a different order is therefore a venture into a new field. Trial and error methods are hopeless, as any burglar would agree, faced with a combination lock with ten thousand rings on it. New techniques must be found. The reward to be hoped for if the search for the structure is successful is, of course, a greater understanding of the properties and behaviour of these molecules. By analogy with the far simpler silicates, we may be able to see why the geometrical demands of the kinds of arrangements permitted to the atoms make the method which Nature has employed the only one which could have effected her purpose in a living body.

The chemists have told us something about these strange bodies which build up living matter. I have called them strange because the way they are built seems at first sight to be so arbitrary, and it is hard to see why Nature should have been forced to use this particular way to achieve her object. The most important constituents are protein and nucleic acid in their various forms.

There are two ways in which one might picture a mechanic building a complex part of a machine which had to perform some very special function. He might take his raw material and fashion it on the lathe and milling machine to some very precise design, to interact in exactly the right way with other components; most mechanisms are of this kind. There is, however, another example of the designer's art which has become of immense importance recently, namely, the arrangement of condensers, inductances and resistances to be found in any radio or other electronic circuit. Here the components are all simple standard pieces, and the art lies in 'composing' them or putting them in the right relation to each other. The complexity in this case lies not in the precise fashioning of a single unit, but in the complex relationship of a number of simple units. It is this second way which Nature has chosen in building living matter.

Proteins are built by joining together in long strings quite simple chemical units, the amino-acids. One half of each amino-acid has always the same plan. This end has, as it were, a chemical hook and eye (that is, acid and basic group), so that the hook can be joined to the eye of its neighbour on its right and the eye to the hook of its neighbour on its left. The other half determines its character, being a small tag of a few atoms of a kind peculiar to that particular amino-acid. There are somewhat more than twenty different kinds of tag. One may compare them to the letters of the alphabet used by the printer, each being a small piece of metal of identical shape at one end, so that it fits into his forme, and with the letter stamped on the other end. In making a protein, Nature works like the printer, joining these letters in a special order to form words and sentences. Just as books of every kind are written with the same letters, so protein of all kinds is composed of these same twenty amino-acids; their special function, it would seem, is due not to some very special kind of complex molecule, but to the order in which these molecules are arranged along the 'polypeptide chain'.

Nucleic acids are also long chains of relatively simple units, the nucleotides. The unit appears to be a very strange one to have been chosen for the particular functions of nucleic acids in the body, which seems to be the determination of the character of the living matter and its handing on from one generation to the next. If the proteins are the machines which do the body's work, nucleic acids appear to be the machine tools used in fashioning them. The common part of each unit is a sugar with a phosphate group attached to it. The character-giving tag is either a six-fold ring or a six-fold ring joined to a five-fold ring, termed a pyrimidine or purine. Broadly speaking, there are only four kinds of these, and it would seem that they always join up in two specific kinds of pair. So, in fact, there are only two kinds of tag in contrast to the twenty-odd amino-acids. We might say that the message of the protein is like one conveyed in writing, whereas the message of the nucleic acid is written in the dot and dash of a Morse code.

I will now indicate in very general terms the way in which it has been found possible to interpret the diffraction pictures given by hæmoglobin. The hæmoglobin crystals have the type of symmetry which is termed monoclinic. They have a two-fold axis of symmetry, so that looking along this axis every element of structure on one side has its counterpart in an equal and opposite direction on the other. We have so far only considered the projection on a plane perpendicular to this axis, that is to say, what we would see if we were looking at the molecule in the direction of the axis. The symmetry is of great assistance in solving the problem.

When X-rays fall on the crystal and a photographic plate receives the diffracted beams, they appear as a complex pattern of spots of different intensities. In dealing with a projection as in this case, the problem is formally analogous to the action of a cross-grating, a regular pattern in two dimensions, which is diffracting monochromatic light. The units of the pattern scatter the incident rays, and the scattered waves build up into wave trains which form the spots. Having recorded these wave trains on the photographic plate, we must somehow try to interpret them and see what kind of pattern produces them. To understand how this is done in a very general way, imagine that we have made an animated cartoon of the process, a rapid succession of drawings of the waves falling on the pattern and being scattered. We should see the incident rays coming along, circular ripples being scattered by each atom, and these ripples combining together to form trains of waves going off in the directions of the different spots. Now imagine that, as we are projecting this animated cartoon, we throw over the lever of the instrument which makes the film run backwards. The trains of waves would start back from the spots, run towards the pattern and there, in a magical way, we would see them combine to turn into little spherical waves, collapsing on the places where the atoms are. So by starting the waves backwards we should see the projected pattern of the crystal by noting the points at which these waves collapse. This must be so because it is always possible to picture a reversal of the light beams in a diffraction problem.

Though, of course, we do not make animated cartoons, this corresponds to what is done in X-ray analysis. We measure the diffraction waves and then calculate mathematically how they would combine if produced backwards into the crystal where they originated.

There is, however, one major difficulty inherent in this process. To make the waves run backwards and reveal the crystal structure, we must know both their amplitudes and phases. The amplitude can be measured because the intensity of each spot is proportional to its square. But we must also start the waves backwards so that their crests and troughs arrive at the atoms at the right relative times, so that they interlace together to reveal the structure. This is expressed scientifically by saying that we must know the phases of the waves, and these phases cannot be measured experimentally. The problem is greatly simplified in the present case because for 'phases' we can simply say 'plus or minus'. This is so because of the symmetry which I have mentioned above. Since the structure is symmetrical about the two-fold axis, the waves which reveal it must be symmetrical; they must make standing waves with either their crests or their troughs at the places of the two-fold axis. So when we look at all the diffracted spots of hæmoglobin, we could solve the structure if we could label each of them with a plus or minus sign. It might at first sight seem easy to try different combinations of plus and minus signs for the spots. There are, however, some hundreds of them, and the number of combinations represented by 2^{100} (about 10^{30}) is very large indeed.

Two technical advances have made it feasible to determine these signs without uncertainty. One is possible owing to a very remarkable property of the hæmoglobin crystal. It can be made to swell and shrink like a concertina, while still remaining a perfect crystal, by altering the constitution of the liquid by which it is surrounded. When it swells, all the diffracted spots appear at smaller angles, and vice versa. Any given diffracted spot may be a 'plus' spot for one crystalline form, and then, as the concertina opens, it may dwindle away to zero and change into a 'minus' spot, because it represents a scattering by the molecule in a series of different directions. So by mapping out the strength of the spots for different stages of expansion and contraction, we can map out regions of alternative sign in the map which represents the way in which the hæmoglobin molecule scatters in different directions. We do not know whether any given one of them is plus or minus, but we can see whether they change from one sign to the other.

The last step has quite recently been made by Perutz. He has found it possible to attach two mercury atoms to the hæmoglobin molecule without altering the crystal structure. Now the way these two mercury atoms scatter is a very simple affair; they produce the well-known diffraction fringes, and it can be told at once whether they are giving a plus or minus contribution in any given direction. If in a place where the mercury gives a plus contribution, it is found that its addition increases the scattering, the hæmoglobin scattering must be plus too. If it decreases, then the hæmoglobin must have been minus. So by noting the differences made by the mercury, Perutz has been able to attach the right signs all over the diffraction picture, reducing the number of possibilities, 2^{100}, to one.

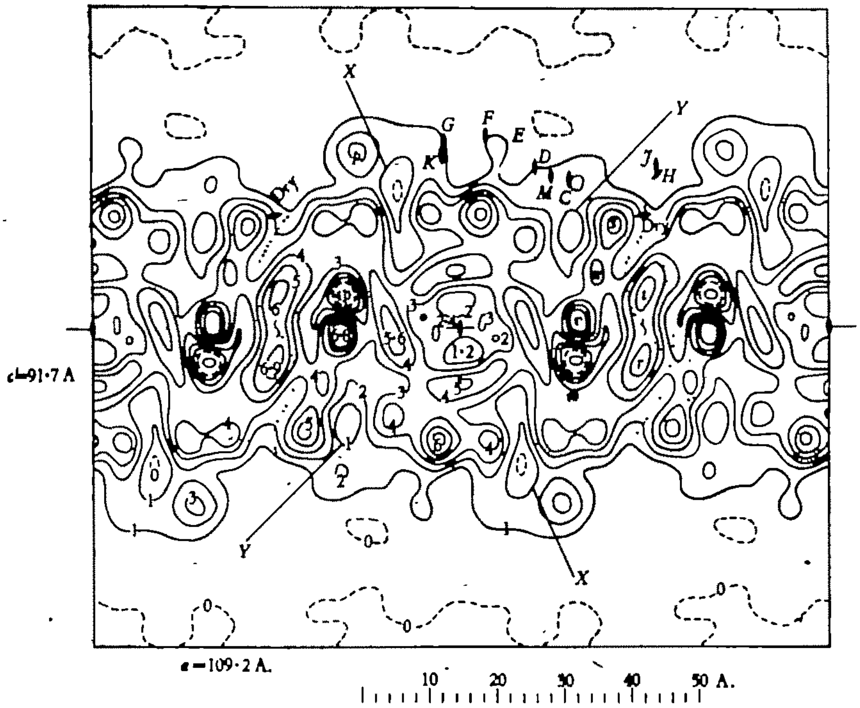

Fig. 2. Projection of a hæmoglobin molecule with two overlapping molecules to right and left. The density is represented by contours. Points where neighbouring molecules in the crystals touch are marked *G*, *F*, *H*, etc.

The rest of the solution follows at once. Knowing these signs, one puts together the waves with the right phase relation, and a picture of the hæmoglobin structure is the result. A picture of this kind is shown in Fig. 2. The masses of scattering matter in the molecules are shown in the way hills and valleys are shown on a map, by drawing contour lines through points of equal density. It will be seen how very incomplete and hard to interpret the results are as yet in this first picture of a protein molecule. In the first place, the resolution, in the sense that this term is used to describe the degree of detail of an image seen in the microscope, is still very low. The inner spots of the diffraction pattern are due to the broader grouping of masses in the molecule, whereas the outer spots arise from the finer details. In the present case only the inner spots have been used, and so the molecule is seen as a kind of diffuse picture with the atoms smoothed out so that they cannot be separated from each other. Now that the secret of analysis has been found, there would appear to be no difficulty in the way of using all the spots in the picture and getting much more detail. In the second place, though the wide variation of the *c* spacing makes it possible to sort the atoms apart in that direction, the crystal does not expand or contract along the *a* direction, which is horizontal in Fig. 2. The molecules overlap to a certain extent along the chain, and so it is impossible to see exactly where one stops and the next starts. Only one crystal has so far been found where the *a* direction shrinks slightly, making it possible to get a hint about the dividing line between the molecules where they overlap. I have not attempted to give here a picture of the separated molecules, because the drawing of the dividing line is still so conjectural.

The structure of nucleic acid should be mentioned in passing, because it illustrates so well one of the main points I have referred to above. Nucleic acid is not crystalline, but by suitable manipulation the long chains can be coaxed into a semi-crystalline form in which they are approximately parallel. Very fine photographs of a form of nucleic acid (deoxyribonucleic acid), prepared by Dr. M. F. Wilkins, have been obtained in Prof. J. T. Randall's laboratory at King's College, London. Quite recently, an X-ray interpretation of this nucleic acid chain was put forward by J. D. Watson and F. H. C. Crick, the correctness of which is strongly supported by the available evidence. The chains are double, the structure being like a spiral ladder with the sides formed by alternate sugar and phosphate groups and the rungs each composed of a purine hydrogen-bonded to a pyrimidine. The special point made by Watson and Crick, to which I should like to refer here, is the peculiar relation of the two kinds of pair, or tag, already mentioned. The two bonds where a rung is linked to a sugar at either end come out at exactly the same positions for either pair turned either way round. It is as if this pair which makes the rung of the ladder were a small bit of 'Meccano' which always just fitted in whichever way round it went. Now it appears highly probable that Nature writes the story of the gene, the hereditary element in the nucleus, by arranging these two pairs in some kind of order along the chain, like a Morse message in dot and dash. For this it is essential that either a dot or a dash may be a rung of the ladder. Is there not perhaps a hint here that Nature had to use phosphate groups, sugar, purines and pyrimidines, because nothing else would do to satisfy such rigid geometrical requirements ?

The main point I wish to make, therefore, is that success in analysing biological molecules by X-rays may explain to us why they have the structure they have. To make a comparison once more with the mineral world, we see that silicon and oxygen together build very stable structures which are light and have a high melting point, and that is why most of the earth's crust is made of silicon and oxygen. Their tetrahedral frameworks conveniently accommodate certain other metal elements, and correspondingly it is found that these rank next to silicon and oxygen in order of frequency of occurrence in the rocks. On the other hand, carbon, nitrogen and oxygen, together with hydrogen, build structures which are relatively unstable, but which are capable of an infinite complexity. This is so because the atoms are fastened together by bonds which have definite positions. Hence Nature has used these elements to make the complex structures of living matter. Now, as in the case of the silicates, we shall perhaps be able to see further into the reason for the arrangements of these elements which Nature actually uses. If in due course we make a voyage to Mars by a rocket-ship, we can confidently predict that mineralogy will be very much the same on Mars as it is on this globe of ours. If we find life there, however, the plants and animals would undoubtedly be of quite a different kind; there is no reason to think they will have developed in a parallel way to ours. But it is quite likely that these strange creatures will be built of protein and nucleic acid, with just the same amino-acids, purines and pyrimidines as Nature has found essential for her purposes here. At any rate, H. G. Wells thought so, for his "The War of the Worlds" gives a ghastly description of the invading Martians capturing and feeding upon the inhabitants of this planet, and how humanity was saved because the Martians succumbed to the bacteria from the attacks of which we had become immune. The Martian could not have assimilated his prey nor fallen a victim to the bacteria unless he were built up of the same proteins as all living matter on this globe. With a prophetic insight Wells appears to have realized that the strange and wonderful way in which we are made is not a matter of chance but is a result of the nature of matter itself.

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

THE ninth international conference of the International Committee for Bird Preservation was held at Scanfs, Ober-Engadin, Switzerland, during May 23–26, and was attended by representatives of the following national sections: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Great Britain, Iceland, India, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, the Union of South Africa, the United States of America and Venezuela, together with representatives of the Conseil International de la Chasse and the International Union for the Protection of Nature, and observers from the Irish Republic and Luxembourg.

One of the most important subjects dealt with was the prevention of the pollution of the sea by waste oil, in which the International Committee for Bird Preservation has taken a leading part for many years. The results of the international conference convened by the British Government during April 26–May 12, with the details of the international convention agreed at that conference, were reported, and the fact that (up to May 18) eleven countries had signed the convention, subject to acceptance, was noted with satisfaction. Proposals for immediate action in order to secure the implementation of the recommendations of the London conference and to secure further information for the future conference envisaged were discussed. It was agreed that the support of all other interested organizations and individuals (such as fisheries, pleasure resorts and hotels, yachting clubs as well as animal and nature organizations) should be secured, and that governments be urged to sign and ratify the convention. to carry out so far as possible the resolutions attached to the convention, and to secure the effective enforcement of the requirements by adequate penalties and supervision. In addition, it was agreed that the keeping of a careful record of the extent of oil pollution on the coasts should be organized, especially with regard to the effectiveness or ineffectiveness of zones, and to promote scientific research on the effect of oil pollution on all marine life, more particularly in respect of fish and plankton, not only in the vicinity of the coasts but also in the ocean, and research on the persistence of the different oils. It was also agreed: to carry out active propaganda to keep the subject of oil pollution before the general public and governments; to give strong support to the recommendation that a further conference be held to review the working of the new arrangements within three years, and that efforts should be made to ensure the inclusion of at least one biologist in each delegation; and to propose to countries concerned with whaling fleets that investigation should be promoted with regard to antarctic conditions, and the possibilities of avoiding discharge of oil by these fleets should be explored.

The representatives of the European national sections present reported on the situation with regard to the ratification by their respective governments of the International Convention for the Protection of Birds, Paris, 1950. Austria, the German Federal Republic, Iceland, the Netherlands and Switzerland stated that their governments were preparing to ratify the convention either in the near future or in the coming year, and at the end of the conference a telegram was received notifying that the Netherlands Ambassador in Paris had ratified the convention on behalf of that country. The representatives of the British Section were in the unhappy position of having to report that there was little chance of their country ratifying the convention, despite the high hopes that had been entertained when the joint proposals for new legislation left the hands of the Wild Birds Advisory Committees to the Home Office and Home Department for Scotland, the main difficulty being the refusal to follow the general trend of modern bird preservation in according the same protection to eggs as to the birds themselves.

Birds which are a menace to other species is an important question, and an international sub-committee to consider the situation with regard to the herring gull (*Larus argentatus*) in the countries bordering the North Sea was set up at the last world conference of the Committee held in Sweden in 1950. The reports of members of this sub-committee were submitted, in which detailed records of breeding colonies of these birds over a number of years were included. Opinions regarding the effect of this bird on other species were widely divergent, representatives from Germany and Holland strongly maintaining that in many places herring gulls were far too numerous and caused great destruction to other species, whereas the Danish ornithologists took the opposite view. Various methods which had been used in controlling the numbers of these birds were discussed, and finally the following resolution was agreed: "The Herring Gull (*Larus argentatus*) has increased, with the aid of disturbances in the balance of nature due to human interference, and in some countries, has, in certain areas, caused a diminution in the breeding populations of other sea-birds. This is only one of a number of biological factors involved, but it seems desirable to obtain the most accurate possible information about the status of the Herring Gull through an annual investigation of breeding pairs and of young reared in the North Sea south of the Skagerrak and the Firth of Forth and in the western Baltic Area. National Sections are invited to arrange such censuses, so far as practicable, according to circumstances in particular countries and to transmit the results of their censuses annually to the I.C.B.P.".

The preservation of wildfowl was dealt with from various aspects, beginning with a report of the work of the International Wildfowl Research Institute (in future to be known as the International Wildfowl Research Bureau), and detailed reports from the organizers of the national counts of wildfowl in Germany, Great Britain, the Netherlands, Sweden and Switzerland. Methods of wildfowl investigations and conservation in the United States were explained, and an account of the work being carried out in Australia was given, followed by more specialized papers such as that on the waterfowl of the Venetian lagoon by Dr. L. Leporati and a review of the situation of the brent goose (*Branta bernicla*) by Dr. Finn Salomonsen, of Denmark. Dr. Salomonsen spoke of the serious decrease in numbers of brent geese and the urgent need for measures to protect this bird, as the species is in danger of extinction. His remarks were supported by speakers from other countries, and finally a resolution was adopted urging the governments concerned to recognize that the brent goose at present be regarded as in danger of extinction, and recommending governments controlling its wintering and breeding areas as well as its migration routes to give it complete year-round protection as an emergency measure, to remain in force unless and until it becomes clear beyond possibility of doubt that the future existence of the brent goose is assured. It was further agreed that the International Committee for Bird Preservation should initiate a detailed international investigation into the status of the European brent goose.

The effect of international trade in plumage, cage birds and carcasses of game birds on the populations of the species involved was dealt with at length. The Venezuelan representative spoke of the difficulties being experienced by his country in preventing the export of feathers of egrets, which though prohibited is continuing illegally, to meet the demand of dealers in Europe. The delegates from India referred to the serious depredations in recent years on the grey jungle fowl (*Gallus sonnerati*) on account of the demand for its hackle feathers; though the bird is protected in India its feathers are being obtained by other countries. In order to assist in preventing the illegal export of birds' feathers from countries where they are protected, and Venezuela and India in particular, it was agreed that the European Organization for Economic Co-operation (O.E.E.C.) in Paris should be urged to remove from the list of merchandise the importation of which member countries have not the right to prohibit, feathers of birds protected in their country of origin, in particular birds of paradise and egrets (the feathers of domesticated birds not included). It was further agreed to recommend that all governments, especially that of the United States of America (where the greatest importation takes place) be urged to prohibit the import of feathers of the grey jungle fowl (*Gallus sonnerati*) from all ports in the Indian sub-continent, since the habitat of this species is peninsular India only, and the species has suffered serious depredation in recent years.

The Australian National Section put forward a resolution regarding the prohibition of the exploitation of live birds in view of the great increase in the exports of wild-caught birds from Australia, which is at present computed to be more than five times that in the years immediately preceding the Second World War, and in 1951–52 was estimated at 48,000 birds. A slightly amended resolution was adopted which recommended that governments of all countries be requested to restrict the export and import trade in wild-caught birds, and only to permit the export of rare and protected species in small numbers to zoos and *bona fide* aviculturists for scientific study and breeding.

The establishment of a series of reserves on migratory routes of birds, initiated at the meeting in Sweden in 1950, was reported upon and maps indicating the position of the reserves were supplied by various national sections.

On the proposal of the German National Section, a resolution was adopted calling for full protection of the white stork in those countries through which these birds migrate in autumn and spring, and on the request of the Danish representatives the black stork was included in this proposal. The need for the better protection of birds of prey was discussed, and the undue destruction of these birds was reported in particular by representatives from France and the Union of South Africa. The importance of birds of prey and the widespread misunderstanding of their value was generally agreed and a resolution adopted as follows: "The Conference learns with regret of the continuing indiscriminate destruction of birds of prey in many parts of the world. This is in conflict with modern biological knowledge regarding the essential part taken by birds of prey in maintaining natural balance of populations. The destruction of birds of prey in general is shortsighted and should be brought to an end, but it is realized that in some exceptional cases properly supervised control measures are sometimes necessary. The Conference recognizes the value of much of the legislation that has recently been enacted and commends the efforts of various governments to enforce such measures. The Conference urges that such measures should be further developed and fully enforced and that educational campaigns be initiated to inform the public of the biological importance of birds of prey". National sections were requested to make suitable representations to their governments to ensure that action is taken in each country in accordance with particular requirements.

Other subjects dealt with were species in danger of extinction. Representatives of various national sections spoke of their concern regarding their native species, among others mentioned being the great Indian bustard and the Australian bustard. The mass destruction of the red-billed weaver (*Quelea quelea*) in French West Africa and the Quaker parrakeet (*Myiopsitta monacha*) in the Argentine by means of fire was discussed; while appreciating that these birds have become pests in these countries, a resolution was passed advocating other less drastic methods of controlling them, and recommending that further investigations be made into the amount of harm caused by their depredations of crops. A report on the International Conference for the Protection of the Fauna and Flora of Africa held in Bukavu in October 1953 was given by Dr. Boje Benzon (Denmark), who had attended the meeting as an observer for the International Committee for Bird Preservation, and representatives of national sections presented reports on the bird preservation situation in their respective countries and on any new legislation that had been introduced.

THE PILTDOWN BONES AND 'IMPLEMENTS'

At a meeting of the Geological Society on June 30, there was again a series of exhibits concerning the bones, teeth and artefacts obtained from Piltdown. This was the third occasion of its kind within nine months. It may be presumed that it will be the last; for the Piltdown objects have lately been reinvestigated in such detail, by so many specialists using so many techniques, that there can scarcely be factual profit from further work upon them.

It is agreed that the skull fragments are human and not of great antiquity; that the jawbone is ape; that they have no important evolutionary significance. More than five hundred articles and memoirs are said to have been written about Piltdown man. His rise and fall are a salutary example of human motives, mischief and mistake.

The first exhibit at the meeting on June 30 was by Mr. A. T. Marston, who has long maintained that the Piltdown mandible and canine tooth are ape, and unrelated to the skull fragments; but who opposes the claim that the jaw and tooth have been deliberately faked. Mr. Marston showed a modern chimpanzee mandible which he had stained with potassium dichromate. It was yellow, in contrast with the chocolate-brown of the Piltdown jaw. He said that he had tried without success to reproduce the Piltdown colour by treating many modern bones with iron salts and chromate. He also contended, illustrating his remarks by specimens, that all the essential characters of wear on the Piltdown teeth are reproduced when articulated casts of orang jaws and teeth, mounted in an appliance to give ape jaw-movements, are 'ground-in' with carborundum paste; that the facet on the upper canine becomes concave from above downwards and spreads to the anterior border; that flatness comparable with that of the Piltdown molars is produced in the molars of the cast; and that the angles of wear on the molars of the cast and the original are identical.

Sir Gavin de Beer, director of the British Museum (Natural History), then introduced a series of exhibits and speakers on work which indicates, in sum, that the Piltdown finds represent a most elaborate and deliberate hoax, and that not one of them came genuinely from Piltdown. He summarized the methods which had been used, and pointed out that they would not only make a successful repetition of a similar style of forgery virtually impossible, but also would be of future value in palæontological research. Sir Gavin emphasized that the author of the Piltdown hoax remains unknown.

Prof. W. E. Le Gros Clark said that the molars in the Piltdown jaw differed from those of a modern large ape in only two significant features—the flat wear of the occlusal surfaces, and the shortness of the roots as seen in X-ray photographs published in 1913. New X-ray photographs had shown that the roots are in fact much longer, and quite similar to those of modern apes. The artificial character of the abrasion of the molars was demonstrated, *inter alia*, by the facts that the dentine on the antero-internal cusp is flat and flush with the enamel; that more dentine has been exposed on the antero-internal than on the antero-external cusps, the reverse of natural wear; that there is no bevel on the margins of the occlusal surfaces and the central talonid basin; that there is lack of conformity between the surface contours of the two molars; and that there are fine criss-cross scratches on them, apparently produced by an abrasive. The canine is evidently a young tooth, yet the whole thickness of the enamel has been removed from the inner surface crown. An X-ray photograph showed that its pulp-cavity had been opened near the apex and plugged with some plastic substance. Lastly, a re-study of the fragments of the so-called 'turbinal bone' showed that they are in fact fragments of a small limb-bone of some animal.

Dr. J. S. Weiner showed that by grinding and polishing the first and second molars of an orang, occlusal surfaces extremely like those of the Piltdown molars, with similar dentine pattern, can be produced; and that the height of the crowns is then almost identical. The chin region of an orang jaw, broken as in the Piltdown mandible, compares closely with the latter in all characters including the simian shelf. After abrading an orang upper canine to the state of the Piltdown canine, it had been easy to insert sand-grains from Piltdown into the pulp-cavity. Dr. Weiner remarked that the Piltdown canine contains very little of the fine sand or silt which one would expect natural infiltration of sediment to introduce.

An exhibit by Mr. S. H. U. Bowie and Dr. C. F. Davidson dealt with the implication of radiometric assays. Dr. Davidson said that during an investigation of the radioactivity of phosphate rock a few years ago, it was found that fossil bones and teeth often have a noteworthy radioactivity, apparently acquired from percolating ground-waters, and with a quantitative relation, taking account of variants of environment, to geological age. He exhibited a tabular statement of the ranges of radioactivity of a large number of bones from sands and gravels of various ages, and another showing the radioactivity of the Piltdown and Swanscombe primate bones. The Swanscombe measurement, 27(eU_3O_8 in p.p.m.), falls within the Middle Pleistocene range. The Piltdown primate fragments all have extremely low radioactivity: 3(eU_3O_8 in p.p.m.) for the left parieto-frontal I; 2, for the occipital I; 1, for the temporal fragment; and all others less than 1. It is possible that the feeble radioactivity of the chromium-bearing left parieto-frontal, and perhaps of other fragments, is due to the presence of the potassium isotope ^{40}K. From these assays, Dr. Davidson said, it appears that the '*Eoanthropus*' remains are Holocene rather than Pleistocene. Dr. Davidson showed that measurements on the other Piltdown vertebrate remains give a remarkably wide range of radioactivity. The three molars of *Elephas* cf. *planifrons* are all far more radioactive than any other British mammalian bones of Tertiary or later age which have been studied; and in an examination of similar *E.* cf. *planifrons* teeth from foreign localities, the same high order of radioactivity is found only once, in a specimen from Ichkeul, Tunisia. On the other hand, the two 'Piltdown' hippopotamus teeth, and some of the beaver bones, are less radioactive than any other Tertiary or Pleistocene fossils which have been examined from any British or foreign source. It seems certain that the bones of the Piltdown 'assemblage' had very different geological and geochemical histories.

Dr. G. F. Claringbull and Dr. M. H. Hey reported on mineralogical and chemical tests. Drillings from the Piltdown cranium were found, on examination by X-ray diffraction, to be mixtures of apatite and gypsum. Gypsum was later found in many other Piltdown specimens. Gravel and loam from the site, and ground-water nearby, were analysed by Dr. R. C. Hoather and Dr. C. Bloomfield and found notably low in sulphate content. But gypsum had also been found in a skull from Barcombe Mill in the C. Dawson Collection in the British Museum (Natural History); and in matrix adhering to this skull there were calcium and ammonium sulphates—though these were not present in freshly collected samples of matrix from Barcombe Mill. It had been thought possible that the gypsum arose from reaction during soaking of the bones in an iron salt to produce staining, and experiments were therefore made on white bone from a neolithic skull. A solution of iron alum even as weak as 2½ per cent produced a fairly full-brown colour accompanied by conversion of the apatite of the skull to gypsum. With ferrous sulphate solution the reaction was less, but there was some replacement of apatite by gypsum. No natural conditions (except perhaps close proximity of a sulphide ore-body undergoing active weathering) could be postulated to produce the same effect. It therefore seemed that the gypsum in the Piltdown specimens was in fact an incidental effect due to artificial treatment by iron solutions in order to produce brown staining.

Dr. K. P. Oakley was the last speaker. He said that other tests had confirmed that the Piltdown mandible is entirely recent. In addition to the nitrogen test, its organic content had been found to be the same as that of fresh bone; and by means of the electron microscope, Prof. J. T. Randall and Dr. A. V. W. Martin had shown that intact collagen fibres occur in decalcified samples of the mandible, whereas none could be detected in the calvaria. Dr. A. E. Werner and Miss R. J. Plesters, of the National Gallery, had reported that the black coating on the canine tooth is a paint of bituminous earth pigment, probably vandyke brown. Dr. Oakley said that the work of Drs. Claringbull and Hey indicates that both the Piltdown skulls I and II are fraudulent; and their composition shows that, unlike the mandible, they are sub-fossil though post-Pleistocene. There is a further complication: the right frontal of Piltdown II could anatomically, from its unusual thickness and histology, have originally been part of Piltdown I. Since analyses have shown that their fluorine/phosphate ratios are in agreement, it could be inferred that these right frontal fragments did belong to Piltdown I, and not to the thinner occipital fragments said to have been found with them. All the Piltdown flints figured as palæoliths, he said, show evidence of artificial iron-staining. Dr. A. E. Moss has estimated that the stain on the flint *E* 606 contains c. 0·1 mgm. chromium per sq. cm. A chip from the cortex of this flint showed that the staining is superficial, with pure white cortex beneath. Dr. Oakley said that the worked elephant bone is certainly fossil, but experiments have demonstrated that it could not have been whittled to its shape while it was a fresh bone, and he showed a fossil bone from the Swanscombe gravel carved with a steel knife to reproduce all the features of the Piltdown implement. From the chemical and other evidence it was judged that the Piltdown bones and teeth had been assembled from a wide variety of sources and that some of them were foreign. The low nitrogen and low fluorine content of the hippopotamus molar can be matched only by material from cave deposits, for example, in Malta [see also p. 65].

OBITUARIES

Prof. J. B. Buxton

Prof. James Basil Buxton, principal and dean of the Royal Veterinary College, died suddenly in his office at the Field Station, Streatley, Berks, on May 25. His death is a severe loss to the veterinary profession in Great Britain, of which he had been a leading figure for many years.

Born in 1888, the son of a veterinary surgeon, he graduated at the Royal Veterinary College in 1919 and, after studying in the University of Liverpool, was for a short time lecturer in hygiene at the Royal (Dick) Veterinary College, Edinburgh.

In 1912 he became the first veterinary superintendent of the Wellcome Physiological Research Laboratories under the directorship of Dr. H. H. (now Sir Henry) Dale, an appointment which afforded him ample scope for development and a congenial atmosphere for work. He there laid the foundations of a department which is noted for its achievements in the field of veterinary research and the control of animal diseases.

In 1922 Buxton joined the scientific staff of the Medical Research Council and was in charge of the Farm Laboratories at Mill Hill, where he organized the investigation into dog distemper which the Council undertook with the aid of *The Field* Distemper Fund. He designed the buildings in which to breed a supply of fully susceptible dogs for experimental use, and drew up the programme of work which was largely followed by Laidlaw and Dunkin in their classical studies on the disease. It was the successful outcome of this project which paved the way to the subsequent work on human influenza.

In 1923 Buxton was appointed to the newly created chair of animal pathology at Cambridge and became responsible for planning and staffing the Institute of that name then about to be established. Within a few years he built up an organization known throughout the world as a centre of research and a training ground for research workers from home and overseas. Among the studies on which he himself was engaged during this period special mention may be made of those on the double intradermal tuberculin test, the standardization of tuberculin and the value of B.C.G. vaccine as an immunizing agent against tuberculosis in cattle.

In 1936 he was elected to succeed Sir Frederick Hobday as principal of the Royal Veterinary College, and under him the College has made great progress as the result of improved staffing and organization. He deserves much credit for the skilful way in which he organized its work in most difficult circumstances when it was evacuated from London during the Second World War, and for the part he afterwards played in its being accepted as a School of the University of London.

Prof. Buxton had a long record of distinguished service to the National Veterinary Medical (now British Veterinary) Association and the Royal College of Veterinary Surgeons and was a past-president of both bodies. For some time he was chairman of the Examinations Committee of the Royal College, and it was largely through his initiative that the course of study leading to the M.R.C.V.S. diploma was extended in 1932 from four to five years.

His name will always be associated with the organization and development of veterinary research and education in Great Britain, in which he has played an outstanding part and thereby made a lasting contribution to the well-being of agriculture.

T. J. Bosworth

Commander J. Hennessy, M.B.E.

The sudden death, in his sixty-ninth year, on May 22 of Commander J. Hennessy, deputy marine superintendent of the Meteorological Office, is announced with regret. Commander Hennessy had been deputy marine superintendent of the Meteorological Office since 1919; but during the Second World War he was in sole charge of the Marine Branch of that Office, in the absence of the Marine Superintendent on active service.

Hennessy played an important part in the reorganization of the fleet of voluntary observing ships after the First World War. This was afterwards developed, in 1930, into the 'Selected Ship' system, whereby weather reports are received by radio from merchant ships all over the world at selected meteorological centres. This forms a modern development of the scheme introduced by Maury in 1855 for the collection of weather information from merchant ships.

Commander Hennessy played a considerable part in organizing the statistical treatment of marine meteorological data. In 1921 the Hollerith punched card system was adopted in the Marine Branch in order to facilitate analysis of the enormous amount of data in ships' meteorological logs which had accumulated and which had previously been laboriously extracted by hand. There is little doubt that without the aid of such a system the compilation of world-wide climatological statistics for all oceans and the resultant preparation of comprehensive marine meteorological atlases which was carried out during the War under Hennessy's direction—in consultation with the Admiralty—would have been an almost impossible task. Since the data used for these atlases covered as long a period as 1855–1939, account had to be taken of the frequent, but unavoidable, changes in international meteorological procedure and codes. The resulting atlases are probably the most accurate and comprehensive of their type in existence.

Among the other work with which Commander Hennessy was closely associated, the preparation of atlases showing the surface currents of the oceans, compiled also from ships' observations, and of atlases giving the distribution of sea ice may be mentioned. He also took a large share of the responsibility for fitting up the British and Norwegian ocean weather ships and the subsequent administration of the former.

Hennessy was a member of the Commission for Maritime Meteorology of the World Meteorological Organization. He was made M.B.E. in the New Year Honours for 1953.

Commander Hennessy not only possessed a square-rigged master's certificate but also had sailed as first mate in a sailing ship—the barque *Minivon*. He later served in steamships and was in command of the Northwest Transport Company's *Uranium*. During the First World War, as a lieutenant R.N.R., he served aboard the armed merchant cruiser *Carmania* and was present during her famous battle with the German *Cap Trafalgar*. He also took part in the Dardanelles landings, aboard H.M.S. *Hussar*, and was later in command of that ship.

Commander Hennessy will be much missed by his many friends in the meteorological world and in shipping circles. He had a very likeable personality; his outstanding characteristics were loyalty and devotion to duty and a fine sense of humour. He is survived by a widow and two sons.

C. Frankcom

Prof. F. London

Fritz London, who died on March 30 at the age of fifty-four years, belonged to those theoretical physicists who in the years between 1920 and 1930 began their first investigations under the guidance of Sommerfeld, and soon were able to make contributions of very great importance. In these years only a very few posts were available for theoretical physicists, and like several others, he aimed at first at a different profession. He took his Ph.D. in Munich in 1921 with a paper on philosophy and started to prepare himself for a teaching career. However, the attraction of theoretical physics overwhelmed his sober plans. His first paper appeared in 1925 (jointly with H. Hönl) and deals with the rules for the intensities of band spectra. Investigations of this type preceded the development of modern quantum mechanics which essentially was completed in 1927. In this year London met W. Heitler in Zurich, where they wrote their classic paper on the homopolar chemical bond. It led to the interpretation of chemical valence in terms of electronic spin and has remained the basic paper on which a vast amount of work by both physicists and chemists has been built. Further developments led to the theory of activation energy in chemical reactions; another important step was the recognition that the tetravalency of carbon is not due to its ground state but to an excited state. Investigation to a higher degree of accuracy of the forces between atoms led in 1930 (in a joint paper with Eisenschitz) to a quantitative understanding of the long-range forces known as van der Waals attraction.

London had spent the years 1928–33 in Berlin where he was *Privatdozent* at the University. In 1933 he went to the Clarendon Laboratory in Oxford and became interested in the old problem of superconductivity. His brother Heinz had just advanced interesting new ideas on this subject, and jointly they found a phenomenological description of the electromagnetic properties of superconductors known now as the London equations. It is on this subject that London has published several monographs which greatly stimulated both theoretical and experimental research.

In 1936 London went to the University of Paris as Maître (later as Directeur) de Recherche, and in 1939 at the beginning of the war to the United States as professor of theoretical (later of physical) chemistry at Duke University. In these years he again extended the subject of his previous interest. Superconductivity had attracted his attention to the high diamagnetism of certain molecules, on one side, and to the superfluidity of liquid helium on the other. In both subjects he found novel points of view linking up with his previous investigations on the structure of matter.

In 1948 he learned that he was suffering of a dangerous heart disease. Thanks to the devotion of his wife, this did not lead to a flagging of his activity and he continued with all his previous fervour in his investigations. The course of London's life was inevitably influenced by the political upheavals of the last few decades; but he moved through all these changes himself unchanged.

H. Fröhlich

NEWS and VIEWS

Chemistry at University College, London :

Prof. H. Terrey

Prof. H. Terrey retires from a University chair of chemistry tenable at University College, London, at the end of September. He will remain associated with University College and the Department of Chemistry there for a further period under the College title of special lecturer, thus continuing a connexion which began so long ago as 1912 (see *Nature*, May 10, 1952, p. 778).

Prof. R. S. Nyholm

Prof. R. S. Nyholm, of the Technical University of New South Wales, Sydney, has been appointed to succeed Prof. Terrey. He is expected to arrive to take up his new duties in the spring of 1955. Prof. Nyholm is a graduate of the University of Sydney. He was appointed an I.C.I. Research Fellow, and afterwards a lecturer, in the Chemistry Department of University College, London, in which he will now serve in his new, senior, capacity. He is distinguished mainly for his extensive and important work on both the structural and physical aspects of co-ordination chemistry.

Division of Animal Health and Production, C.S.I.R.O., Australia :

D. L. B. Bull, C.B.E.

Dr. L. B. Bull, the most senior chief of division of the Commonwealth Scientific and Industrial Research Organization, Australia, has retired from his post as chief of the Division of Animal Health and Production, after twenty years service with the Organization. He has been succeeded by Mr. D. A. Gill, formerly an assistant chief of the Division and officer-in-charge of the McMaster Animal Health Laboratory, Sydney (see *Nature*, June 12, p. 1123). Dr. Bull, who is sixty-five, was born in Auburn, Victoria, and graduated B.V.Sc. at the University of Melbourne in 1911, gaining his D.V.Sc. eight years later. He was appointed deputy chief of the then C.S.I.R. Division of Animal Health, and became chief in the following year. Under his guidance, the Division has become the most extensive of the Organization's establishments, with a total staff of 320 distributed among five main laboratories and eight field stations in different parts of Australia. His advice has been widely sought on the application of scientific method to investigations of problems of national importance, and he was appointed a member of the Australian National Research Council in 1932. He was elected an honorary member of the Section of Comparative Medicine of the Royal Society of Medicine in 1945, and was awarded the diploma of honorary fellowship of the Royal College of Veterinary Surgeons in 1951. He was made a C.B.E. in 1952.

In spite of the heavy administrative burden entailed in Divisional duties, Dr. Bull has continued his personal research work and in recent years has played a leading part in the study of such problems as mastitis in cattle, and copper metabolism in sheep and liver pathology in domestic animals generally. The spectacular success achieved in Australia since 1951 in the control of the rabbit through the agency of the virus disease myxomatosis is in no small measure due to his pioneering research on this problem during 1934–42. He was able to demonstrate not only the difficulties which stood in the way of the spread of the disease by transmission from rabbit to rabbit, but also the possibilities of transmission by means of insect vectors such as various species of Australian mosquitoes and the stick-fast flea. Dr. Bull will not be severing his connexion with the Organization, for he has accepted a senior research fellowship and will be continuing his researches in the field of animal pathology with particular reference to the liver.

United Kingdom Atomic Energy Authority

The following have been appointed members of the United Kingdom Atomic Energy Authority, which takes over the control of atomic energy developments in Great Britain on August 1 : Sir Edwin Plowden (chairman), formerly chief planning officer and chairman of the Economic Planning Board ; Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell ; Sir Christopher Hinton, deputy controller of atomic energy (production), Ministry of Supply ; Sir William Penney, director of the Atomic Weapons Research Establishment, Aldermaston ; Sir Donald Perrott, chairman of the Interdepartmental Committee on Woolwich Arsenal ; Lord Cherwell, professor of experimental philosophy in the University of Oxford ; Sir Luke Fawcett, general secretary of the Amalgamated Union of Building Trade Workers ; and Mr. I. A. R. Stedeford, chairman and managing director of Tube Investments, Ltd. One other member remains to be appointed.

George Eastman (1854–1932)

George Eastman, one of the great pioneers of modern photography, was born in the village of Waterville, New York, on July 12, 1854, and in honour of the hundredth anniversary of his birth a postage stamp bearing his portrait is being issued by the United States Postmaster-General as one of the "Famous American" series. In addition, the Royal Photographic Society will be holding a commemoration exhibition at 16 Princes Gate, London, S.W.7, during August. At the age of fourteen, poverty forced Eastman to leave school and get a job as a messenger boy at 3 dollars a week. He first became interested in photography at the age of twenty-three and, after mastering the clumsy wet-plate process then in general use, turned his attention to the newly invented gelatine dry plate. In 1879 he received a patent for a plate-coating machine, and in the following year began to manufacture dry plates for sale. Within a very few years he substituted for glass his perfected system of roll film photography, and in 1888 brought out a greatly simplified camera which he called the 'Kodak'. With Eastman's box camera the amateur photographer merely pressed a button ; the finishing of the pictures was done in the factory. In 1889 Eastman produced flexible transparent film, and this was utilized by Thomas Edison to make cinematographic pictures. Eastman created a great photographic industry, which to-day as the world-wide Kodak organization has factories and experimental centres in Britain, the United States, Australia, Canada, France and Germany ; photographic products of all sorts and descriptions are manufactured. Eastman was also a pioneer in the field of industrial relations and a great philanthropist. In the early years of his firm, when he had earned a substantial amount of money, he made a personal gift to his employees, and later he instituted a wage dividend plan by which each employee shared in the firm's earnings. In 1919 he gave one-third of his own holdings of company stock, then worth ten million dollars, to his employees, and later he established the retirement annuity, life assurance and disability benefit plan for his workers. He gave dental clinics to London, Paris, Rome, Brussels and Stockholm, and large sums of money to educational institutions, so that in all he gave away more than one hundred million dollars.

The Piltdown Bones and 'Implements'

In view of the recent meeting of the Geological Society (p. 61 of this issue), a communication by Prof. M. F. Ashley Montagu, of the Department of Anthropology, Rutgers University (*Science*, 119, 884; June 18, 1954), in which he poses some pertinent questions, is of interest. He examined the original Piltdown bones in 1951, and now questions the presence of portions of a turbinate, since he cannot recall any instance in the annals of palæoanthropology of this extremely fragile bone ever having been recovered in a fossil hominid. He continues: "If it does naturally belong with the Piltdown bones, then it may be regarded as casting considerable doubt upon the antiquity of the Piltdown skull. . . ." After questioning other points, hitherto accepted as authentic, Prof. Ashley Montagu refers to the 'bone implement', saying: "It is highly probable that when this alleged 'bone implement' is carefully studied it will be found that the terminal facets were produced by a sharp metal blade probably of the Sheffield steel variety; in short, that this 'bone implement' is quite as much a fake as the mandible".

Registration of Chemists and Engineers in the United States

The United States National Science Foundation is to compile a National Register of Scientific and Technical Personnel, and recently it has received two grants for the registration of chemists and engineers, with which it is possible to make a start on the work. The registration of chemists will be undertaken by the American Chemical Society, Washington, D.C., and the Society is sending out questionnaires to an initial list of fifty thousand American chemists. In all, it is expected that information will be obtained from approximately sixty-five thousand chemists, and the details will be kept up to date by the Society. The registration information on each individual will include name, address, education, chemical specialty and current employment. Duplicate copies will be sent to the Foundation for statistical studies and to assist in the mobilization of scientists in time of war. The information will not be used normally for finding posts for, or placing scientists. The registration of engineers will be conducted by the Engineers Joint Council, New York. At present, no attempt will be made to obtain registration information on all the estimated half a million engineers in the United States, but this section of the Register will be limited to about twenty thousand leaders in all engineering fields. The selection will be based on "Who's Who in Engineering" and other sources. The list will be maintained up to date by the Engineers Joint Council.

At the present time ten professional societies or associations are collecting registration information for the Register, the estimated numbers of scientific workers who will be listed being as shown: American Institute of Biological Sciences, 40,000; Federation of American Societies for Experimental Biology, 10,000; American Veterinary Medical Association, 14,000; American Geological Institute, 18,000; American Psychological Association, 11,000; American Institute of Physics, 15,000; American Meteorological Society, 10,000; American Mathematical Society, 12,000; American Chemical Society, 65,000; and Engineers Joint Council, 20,000. The National Science Foundation expects the initial registration of all these classes of scientific workers to be completed by June 1955. Inevitably, some workers are classified in more than one field; but, although there is a danger of duplication of names owing to the decentralized manner in which the registration is being carried out, this is being avoided by liaison between the various bodies, and in the preliminary consolidation of the individual lists it is hoped to be able to eliminate most of the duplications.

The Botanical Survey of India

A scheme for the reorganization of the Botanical Survey of India has recently been approved by the Government of India. The main features of the scheme are: (1) The division of India into a number of regional groups based on phyto-geographic affinities, each under a regional botanist, who will be responsible for the survey of that region. The regional groups will be designated as north, south, east and west, with their headquarters at Dehra Dun or Lucknow, Madras, Calcutta and Poona, respectively. (2) Establishment of a central directorate under an officer who will be designated as the chief botanist, for co-ordinating the activities of the various regional groups and for implementing the policy laid down by Government. (3) The creation of a central botanical laboratory under a director at a suitable place in India, where the living plant will be studied in relation to its biology and its utility to the nation. (4) The maintenance of a Central National Herbarium which will house the 'type specimens' and a fully representative collection of the plants comprising the flora of India. (5) Maintenance of a botanical museum on modern lines in Calcutta.

All existing facilities in the country will be utilized to the fullest in the reorganized Botanical Survey. Collaboration with the universities and research institutions will be encouraged by making grants to staff and research students to conduct research on problems dealing with the flora of India, and for collecting material for the long overdue revision of Hooker's "Flora of India". Inclusion of university students in Botanical Survey explorations and the imparting of practical instructions in collecting and preserving of specimens is also envisaged. The Botanical Survey will search for new economic plants in the unexplored regions of India. The introduction of plants from outside India will also be the function of the reorganized Survey. The director of the Central Botanical Laboratory has been already appointed. She is Dr. E. K. Janaki Amal, who has graduated in the United States, worked at the John Innes Horticultural Institute, London, during the War, and spent several years in the Wisley Gardens of the Royal Horticultural Society.

Two Meteorites Found in Australia

The curator of the Western Australian Museum (Beaufort Street, Perth), L. Glauert, reports that two unusually large meteorites have been acquired by the Museum. Mr. E. C. Johnson, whose farm is about twenty miles south-east of Quairading, has presented what is as yet the largest known fragment of the

Youndegin meteorite (see Simpson, E. S., *Min. Mag.*, 25, 166; 1938), weighing 5,789 lb.; the other meteorite, which weighs 1,057 lb., has been given to the Museum by H. E. and A. G. Carlisle, and was found twenty miles from Rawlinna, on the Trans-Australian Railway crossing the Nullarbor Plain. Although their exact classification has not yet been determined, both are iron–nickel meteorites (siderites).

The Abbey House Museum, Leeds

In 1925 the Corporation of Leeds purchased the Abbey House, and under the direction of the Committee of the City Museums it has been transformed into an interesting museum. A guide, price 6*d*., to the collections has been issued. The guide is well illustrated and clearly indicates how the objects as now arranged are illustrative of the life and work of the people of the region from the Stone Ages in general and from the twelfth century in particular. The costume display is peculiarly effective in that it is supplemented by the Eleanor Williams series of costume dolls, which on account of the accuracy of their dress portrays vividly the fashions and foibles of our ancestors.

Museum of South Australia: Annual Report for 1952–53

The annual report for 1952–53 of the Board of the Museum of South Australia, Adelaide (pp. 12. Adelaide: Government Printer, 1954), directs attention to the fact that there has never been adequate funds to carry out field-work. This is all the more important on account of the great increase of agricultural and other activities and the consequent rapid decrease of the native fauna and flora. For example, during recent years the widespread laying from aeroplanes of baits for wild dogs has had a profound effect on the small marsupials. Notwithstanding the lack of finance, it is interesting to note that a grant of £A.300 enabled a reconnaissance trip to be made to Lake Callabonna to collect specimens of *Diprotodon*. As a result, this important genus is now represented by additional material, including a complete adult, a juvenile skeleton less pelvis and tip of tail, and two large skulls. A detailed report on this material is awaited with interest.

Training in Taxidermy

It is announced in the April number of the ***Museums Journal*** that arrangements have been made by the British Museum (Natural History) and the Royal Scottish Museum for training to be given in taxidermy to members of museum staffs as a preliminary to the examination for the Museum Association's Technical Certificate. Candidates, who must be on the staff of a museum, will be selected by the Education Committee and given training for a period of three months in one of the two institutions. In exceptional circumstances financial assistance may be considered. Applications should be sent to the Secretary of the Museums Association, Meteorological Buildings, Exhibition Road, London, S.W.7.

Floristic Studies

Systematic studies of the flora of tropical America by the Chicago Natural History Museum have been taken a stage further by the publication of another section of "Contributions to the Flora of Venezuela" (***Fieldiana***: Botany, 28, No. 3, 449–678, with line drawings, 1953; 4.25 dollars). This is the work of J. A. Steyermark and collaborators and deals with the orders "Ericaceae through Compositae". A floristic study of a somewhat different kind is that by H. Santapau on "The Flora of Khandala on the Western Ghats of India" (*Rec. Bot. Surv. India*, 16, No. 1, 1953; price Rs. 32 or 49*s*., from Manager of Publications, Delhi). This aims at being a complete Flora (flowering plants only), based on an intensive study of a small but interesting region situated on the western edge of the Deccan Plateau, some 116 km. from Bombay. In an introductory essay the general features of the region are described and matters of special ecological interest discussed. "The Vegetation of Jamaica", by G. F. Asprey and R. G. Robbins (reprinted from *Ecol. Monogr.*, 23, 359; 1953), is a study of plant geography and ecology of an island of special botanical interest. The general features of the island are briefly outlined, and the floristic features are then analysed and discussed under the headings of phytogeography and the varied formations and communities comprised in the flora. This monograph is illustrated by some good photographs, maps and vegetation profile diagrams. The authors conclude that the present vegetation of Jamaica enables a reasonably accurate reconstruction of the original vegetation to be made. They consider that the early descriptions of the island as being covered in dense jungles, with extensive lowland tropical rain forest, are not borne out by this survey.

Discovery

The June 1954 issue of *Discovery* retains the high standard which has been set by its editor, W. Dick, during the past ten years. Dr. W. E. Swinton contributes an imaginative but well-authenticated article on the possible flight mechanisms of pterodactyls which is admirably illustrated by some original line drawings. S. Rogerson links up the prehistory of Brandon in Suffolk with the 'knapping' or chipping of flint stones which is still carried on to-day, complete with a vocabulary which reveals its ancient origins. Britain's false-scorpions are the subject of an article by T. H. Savory, who describes not only their structure, habitat and behaviour but also ways of keeping and feeding them. Horticulturists should appreciate Dr. Kenneth Smith's account of the virus diseases which cause colour breaks in flowers as well as Dr. G. Haskell's description of the history and genetics of the raspberry. Another article deals with the early scientific work on platinum which was done in Spain some time before W. H. Wollaston produced malleable platinum around about 1805. The air correspondent to the journal discusses the atom bomb's effect on airplane design, while short leading articles deal with such varied topics as the future of British sociology, 'hibernation' in operating theatres, coal pumping and myxomatosis.

Earthquakes during March

During March there were some thirty-four strong earthquakes in the world, ten of which had magnitude 6 or greater, and three of these latter had magnitude 7¼. On March 1, at 3.40 a.m. local time, an earthquake was felt over an area in Australia of some seventy thousand square miles from Kangaroo Island to Melrose, near Adelaide; there was some property damage, but no casualties. On March 11 tremors of unknown origin were felt in Bridlington and adjacent places on the east coast of Yorkshire, which caused cracks in plaster, doubtful disturbances being observed on seismograms at the University of

Durham Observatory at 11h. 37m. 59s. and 11h. 38m. 38s., G.M.T. On March 29 one of the earthquakes of magnitude 7¼ occurred in the Sierra Nevada in the south of Spain. Extensive minor property damage occurred over a very wide area, but the maximum felt intensity was only about 4 on the Modified Mercalli scale. The shock was recorded at Edinburgh at 06h. 21m. 04s., G.M.T., and over a very wide area. More than a hundred observatories sent seismogram readings to Strasbourg, where the initial time of the earthquake was evaluated as at 16h. 17m. 09s., G.M.T., and the epicentre at lat. 37° N., long. 3¼° W. From the facts already mentioned, from arrival times at the various observatories, and from the observations that surface waves, if present, had extremely small amplitudes, it is considered that this earthquake had a very great depth of focus (600–650 km.). This is most unusual, since earthquakes with such great depths of focus have only previously been known from foci near the Pacific Ocean; none has previously been found in Europe since adequate instrumental recording began (say fifty years ago). The other shocks with magnitude 7¼ occurred on March 3 with an epicentre in Central New Guinea and on March 31 with an epicentre in the Arabian Sea; the only other shock with deep focus (550 km.) occurred in the Fiji Island region on March 6. Apart from the above, five of the thirty-four earthquakes were experienced in Europe.

Peaceful Uses of Atomic Energy

More than seven hundred scientists, working on the peaceful uses of atomic energy in thirty different countries, are to meet at Oxford during July 19–22 to discuss advances made in the past three years. They are to attend a conference organized by the Atomic Energy Research Establishment, Harwell, on isotope techniques. Developments in medical research and treatment, in industrial processes and in agricultural research will be discussed. Britain has become the leading exporter of isotopes to Europe, the Commonwealth and other countries outside the United States. Most of the materials come from Harwell; but at the Radiochemical Centre, Amersham, the work of a team of chemists specializing in the production of chemical compounds incorporating isotopes has been arousing world-wide interest. Orders at these two centres are now being dealt with at the rate of 15,000 a year, of which more than 5,000 are to other countries. In the past six years radioactive isotopes have been sent to forty-two different countries from the United Kingdom. The conference will be opened by Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell. The sessions will be private, but further information can be obtained from the Secretary, Atomic Energy Research Establishment, Harwell, Nr. Didcot.

Royal Meteorological Society: Officers for 1954–55

The following have been elected officers of the Royal Meteorological Society for the year 1954–55: *President*, Dr. O. G. Sutton; *Vice-Presidents*, Prof. P. R. Crowe, Sir Charles Normand, C. D. Ovey and Prof. P. A. Sheppard; *Vice-President for Canada*, F. W. Benum; *Vice-President for Scotland*, Dr. A. E. M. Geddes; *Treasurer*, Dr. J. S. Farquharson; *Secretaries*, Dr. H. L. Penman, Dr. G. D. Robinson (librarian), R. G. Veryard and Dr. T. W. Wormell (editor).

Announcements

The following elections have been made in the Paris Academy of Sciences: M. André Couder, director of the Paris Section of the Service des Mouvements Progrès Stellaires, to be a member of the Astronomy Section, in succession to the late Prof. E. Esclangon; Prof. J. Kampé de Feriet, professor of fluid mechanics in the University of Lille, to be a *correspondant* for the Mechanics Section in succession to Prof. L. Escande, recently elected a non-resident member of the Section.

Mr. R. D. Edge, of the Cavendish Laboratory, Cambridge, has been appointed a Research Fellow in the School of Physical Sciences of the Australian National University, Canberra. He will work with Prof. E. W. Titterton on the 30-MeV. electron synchrotron which will shortly be erected in the Department of Nuclear Physics. This machine, which was in use at the Atomic Energy Research Establishment, Harwell, until recently, was given by the U.K. Government to the Australian Government for installation in Canberra.

Dr. Charles Kemball, demonstrator in physical chemistry in the University of Cambridge, has been appointed to the chair of physical and inorganic chemistry in The Queen's University of Belfast. The following have been made lecturers in the University: V. C. R. Ford (geography), J. Drewery (psychology), Dr. W. Schwarzacher (geology).

The thirty-third annual general meeting of Fellows of the National Institute of Agricultural Botany will be held at Cambridge on July 16; Sir John Russell is to address the meeting.

The Universities Federation for Animal Welfare will be holding a summer school, open to both members and non-members of the Association, at Knuston Hall, Northamptonshire, during September 18–25. The programme will include expeditions to the Animal Health Trust Research Station at Huntingdon and to an artificial insemination centre and to Cambridge, as well as lectures, discussions and social activities. A fee of 5 guineas, which will include full board and all the expeditions, will be charged (3 guineas for students). Application and all other communications should be sent to the local branch secretary of the Association or to Miss M. Williams, UFAW, 7a Lamb's Conduit Passage, London, W.C.1.

The Electrical Engineering Department of the Imperial College of Science and Technology, London, will hold a five-day vacation school on aircraft electrical systems during September 20–24. The course is designed for a maximum of sixty engineers who already have some experience in the design and application of aircraft electrical power equipment, the object being to bring out, partly by lectures and partly by mutual discussion, the scientific principles underlying the design and application of all types of equipment. The fee for the course (including lunches, refreshments, transport, etc.) will be eight guineas. Hostel accommodation is available. Further information can be obtained from B. Adkins, Department of Electrical Engineering, Imperial College of Science and Technology, London, S.W.10.

RADIO TELESCOPE AT JODRELL BANK EXPERIMENTAL STATION, UNIVERSITY OF MANCHESTER

ON June 10, representatives of the Press and others assembled at the Jodrell Bank Experimental Station of the University of Manchester to inspect the progress on the erection of the radio telescope. The reasons for building the telescope, which is sponsored jointly by the Department of Scientific and Industrial Research and the Nuffield Foundation, were explained by Prof. A. C. B. Lovell, and the engineering consultant, Mr. H. C. Husband of Sheffield, described some of the engineering problems. The essential feature of the telescope is a 250-ft. diameter steel bowl, paraboloidal in shape, 62·5 ft. deep at the focus. This is to be covered with a reflecting screen of 1 inch square mesh. This main bowl, weighing 600 tons, will be carried on two towers so as to pivot on a horizontal axis 180 ft. above ground. The drive for the elevation movement will be by 100-h.p. metadyne motors through 27-ft. tracks which were originally in the battleship *Royal Sovereign*. The two towers are each mounted on six bogies which move on a circular railway track. The bases of the towers are connected by a cross girder to the central pivot. The azimuth motion is obtained by an electrical drive from four of the bogies.

The foundations were completed by the end of 1953. They consist of a concrete ring supported on reinforced piles sunk to the keuper marl (in places up to 90 ft. below ground-level), which carries the 17-ft. gauge double railway track of diameter 350 ft. This railway track, which has to carry a superstructure weighing 1,500 tons, is level to $\frac{1}{4}$ inch, and in order to provide the necessary stability nearly 5,000 tons of steel and concrete have been used in the foundations. The central pivot, which is already in position, is carried on similar deep foundations. A sample of the twelve bogies on which the main steel framework is to be carried was also available for inspection. At the time of the visit, a 120-ft. crane mounted on 60-ft. gabbards was erecting the first of the main 15-ton 120-ft. jib cranes on 120-ft. gabbards, two of which are required to erect the telescope itself. The erection of the steelwork is expected to begin this month and to be largely complete by the end of the year. It is anticipated that the radio telescope will be finished in 1955.

The radio telescope was also discussed by Prof. Lovell in a Friday evening discourse at the Royal Institution on May 21. The need for such a large instrument arose from the desire to obtain high power gain and directivity in the investigation of the radio waves from space. In this the requirements are analogous to those of conventional telescopes. The significant advances in the study of the universe have been made through the medium of large telescopes. Successive increases in aperture, culminating in the great 200-in. on Mt. Palomar, have given more resolving power and more light-gathering power, thereby enabling more distant regions of the universe to be explored. The analogy in radio astronomy is very close; but since the wave-lengths are a million times longer than light, the radio telescopes have to be of far greater size than their optical counterparts. Prof. Lovell described how the new radio telescope would be used for investigating the extra-terrestrial sources of radio noise, or radio stars, so few of which have so far been identified with visible objects. Demonstrations were also given of the use of the radio telescope in the study of meteors, the moon, and of the complex relationships between events on the sun and the disturbances in the earth's ionosphere.

METHODS OF LAND-CLEARANCE FOR AGRICULTURE

ON April 20 a meeting arranged by the Agriculture Group of the Society of Chemical Industry was held at the Royal College of Science, London, to discuss the large-scale clearing of forests. Unfortunately, three out of the five speakers named on the programme were unavoidably absent; the subject-matter of two papers, however (those of R. H. Gunn and A. McBride), was incorporated by Dr. A. H. Bunting, of Tozi Research Farm, Singa, Sudan, into a joint paper entitled "A Review of Methods of Land Clearing".

Dr. Bunting began by pointing out that in many regions of the world land-clearing has always been a fundamental component of agricultural systems and is an integral part of the system of shifting cultivation still widely employed by primitive communities who grow their crops on patches where the bush or forest has first been cut down or burnt. In many tropical areas the nutrient status of the soil is so low that, under the existing conditions of management, only one or two crops can be taken from the cleared area, which is then abandoned and soon becomes covered by vegetation consisting in the main of regrowth from the roots and stumps of the cut woody plants. It is accepted that burning of the cut vegetation before cultivation gives rise to increased yields. The nutrient value of the ash is probably only one of several factors involved. Dr. Bunting stressed the need for further analysis of the function of bush fallow in restoring productivity. Recent work in the Sudan suggests that a type of erosion described as 'surface wash' of the exposed soil may be one reason for the rapid decline in productivity of tropical soils after the bush canopy has been removed. Under these conditions, the top few inches of the soil which may contain the bulk of the accumulated fertility can be washed away.

Modern methods of farming often demand a different type of clearing, involving the complete and large-scale removal of stumps and roots of the existing trees and bushes. Such large-scale clearance schemes are likely to include the following phases: survey of the area by aerial photography and ground observations, followed by the preparation of detailed soil and vegetation maps; production of a land utilization and conservation policy and construction of access roads and labour camps; cutting of the vegetation; disposal of debris; removal and disposal of stumps; and installation of soil conservation works.

An informative analysis was given of the different methods of bush-clearing employed in the Groundnut Scheme in Tanganyika, together with the costs of each operation. Much of the heavy equipment, particularly that used for the removal of roots, caused severe damage to the soil, and the current view is that lighter implements should be used wherever possible. Dr. Bunting concluded by saying that it is not generally appreciated how much detailed information on the bush-clearing techniques had been obtained in Tanganyika and that this information would be of great value in the planning and execution of clearing projects.

The second paper, entitled "The Present Role of Arboricides in Bush and Forest Clearance", was given by Mr. J. D. Fryer, of the Agricultural Research Council Unit of Experimental Agronomy, University of Oxford. The paper was in two parts. The first section reviewed the development of chemicals for killing individual trees or scrub either by individual treatment or by overall spray application. The second part summarized some work on arboricides carried out in Tanganyika and Kenya by members of the Unit of Experimental Agronomy working in conjunction with various organizations in East Africa.

Of the many chemicals that have been tested, arsenical compounds have proved to be by far the most successful, and they are at the present time widely employed in forestry and plantation work for the local treatment—in frill girdles, bark notches or auger holes—of unwanted trees. There is, however, a definite need for non-poisonous substitutes, and much work has been done during the past ten years in an attempt to find materials that are both efficient and safe. The most promising is undoubtedly ammonium sulphamate; but the synthetic growth regulators 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) have also given good results when applied in the same way as arsenical compounds, particularly with smaller trees. These phenoxyacetic acids also show promise when applied in an oil carrier to the bark of the trunk as a basal band of one or two feet. This treatment in effect 'girdles' the stem by killing the bast and cambium and may also destroy dormant buds, thus preventing or reducing regeneration.

During the past few years considerable advances have taken place in the destruction of bush or scrub by arboricides. Extensive areas of scrub along roadsides, under power and telegraph lines and in grassland are being sprayed each year in the United States and Canada with good results; this practice is being developed in other countries, particularly New Zealand. The chemical most commonly used for this work is 2,4,5-trichlorophenoxyacetic acid, generally as a long-chain ester, applied either alone or mixed with 2 : 4-dichlorophenoxyacetic acid. For overall applications from the ground, oil/water emulsions are often applied in a relatively high volume per unit area; but when application is made by aircraft more concentrated oil solutions or emulsions are employed. Ammonium sulphamate in an aqueous solution is also being widely used as an overall application from the ground.

The investigations in East Africa have been mainly of two types: the development of arboricides for the control of regenerating bush of the types found in tsetse-fly barrier clearings in Tanganyika, or for the destruction of *Isoberlinia-Brachystegia* bush in Nyasaland, which is characteristic of large areas where shifting cultivation is practised by the natives; and secondly, the testing and assessment of the value of chemicals as defoliants of woodland as an aid to tsetse-fly control. The results to date of spraying regenerating bush indicate that a complete kill is unlikely to be obtained with the existing arboricides because they are not transported in toxic quantities to the roots and because the species which are adapted to frequent cutting and firing sucker freely from the roots. The overall spraying by aircraft of the butyl ester of 2,4,5-trichlorophenoxyacetic acid on to an area of forest in Kenya resulted in defoliation and death of a great many woody species, including large *Ficus* trees and two succulent species of *Euphorbia*. The role of a defoliant in increasing the light intensity and thereby allowing the rapid growth of the grasses during the rainy season was of particular interest, since a normally unburnable vegetation was destroyed by fire during the following dry season. Further work on arboricides in East Africa is now being carried out in conjunction with the Unit of Experimental Agronomy at Oxford.

After a short discussion, the meeting was closed by Sir Harold Tempany, who said that there is no doubt that, if world food production is to keep pace with the increasing population, extensive clearing of land will have to be undertaken prior to agricultural development and that the techniques and principles of bush and forest clearing discussed during the meeting are likely to have a very real value.

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS

At the invitation of the Maidstone Scientific and Antiquarian Society and the Mayor and Corporation of Maidstone, the South-Eastern Union of Scientific Societies held its fifty-ninth annual congress at Maidstone during June 10–13 under the presidency of Dr. Glyn Daniel. The local committee for the Congress was under the chairmanship of Sir Garrard Tyrwhitt-Drake, with L. R. A. Grove as local secretary. At the young naturalists' evening Maxwell Knight lectured on "The Hand Rearing of a Cuckoo", illustrating his remarks with lantern slides.

The presidential address to the Archæological Section, on "The Present State of Monastic Archæology in Kent", was given by F. C. Elliston Erwood, who dealt with the development of monastic buildings, using Kentish examples to illustrate his points. In mentioning the difference between usual monastic buildings and those of orders of military origin, he emphasized the scope for the examination of the latter within the county. G. E. Newell gave the presidential address to the Zoological Section, his subject being "Animal Zones of the North Kent Coast". He said that the physical environment, the exposure of animals for long periods by tidal action twice daily and large thermal differences demand a toughness in the faunal population. The direction of the beach drift is from east to west, opposite to that often suggested as existing in the Thames Estuary.

Dr. Glyn Daniel's presidential address to the Union was on "The Art of the Megalith Builders". He commenced by saying that although Stonehenge had been examined and studied for a great number of years, it had only recently been noticed that some of the stones had engravings, or decorations, upon them. He then spoke of the engravings on Megalithic stones in Anglesea (circles, lozenges and wavy designs), suggesting they may have been derived from Irish sources, and he compared them with similar patterns on examples in Brittany, Spain, Portugal and along the northern Mediterranean shore to its eastern limit, where engravings of an anthropomorphic character are well advanced. His address was illustrated by excellent lantern slides of subjects very difficult to photograph.

J. E. Lousley, as president of the Botanical Section, spoke on "The Amateur Botanist in 1954", saying that although botanical work now is so highly specialized that, besides expert knowledge, a modern laboratory is necessary, there still remains a great deal of work which can be successfully undertaken by the amateur. Mass observations on species and habitats are needed, and examples where amateurs can assist in collaboration with professional botanists are: a rose survey (charts would be provided and specialized knowledge is unnecessary); records of plant distribution within the vice-counties (plotting species upon maps using the 10-km. grid scale and marking with dots within the grid squares); noting the variation in numbers of a species in a known colony over a number of years; and the study of life-histories and of the method of conveyance of plants to new habitats, especially by the germination of seeds from bird droppings collected after careful observation. H. E. P. Spencer chose, for his presidential address to the Geological Section, the theme of "The Pleistocene Period and Work for the Amateur Geologist", and dealt with his recent work in East Anglia. He said that much remains to be investigated regarding the correlation of the fauna of the interglacial periods, and he suggested that amateurs could render considerable help by recording and collecting from temporary exposures. Norman Cook addressed the members on "Early English Antiquaries".

At the general assembly of the Union schemes for the development of its work were discussed and subjects for investigation outlined. Despite bad weather conditions, the full programme of excursions was carried out. The archæologists visited the Roman villa in course of excavation at Lullingstone, the Keep at Eynsford Castle now being excavated by the Ministry of Works, and Bodiam Castle. The botanists and zoologists went to Funton Creek, Queendown Warren, Bedgebury Pinetum and the Maidstone Zoo at Cobtree Manor. The geologists had an excursion to the Peninsula of Hoo to study the Tertiaries, the Chalk outcrop and the history and development of the North Kent marshes.

The sixtieth annual congress of the Union will be held next year in Folkestone during April.

BASIC SCIENTIFIC RESEARCH AND PUBLIC POLICY IN THE UNITED STATES

DESPITE the concern still being expressed in the United States regarding the adequacy of support for fundamental research, of which Dr. W. D. Coolidge's plea for more fundamental research effort (see *Science*, 119, 110; 1954) is a recent example, there is not the same sharp note of anxiety on this score in the third annual report of the National Science Foundation*. Removal by Congress of the 15 million dollar ceiling upon annual appropriations to the Foundation has permitted the Foundation to assume greater responsibility for the support of basic research; and the Board of the National Science Foundation has been encouraged by the sympathetic understanding of its problems by many members of Congress, although misunderstanding of science and its methods is still widespread. Wider public understanding of science, scientists and the implications of scientific development is of vital concern, in the view of the Board, not only to the Foundation itself, but also to the Federal and State Governments, academic institutions and industrial concerns.

The limits of expenditure on fundamental research are now set, the Board believes, not by financial resources but by the numbers of men and women with the capacity, interest and willingness to pursue science. They constitute a restricted section of the population, and science is not the only profession calling for high intelligence and disciplined ability. Accordingly, solutions to many current problems reside in the long-term functions of the National Science Foundation, and in his foreword to its annual report, Mr. Chester I. Barnard, chairman of the Board, makes it clear that the Foundation is increasingly concerning itself with these long-term functions.

Fundamental research has three relatively immediate consequences: the production of scientific workers; the production of new knowledge, much of which may prove useful in ways unforeseeable to-day; and the application of the results of research to the solution of practical problems. These consequences could encourage a tendency to utilize the Foundation for secondary purposes and administrative convenience, or else government interposition in science to an extent which, by attempting to dominate, might destroy it. Mr. Barnard insists that the Board is alive to these dangers and determined to operate so as to minimize them; and this contention is fully supported by the most important section of the director's report, namely, that dealing with science and public policy.

The detailed work of the Foundation during the year is described by Dr. A. T. Waterman. Studies carried out by the Foundation of the Federal Research and Development Budget on which he here comments have already been noted in *Nature* (172, 575; 1953). Dr. Waterman states specifically that it will be desirable to review periodically the relative support furnished to fundamental and applied science; but he points out that centralization of support of fundamental research in the Foundation will not be in the best interests of science unless, together with other research agencies, the Foundation can provide sufficient support for fundamental research to bring it in balance with the support given to applied research and development. Moreover, if operating agencies are to carry on fundamental research programmes directly related to their operating functions, they must be assured of a continuous direct flow of fundamental knowledge relating to their practical problems, and their staff should be in effective touch with other scientific workers.

Dr. Waterman's report indicates certain steps already taken by the Foundation towards the co-ordination of Federal research, and he refers to the appointment by the Foundation, in accordance with the recommendation of the President's Materials Policy Commission, of a committee to assist in formulating a broad programme of research and training directed towards strengthening the exploration and discovery of mineral resources; the development of measures to finance and execute such a programme; and the identification and study of background data and questions of policy which affect the conduct of research and training in this field. Of even wider interest, however, is the section of this report which deals with travel restrictions on foreign scientists, and this puts the question of contacts between scientific workers in its widest perspective.

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* The Third Annual Report of the National Science Foundation. Year ending June 30, 1953. Pp. vii+110. (Washington, D.C.: Gov. Printing Office, 1953.) 40 cents.

Dr. Waterman then turns to the question of admission of foreign scientists to the United States. Since the restrictions were enlarged between 1948 and 1950, and afterwards embodied in the codified law which became effective in December 1952, it has been the practically unanimous opinion of scientific workers that relations between American scientists and their opposite numbers in countries friendly to the United States, particularly in the United Kingdom and other countries in Western Europe, have deteriorated. At least half of all foreign scientists who apply to enter the United States meet difficulties or serious delays. Refusals of permission to enter are much less frequent, and the chief damage to international relations arises from a few instances of refusals to outstanding persons, and from the tediousness and uncertainty of the procedure even for those who are admitted.

In testifying in October 1952, before the President's Commission on Immigration and Naturalization, concerning the impact of existing immigration laws on science, Dr. Waterman pointed out that creative scientific ability is not circumscribed by national boundaries. He referred to America's dependence on findings and accomplishments in pure science abroad in achieving her own advanced technology and standards of living. Excluding students, about three thousand foreign scientists are estimated as having visited the United States in 1951, and Dr. Waterman said that their importance to the scientific strength of the United States was out of all proportion to their number, as, generally speaking, they represented the best scientific minds of the free world outside the United States.

In closing his comment, Dr. Waterman made four specific recommendations which would, he believed, achieve a better balance between security by isolation and security by technological achievement. First, he suggested a distinction between procedures and criteria for temporary admission, particularly a visit of a few weeks or months, and those for permanent residence. For the former, he suggested that the criterion for exclusion might rationally be based on present sympathetic association with a foreign subversive organization, rather than, as now, affiliation in an extremely broad sense of the word at any time in the past with such an organization. Third, he suggested that provision should be made for selective audit from time to time of applications for temporary admission by a competent, reliable and disinterested group with appropriate experience both inside and outside government. This suggestion is prompted by the wealth of experience accumulated with security programmes in which a balance must be struck between isolation and technological achievement.

Lastly, if these suggestions prove impracticable, Dr. Waterman recommends the establishment of a separate section of the immigration law, creating a simplified and expeditious system for admitting students, trainees, teachers, guest research workers, professors and leaders in fields of specialized knowledge and skill who have applied for admission for a purpose directly related to the activities of a government agency, an accredited institution of higher learning or a scheduled meeting of an accredited international professional organization.

It is not known what reception these proposals met; but if in due course even the fourth only is adopted, some of the friction at present experienced should be removed and a real contribution made to the exchange of thought, of experience and of knowledge upon which the advance of science and technology alike depend. As Dr. H. W. Dodds, president of Princeton University, remarked in a recent comment in the *Universities Quarterly* on the Seventh Congress of the Universities of the Commonwealth last July, one welcome result of the presence of its American guests was to remove some misunderstandings outside the United States as to the extent to which current Congressional practices have endangered freedom of scholarship and of communication. None the less, it would be ungenerous not to welcome the firmness of Dr. Waterman's evidence in favour of scientific and technological mobility and communication or to fail to note that the leadership of the National Science Foundation is in the hands of those who understand so clearly the fundamental conditions of the advancement of science and technology and who are not afraid to add their testimony to that of other leaders in science, scholarship, teaching or industry, whether in the United States or elsewhere in the free world.

PLANT GENERA

THE Chronica Botanica Co. has once again placed botanists in its debt by bringing together the papers of a symposium (Cornell, 1952) of the American Society of Plant Taxonomists and the Botanical Society of America under the title of "Plant Genera, Their Nature and Definition" (*Chronica Botanica*, **14**, 3, 89–160; 1953; 2 dollars; Chronica Botanica Co., Waltham, Mass.; Wm. Dawson and Sons, London, W.C.1). The book contains a foreword by Dr. Frans Verdoorn, an introductory essay by Dr. Th. Just on "Generic Synopses and Modern Taxonomy" and the following symposium contributions: "Plant Genera, their Nature and Definition: the Need for an Expanded Outlook", by Dr. G. H. M. Lawrence; "The Anatomical Approach to the Study of Genera", by Dr. I. W. Bailey; "Floral Anatomy as an Aid in Generic Limitation", by Dr. A. J. Eames; "Cytogenetical Approaches to the Study of Genera", by Dr. R. C. Collins; "Cytology and Embryology in the Delimitation of Genera", by Dr. M. S. Cave; and "Plant Geography in the Delimitation of Genera: the Role of Plant Geography in Taxonomy", by Dr. H. L. Mason. Interleaved with these essays are facsimiles from early generic Floras.

As the above titles indicate, the nature of the botanical genus in its many aspects and relationships is very fully reviewed and discussed; and while the delimitation of genera in all classes of plants by hard-and-fast rules has not yet been found possible, there is general agreement that the genus is probably the most natural, comprehensive, useful, important and effective taxonomic unit applicable to all groups. It is probably also the unit—the genus being most simply defined as a group of related species—of greatest use to the non-taxonomic botanist.

In his discussion of the difficulties of generic delimitation, Dr. Lawrence considers that taxonomists must function as synthesizers, and bring to bear on each problem all relevant data from related fields of botanical study. He also suggests a number of practical steps which may be taken to achieve this desirable end. Dr. Bailey considers that it is essential to determine what contributions anatomy can actually make to taxonomy, since some characters that appear to be relatively stable in some groups may be highly plastic in others; that is, internal characters are inherently no more reliable than external ones. One of his conclusions is that, because the anatomical approach is so time-consuming, it should in the main be reserved for those specially difficult problems where the significance of the results is likely to justify the effort expended. The anatomical approach to taxonomy has been especially rewarding in certain groups, in particular in certain ancient and primitive woody dicotyledons. Dr. Eames points out that, in taxonomic and phylogenetic studies, the internal structures of the flower are just as valuable as, and, in some instances, for example, where parts are vestigial, may be even more valuable than, the external form. But the evaluation of internal floral structures, as evidence of natural relationships, requires a wide knowledge of this field of observation and an awareness of the prevalence of evolutionary parallelisms and convergences. At the generic level, groups of floral anatomical characters, and even some rather specific ones, may be surprisingly well defined. Dr. Eames gives many interesting examples of the application of floral anatomy to problems of taxonomy; in the Ranunculaceae, for example, which has long been regarded as a "very natural family", the anatomical evidence yields a quite contrary view, and indicates that some of the included genera should be raised to family status. This illustrates the critical importance of the combined taxonomic and anatomical approach.

In a critical discussion of the cytogenetical contribution to the delimitation of genera, Dr. R. C. Rollins makes the point that, in determining the nature and limits of a particular genus, it is not a question that the investigation must be done at the generic level or not at all: rather, the interest should centre on the relatedness of the species involved; and it is here especially that cytogenetics can make an important and, in some instances, essential contribution. Examples are cited where the genetical evidence has pointed the way to the correct generic placing of previously intractable species; but because of the time involved, genetical studies can only be directed towards especially favourable groups.

The value of a knowledge of chromosome numbers in taxonomy is critically considered and the use and limitations of the data assessed. Chromosome number affords valuable evidence for taxonomic purposes in some instances but not in others. Where the chromosome number is constant within a genus, a useful test is available for the inclusion or exclusion of a species where doubt as to its affinity exists; on the other hand, if both aneuploidy and polyploidy occur within a genus, the cytological evidence may not be of much assistance in delimiting the genus, although it may be useful as an indication of relationships between the species. It is held that chromosome morphology, critically ascertained, may perhaps offer greater possibilities in generic definitions than chromosome numbers; but where the chromosomes are of very small size, or present in large numbers, this approach tends to be beset with difficulties. The general conclusions reached are that chromosome study provides, for taxonomic purposes, essentially the same kind of evidence as that derived from other parts of the plant, and that cytogenetics may aid substantially in the construction of the kind of generic classification that most adequately reflects the evolutionary relationships of the component species and of the families to which they belong. The respective contributions of embryological and plant geographical studies to an understanding of genera are also adequately discussed. The general effect of this collection of papers is to bring before the reader a fund of valuable and interesting information on many aspects of botany as they relate to a central and traditional theme.

STUDIES IN SOCIAL ANTHROPOLOGY

SIR JAMES FRAZER, a classical scholar and a type of prehistorian more than he was a historian, was interested in what he termed "the general laws which have regulated human history in the past, and which if nature is uniform may be expected to regulate it in the future". The lecture by Prof. Max Gluckman on "Rituals of Rebellion in South-East Africa"* is the Frazer Lecture for 1952, and that by Prof. M. Fortes†, which is his inaugural lecture as William Wyse professor of social anthropology in the University of Cambridge, is in agreement with Frazer, Haddon, Malinowski and Radcliffe-Brown that there are regularities independent of period and place in social organization and culture, defined as morals, law, custom and socially acquired capabilities and habits. Therefore, it is appropriate to consider here Frazer on the topic of uniformities about man's natural status.

Frazer was distinctly uncritical in his acceptance of what missionaries wrote about primitive culture and personality. For example, of the Kai Papuans of the 1899–1902 and earlier period, Charles Keysser remarked that they were fearful of the military power of an enemy, and parsimonious about making payments to allies whom they needed to mount successful offensives, preferably with superior force, against some neighbouring small group of Kai they termed sorcerers. On account of these traits of character, the leaders of the small territorial groups into which the natives were divided before their conquest sometimes delayed launching attacks against sorcerers for some interval of time after their fellows' deaths which they regarded as provocations. They attributed droughts, inroads of garden pests, bad luck in hunting and epidemics of colds in the head, which sometimes supervened in time of delay and of unreadiness for mounting attacks against sorcerers, to the wrath of the spirits of their kindred, which they worshipped in a manes cult, but whose deaths—to discuss dead men as if they were spirits—had not provoked prompt retaliatory (that is, offensive) attacks against sorcerers.

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* Rituals of Rebellion in South-East Africa. (The Frazer Lecture, 1952.) By Prof. Max Gluckman. Pp. ii+36. (Manchester University Press, 1954.) 3s. 6d.

† Social Anthropology at Cambridge since 1900: an Inaugural Lecture. By Prof. M. Fortes. Pp. 47. (Cambridge University Press, 1953.) 2s. 6d.

The Kai thought that the greatest love and the deepest sympathy which they could display to their dead was to retaliate for their dead against sorcerers, and so help their spirits to attain rest and peace in the other world, which in their belief was an underworld to which the spirits went about the time the flesh decayed on the skeleton. If the Kai had not feared the ghosts of their fellows more than they feared the military power of an enemy, and more than they valued their savings of shell ornaments, boars' tusks and pork, which they expended to procure allies, they would not have launched their offensives against sorcerers, but would have remained peaceful. The Kai of the 1902–11 period under German administration up to the date of Keysser's publication in "Deutsch Neu Guinea" (edited by R. Neuhauss) were peace-loving by nature, and in this respect considered to be comparable to Germans.

Keysser's views on the topic of Papuan tribal culture and personality require critical analysis. Sir James Frazer, however, searching for general laws of prehistories, uniformities of human nature and expected regularities of histories, accepted Keysser without question, attributed homicides in connexion with sorcery once held justifiable by Australian aboriginals, some Melanesians and some Papuans to ghost fear, and compared primitive warring about pretexts proper to a general belief in magic with European wars over religious differences. In his work "The Belief in Immortality" (Vol. 1) he summed up this view of uniformity in human nature, and of general laws which have prevailed in human history, with the remark: "The state of war, which normally exists between many, if not most, neighbouring tribes, springs in large measure directly from their belief in immortality; since one of the commonest motives for hostility is a desire to appease the angry ghosts of friends, who are supposed to have perished by the baleful arts of sorcerers in another tribe, and who, if vengeance is not inflicted on their real or imaginary murderers, will wreak their fury on their undutiful fellow tribesmen. Thus the belief in immortality has not merely coloured the outlook of the individual upon the world; it has also deeply affected the social and political relations of humanity in all ages; for the religious wars and persecutions, which distracted and devastated Europe for centuries, were only the civilized equivalents of the battles and murders which the fear of ghosts has instigated amongst almost all races of savages of whom we possess a record".

The remark is an instance of error in an attempted explanation of miscellaneous facts in a formula about motives and character. Another instance of the kind is the thesis of "The Golden Bough", which discusses in odd places the homicides of divine kings by their successors, with no good reduction of miscellaneous facts to a formula including the affair of Cromwell and Charles I, or the homicide of a Hapsburg in Serbia in 1914. Ruth Benedict and Margaret Mead have also written anthropological works in the culture and personality field; but, as Bernard Notcutt notes in his recent work entitled "The Psychology of Personality", what the subject needs at the moment is some kind of discipline. Papuan culture, although it varied somewhat in different areas of New Guinea, probably did not vary in an entirely disorderly manner; and partly with an intention of testing Margaret Mead's theories about Papuan character, we studied a bow-and-arrow fighting over sorcery among the Kamano Papuans in 1935. The Kamano said upon question in 1951–52 about motive that they had not thought that the spirits of their dead needed their former actions against sorcerers of them; they had not maintained a doctrine that ghosts required the deaths of sorcerers; and they had not feared ghostly commination for delay in launching offensives, although they had not delayed. The provoking natural deaths which had preceded the fighting incidents we had seen in 1935 had taken place one, five days before an incident broke out, and one nine days before another. We investigated antecedents and sequences in detail; but there is no space to discuss them here.

Nature, when known, is a critic of such gross imputations of responsibility for the purpose of punishment or of dispute of land tenure as may be implied by the belief in sorcery as the cause of death, and one may be interested in the truth or error of statements claiming to state uniformities about man's natural status without expectation that men will return to prehistoric conditions. Prof. Fortes's inaugural lecture takes issue with a view expounded by Evans-Pritchard in his "Social Anthropology" that 'social systems' are not 'natural systems' and that therefore social anthropology and sociology need not have as their aim statements of uniformities about man's natural status. Prof. Gluckman discusses first-fruit rituals of the agricultural year among the Zulu and the Swazi. The thesis is that ritual expresses the tensions of the social organization. A similar thesis is maintained by Evans-Pritchard in his Frazer Lecture for 1948, "The Divine Kingship of the Shilluk" of the Nilotic Sudan, with a note that there was no knowledge that actual regicide had occurred often in their unwritten past.

R. F. Fortune

THE HANFSTAENGL COLOUR COLLOTYPE REPRODUCTIONS

THE colour reproductions of old and modern masters, printed and published by the firm of Hanfstaengl of Munich, which since the beginning of the War were unobtainable in many countries, are happily once more available. The firm of Hanfstaengl is well known for the high quality and fidelity of its reproductions; moreover, it has covered a very wide range of original paintings and schools—from the classics to the impressionists and expressionists.

The Pallas Gallery, Ltd., 28B, Albemarle Street, London, W.1, are sole agents in Great Britain and the British Commonwealth for Messrs. Hanfstaengl, and has recently issued a well-illustrated catalogue of the 150-odd prints now available. The prices are 42*s*., 52*s*. 6*d*., 63*s*., and 73*s*. 6*d*.; and some four-colour prints (20 in. by 16 in.) may be obtained at 21*s*. each.

Among the various artists represented are (with examples given in brackets): Italian School (Titian, Botticelli); German School (Dürer, Holbein); Flemish and Dutch Schools (van Dyck, Rubens); French Impressionists (Renoir, Monet); Post-Impressionists (Cézanne, Gauguin, van Gogh); School of Paris (Matisse, Picasso); Kokoschka; German Expressionists (Marc); German Romantics (von Hess); and a collection of decorative pictures including landscapes (Heffner, Mercker), animal paintings (Olszewski, Roloff) and flower pieces and genre pictures (Berndt).

The sample reproduction submitted for review is "Horses in a Storm" by A. Roloff (24 in. by 29½ in., 52*s.* 6*d.*). This print admirably conveys the feeling and tonal qualities of the original, for the impasto, though evident, is not intrusive. From the purely technical point of view, closer register in the printing would have added to the excellence of this reproduction; but this does not detract from the fact that it is a splendid piece of printing. Moreover, the reproduction itself conveys the gripping vitality of the original; yet withal it is unusual among horse paintings in that the artist strikes the reviewer as having, with consummate cunning, transferred action and virility from the animals to the elements around them. So excellent is this reproduction of a superb painting that anyone would surely be proud to possess it.

Men of science, whether academically interested in art or practically concerned with *décor*, would do well to examine this catalogue (a piece of good printer's art in itself). Geographers and natural historians might show more specific interest and appreciation; but all will be grateful to the Pallas Gallery, Ltd., for making these prints again available, and at such comparatively modest prices.

L. J. F. Brimble

AMERICAN PHILOSOPHICAL SOCIETY

YEAR BOOK FOR 1953

The "Year Book 1953" of the American Philosophical Society* covers the year ended December 31, 1953, and includes the customary brief history of the Society, and a copy of its charter and laws, together with lists of officers and committees and members, biographical memoirs and the reports of standing committees. The report of the Committee on the Library refers to satisfactory progress in implementing the Darwin programme and says that the search for secondary material pertaining to the evolution theory is meeting with much success; nearly five hundred volumes have been added, and more letters to and from Darwin and his associates have been acquired. The collection promises to become one of the foremost on the subject in the world.

More than a third of the volume is occupied by the report of the Committee on Research, which details 151 grants, totalling 135,661 dollars, from the Penrose Fund, eight, totalling 15,750 dollars, from the Johnson Fund, and eight, totalling 15,255 dollars, from the Daland Fund for Research in Clinical Medicine. Five grants, totalling 15,700 dollars, were also made during the year from the Michaux Fund. This part of the report consists mainly of brief reports from recipients of grants, arranged alphabetically by sciences. Among the more detailed of these summaries may be mentioned those of the following: O. Struve, on measurements of the spectrum of Capella, which point to 0·9 for the mass ratio of the cool component to the hot component; H. L. van Dyke, on the formation of alkylbenzenes through the Friedel–Crafts, Fittig and Grignard reactions; H. S. Colton, on Lower Pliocene mammalian fauna from near Walnut Grove, Yavapai County, Arizona; R. Chambers, on studies of the permeability of the egg of *Fundulus* (sea minnow) to water and electrolytes, which suggest that the constant plateau level of the pressure observed when the eggs, activated by puncture, were freshly shed into sea water, is due largely, if not entirely, to the ability of the perivitelline colloid to hold water, and possibly electrolytes, irrespective of the tonicity of the surrounding media; S. S. Roback, on the tendipedid larvæ of the Philadelphia area; R. I. Sailer, on the significance of hybridization among stink bugs of the genus *Euschistus*; and T. A. Stephenson on plant and animal ecology of the sea-shore between tide-marks in the Bermuda islands in which a flourishing colony of the unusual barnacle *Catophragmus imbricatus* was discovered, and evidence obtained that the progressive smoothing-off of the æolian limestone around Bermuda between the high-water and low-water level is due to a considerable extent to the browsing activities of beaked fishes and of various invertebrates. F. W. Crane, studying the diagnostic characters of fern spores, particularly of *Dryopteris*, reports that the species of *Dryopteris* observed can be separated on the basis of spore characters, that the hybrids are easily recognized as such by their peculiar spore production and that hybrid spores are not in themselves completely diagnostic; the morphology of the specimen must be considered. J. Merkle reports on an ecological analysis of the meadows on the Kaibab Plateau, Arizona; F. D. Reed on progress with a monograph on the Calamites; D. J. Rogers on variations in *Manihot utilissima* and related species in Jamaica and Costa Rica; and W. A. Weber on variation in *Balsamorhiza* (Compositae).

R. A. Waterman describes an ethnological and ethnomusicological field investigation of the aboriginals of Yirkala, North-Eastern Arnhem Land, Australia; N. C. Li reports on his investigations on the stability of zinc complexes with glutathione and oxidized glutathione and of copper II complexes with oxidized glutathione; D. W. Wilson on investigations of the biochemistry of nucleic acids with the Beckman ultra-violet spectrophotometer and the International refrigerated centrifuge; and L. W. Bluemle on the application of extra-corporeal hæmodialysis to remove œdema fluid, re-evaluate the toxic factors in uræmia and in studying the effect of dialysis upon the production of urea, in which the value and versatility of the artificial kidney in treating and investigating problems of fluid and electrolyte metabolism have been demonstrated.

Among reports on research work grouped under the humanities which are of scientific interest may be noted those of E. G. Allen on John Abbot, the ornithologist of Georgia, which should facilitate the writing of his biography as well as an account of his pioneer work in natural history in America; G. E. Fay on the archæological cultures of the southern half of Sonora, Mexico; A. J. B. Wace on excavations at Mycenæ, Greece; S. S. Weinberg on the comparative archæology of the Ægean and the Near East in the Neolithic period; W. D. Wallis on the ethnography of the Maliseet (Malicete) and of the Micmac Indians of New Brunswick, Canada; and G. M. A. Hanfmann on the development of geometric and orientalizing art in Ionia with special reference to vase-painting and minor arts.

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* American Philosophical Society. Year Book 1953, January 1, 1953–December 31, 1953. Pp. 517. (Philadelphia: American Philosophical Society, 1954.)

MEASUREMENT OF EYE MOVEMENTS ACCOMPANYING VOLUNTARY HEAD MOVEMENTS

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AMONG the many methods of eye-movement measurement which have been described, that using the corneal–retinal potential difference is notable for causing minimum interference with the subject. The method has been fully described elsewhere[1]; but a brief résumé will be given here.

A steady potential difference exists between the back and front of the eye, the latter being more positive; the magnitude of the potential difference is of the order of 1–2 mV. As a consequence of this, when the eye moves to left or right, a change occurs in the potential difference between points on the skin on either side of the eye; a similar change occurs between points above and below the eye when the eye moves up or down. These potential changes can be detected by pairs of electrodes attached to appropriate points on the skin. When amplified and recorded, the changes may be used to deduce the horizontal and vertical deflexions of the eye, since they may be shown to be directly proportional to the angular displacement of the eye. For the measurement of horizontal eye movements, the electrodes may be placed, either one on each temple, giving the movements of both eyes, or one on the temple and the other on the nasal bone on the same side, giving the movements of one eye only.

The corneal–retinal potential method has the further advantage that, if flexible leads are used for connecting the electrodes to the amplifier, the head is quite free to move, and therefore eye movements occurring during head movements may be investigated.

In the present experiments, movements of the eyes and head about vertical axes have been recorded simultaneously. The electrodes used were concave copper disks 1 cm. in diameter, placed one on each temple and held in position by adhesive tape. A third electrode of 2 cm. diameter was fastened behind one ear and connected to earth. Light screened leads connected the electrodes to a high-gain symmetrical d.c. amplifier, the output of which operated a push–pull cathode-follower output-stage*, driving one pen of a multichannel recorder unit. The sensitivity of the method was limited by the noise-level of the 50-c./s. pick-up from the subject, which was usually equivalent to ½–1° of eye movement. To keep the 50-c./s. hum at this low level, it was necessary to lower the skin resistance of the subject to not more than 2,500 ohms. This was effected by using saline jelly, contained in the hollow of the electrode for the actual skin contact, and by thoroughly cleaning the skin with electrode jelly and cotton wool. To eliminate noise caused by the leads pulling the electrodes when the head moved, each lead was attached to the skin with adhesive tape, about 1½ in. from its electrode.

Preliminary photographic work had shown that the head can, when free, rotate about a single near vertical axis; the inclination of this axis to the vertical depended on the sitting posture of the subject. Head movements about this axis were recorded simultaneously with the eye movements by another pen of the multichannel recorder. Each subject wore a plaster cap (Fig. 1) in the top of which was embedded a 5/16-in. spindle, placed so as to coincide with the axis of rotation of the head. To ensure that the spindle rotations followed those of the head completely, a dental wax impression was made for each subject, and rigidly connected to the plaster cap by a brass rod and strips, as shown. The spindle was connected by a flexible bellows-type coupling to the spindle of a linear potentiometer. The potentiometer was held in a cradle above the head of the subject, who was seated in a specially constructed chair; provision was made for the potentiometer axis of rotation to be tilted slightly from the vertical, if necessary. A potential difference of 360 V. was applied to the terminals of the potentiometer, and the output from the slider was applied to the grid of an output valve, which operated a second pen of the recorder.

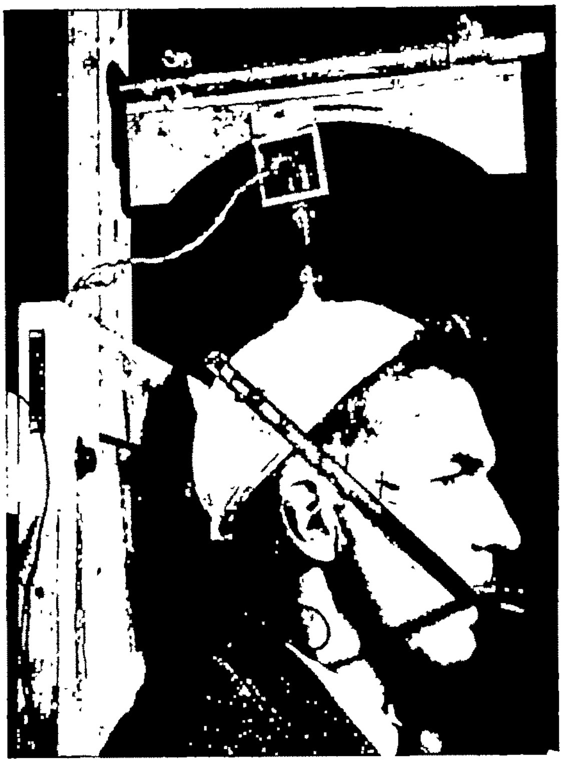

Fig. 1. Head-movement apparatus and electrode positions

A third pen of the recorder produced time markings at the rate of 10 per second, being connected to a multivibrator, synchronized by the 50 c./s. mains.

The apparatus has been used for investigating eye movements associated with two types of side-to-side head movements: those performed in the subject's own time without significant pause at the extreme positions; and those performed at the operator's request with pauses of a second or so at the extreme positions. In both cases, three speeds of movement were attempted—fast, medium and slow. Movements of the eyes with no attention paid to the eyes have been recorded for both types of head movement. For the first type only, eye-movement records have been obtained when the subject tries to maintain his eyes in the central position relative to the head. In all cases, records have been obtained for eyes both open and closed.

A detailed account of the results obtained will be published elsewhere. It would appear that the eye-movement pattern is largely determined by impulses arising from the head-movement stimulus rather than by the subject's will, since almost all eye-movement records show a similar saccadic pattern; the magnitude and frequency of the saccades depended on the speed of head movement. However, the saccade-rate was greater when the subject attempted to keep his eyes in the central position in the head than when no attention was paid to the eyes; moreover, further investigation showed that the subject can maintain fixation on a stationary object while moving the head. The records also show that the head movements from a position of prolonged rest were retarded relative to the eye movements; this may be due to the greater inertia of the head compared with that of the eye—from an instantaneous position of rest, the head moved before the eye. The effect of closing the eyes seems to be merely one of damping.

We wish to thank the subjects, Messrs. I. M. Gibson, B. Mofflitt and E. J. Spain, with all of whom we have had stimulating discussions, and Mr. G. Mallet for assistance with the construction of the apparatus. The continued financial support of the Medical Research Council is gratefully acknowledged.

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ELECTRON DIFFRACTION DIAGRAMS OF CELLULOSE MICROFIBRILS IN *VALONIA*

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ELECTRONMICROGRAPHS of native cellulose (cellulose I) invariably reveal the presence of long narrow threads, termed microfibrils, whatever the source of the cellulose may be. In view of the known structure of cellulose, derived in the main from X-ray diffraction studies of comparatively very much larger specimens, it is equally invariably implied that these microfibrils are composed of molecular chains of cellulose lying more or less parallel to each other. It has indeed been claimed, using arguments based on the breakdown of cellulose in sulphuric acid, that the microfibrils are built from sub-units resembling 'micelles' and should therefore be referred to as 'micelle strings'[1]. Direct evidence has so far, however, been lacking.

In the course of a reinvestigation of the structure of the walls of *Valonia*, we have found it possible so to modify our Philips electron microscope as easily to record electron diffraction patterns. These to a large extent provide the direct evidence as to the structure of microfibrils. Since, in addition, they have a distinct bearing upon the statements which have recently been made concerning the wall structure of *Valonia*[2], they are presented at this time as being relevant both to the general problem of cellulose structure and to the special one of *Valonia* cellulose.

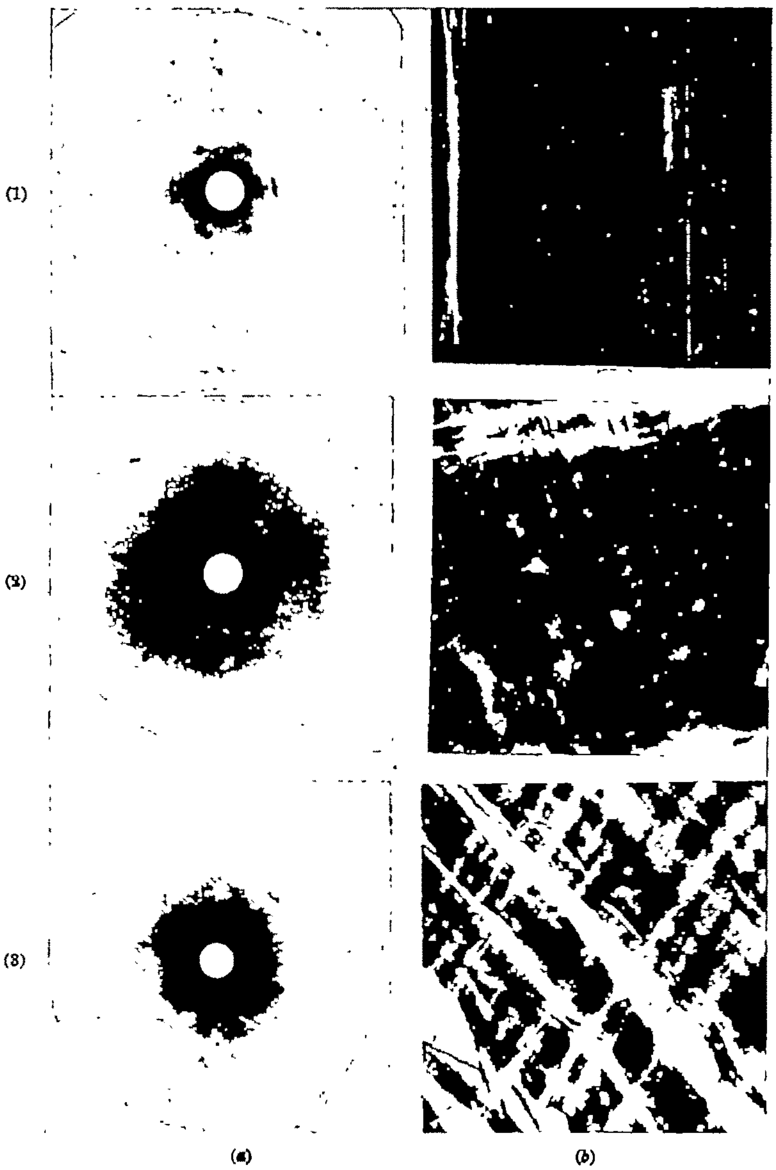
Material has been examined of *V. macrophysa* collected at Naples and of *V. ventricosa*, the specimens being prepared, as elsewhere described[3], as free from distortion as possible. The electrical circuits of the microscope have been so modified as to enable a considerable reduction in beam intensity and a reduction in the accelerating voltage across the electron gun to 25 kV. Under these conditions, electron diffraction diagrams which otherwise flash up and disappear in less than a second remain visible and essentially unchanged for many minutes. Three representative diagrams are presented in Figs. 1*a*–3*a* and the corresponding electronmicrographs in Figs. 1*b*–3*b*. The specimens were mounted without a supporting film and were, of course, unshadowed. Contrast is therefore lacking in the electronmicrographs, but the general run of the microfibril directions can nevertheless be seen.

In Fig. 1, the prominent equatorial arcs, beginning at the outside of the diagram, can be unequivocally referred to planes of spacing 3·9 A., 5·4 A. and a very weak arc at 6·1 A., which will be discussed later. Comparison with Fig. 1, *b* shows that the microfibril direction lies at right angles to this equatorial row of arcs, as would be expected if the molecular chains of cellulose lay along the length of the microfibrils. Equally, in Figs. 2 and 3, the two sets of microfibrils each lie at right angles to the corresponding row of arcs. This constitutes, therefore, direct evidence concerning the orientation of the cellulose chains within the microfibrils. The radial broadening of the arcs is, however, just as impossible of unique explanation as it is in X-ray diagrams from bulkier specimens.

Turning now to the special problem of the organization of the cellulose in *Valonia*, one or two relevant and important points may be made. The arc corresponding to planes of 6·1 A. spacing is recorded only when the specimen has torn and one edge has rolled up. In specimens which appear to be completely flat (for example, Fig. 2) this arc is missing. In this thoroughly desiccated material, therefore, the planes of spacing 6·1 A. tend to lie parallel to wall surface, just as they were shown to do in air-dried material by the X-ray method[4]. It should further be recalled that a similar uniplanar orientation has been demonstrated in wet, living specimens of *Rhizoclonium*[5], a filamentous alga the wall structure of which resembles that of *Valonia* very closely. This orientation is therefore maintained over the whole range of water content. In quoting the opinion of Preston and Astbury, stated some sixteen years ago[4], that this orientation then observed in air-dried material might have been induced by dehydration, Steward and Muhlethaler[2b] have evidently failed to appreciate the more recent observations on fresh specimens[5].

The microfibrils do not therefore roll over markedly even under the intense desiccation in the electron microscope. It is consequently impossible to conceive that desiccation could effect a mass reorientation of the microfibrils such as Steward and Muhlethaler[2] seem to consider in comparing their three-layer repeat structure with the original two-layer repeat proposed by Preston and Astbury[4]. Whatever may be the cause of the discrepancy between the findings of Preston and Astbury[4] and Steward and Muhlethaler[2], it is quite incredible, on this as well as other grounds, that a change in orientation induced by desiccation can have any part to play.

The diagrams presented here are significant in still another way. The original findings of Preston and



Figs. 1–3. (a) Electron diffraction diagrams; (b) electronmicrographs of identically the same specimen, using lamellæ stripped from *Valonia macrophysa*. (a) and (b) are arranged in mutually correct orientation

Fig. 1. A single lamella. Note the single set of prominent equatorial arcs. Fig. 1, b, magnification 5,600. Note that the edge of the specimen to the left has rolled up. This has caused a weak 6·1-A. arc to develop in Fig. 1, a

Fig. 2. Two lamellæ, inter-microfibrillar angle about 60°. Fig. 2, b, magnification 6,000. Note the absence of an arc at 6·1 A. in Fig. 2, a

Fig. 3. Two lamellæ inter-microfibrillar angle about 80°

Astbury[4], based on some 15,000 X-ray diagrams from many adult vesicles, were that the wall consists of two sets of lamellæ, the cellulose chains crossing at an angle which was variable from place to place in one vesicle, and from vesicle to vesicle, between about 60° and about 90°. Steward and Muhlethaler[6], from what must be far fewer observations and certainly based on a very much smaller bulk of material, claim that the wall is three-layered with an angle of 60° between the three sets of cellulose microfibrils. We have taken up to the present at least two dozen electron diffraction diagrams and these lend full support to the findings of Preston and Astbury[4]. None of them reveals the presence of more than two sets of arcs even when three sets of microfibrils are visible in the electronmicrograph of identically the same specimen. We do not propose at the moment to lay any stress on the absence of diffraction from one set of microfibrils since it is difficult to be sure that all three sets are present in equal amounts; but rather to emphasize that the commonest type of observation is that recorded in Fig. 3. If, in such cases, there could be lamellæ with a third orientation stripped away during specimen preparation, then the mutual angle between the microfibrils could not be anywhere near 60°. On the whole, the evidence at present available in mature vesicles leads firmly to a basic structure of two sets of microfibrils at an angle less than 90° to each other, with an occasional third set interspersed. Only in the special circumstance that the angle between the two basic sets is 60° can there then be, even sporadically, three sets at 60°.

It is not proposed to comment further on the special case of *Valonia* until further work in progress is completed. Two general facts may, however, be quoted which have not hitherto been mentioned in the discussions on *Valonia*. First, it is now quite clear that some, perhaps many, algal walls reveal the presence of microfibrils in the electron microscope but yield only very diffuse X-ray diagrams. Not all microfibrils visible, therefore, are crystalline or, indeed, cellulosic[7]. Secondly, some algæ other than *Valonia*, notably the Cladophorales (except the *Spongomorpha* group), show the same type of wall structure as *Valonia*[8]; and here only two sets of microfibrils have been reported, and both the interchain angles (derived from X-ray diagrams) and the intermicrofibrillar angle (observed in the electron microscope) are commonly about 90°. The condition in *Valonia* should therefore not be dealt with solely as a special case but should be interpreted in terms of this very wide background we now have of algal wall structure generally.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Synthesis of Branched Polymers

Little is known about the behaviour of branched-chain polymer molecules either in solution or in the solid state. One of the difficulties hindering the acquisition of this knowledge is the lack of synthetic methods for building molecules to a predetermined pattern. This communication is concerned with one approach to a solution of this problem in the case of vinyl polymers. Polystyrene may be taken to illustrate the application of the method.

Polystyrene in solution in carbon tetrachloride is brominated photochemically at room temperature until the bromine content rises to about 5–10 per cent. The brominated polymer is dissolved in styrene monomer and the solution irradiated with ultraviolet light of such a wave-length that the bromine atoms are removed, leaving polymer radicals and free bromine atoms both of which initiate polymerization, branches growing from the polymer radicals. Unless the bromine content of the initiating polymer is very low the product is precipitated as a gel, showing that cross-linking has occurred by the radical branches combining[1]. However, cross-linking may be prevented by the addition of carbon tetrachloride, which then acts as a transfer agent and gives rise to shorter branches. By a judicious choice of conditions it is possible to obtain a mixture of branched-chain polystyrene and linear polystyrene so different in molecular weight that the two components may be separated by fractional precipitation. From the fractionation results, it is possible to estimate the weight fraction of high polymer molecules present as branches. The use of styrene monomer labelled with carbon-14 for the branch-growth polymerization makes possible an alternative determination of this quantity.

The determination of the number of branches per molecule is more difficult. From the observed rate of polymerization it is possible, with a knowledge of the velocity constants of propagation and termination and of the transfer velocity constant of the styrene radical for carbon tetrachloride, to calculate the average length of the branches.

Unfortunately, transfer constants are not known with a very high degree of precision. Determination of the average length of the branches and the weight fraction of the branches enables a simple calculation of the frequency of the branches. A second method is available for determining the frequency of the branches. The branched polystyrene will have a smaller bromine content than the starting material partly because of the dilution effect of the added branches and partly because each branch replaces a bromine atom. The bromine contents of a brominated polymer before and after branching were determined by the neutron activation technique and provided data for the calculation of the number of monomer units in the backbone of the polymer per branch. The results of a number of branching experiments are summarized in the accompanying table.

Expt. No.	% branching	Chain-length of branches (P_n)	No. of monomer units of backbone/branch	M_w of backbone	Branches per molecule
$A1$	37	130	220	300,000	14
$E3$	39	310	480	900,000	19
$E4$	25	95	290	900,000	31
$F1$	34	230	450	200,000	4·6
$F2$	37	210	390	200,000	5

The branching figures given in the table have been calculated from the fractionation data. The molecular weights of the backbones of the polymers have been estimated from viscosity measurements on the brominated linear polystyrene.

In the case of experiment $F1$, radioactive monomer was used. This tracer technique indicated that the product was 35 per cent branched, or one branch per 430 monomer units of backbone. Bromine analyses on the branched polymer $F1$ indicated one branch per 350 monomer units of backbone or 40 per cent branched.

Experiments with radioactive monomer and the determination of bromine by neutron irradiation were carried out in collaboration with Dr. J. C. Bevington, whose advice and assistance are gratefully acknowledged. The work is being extended to other vinyl polymers.

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Chemical Action of Ionizing Radiations: Excitation of Optical Levels by Particles of Relatively Low Energy

It is well known that the energy lost by the fast particles of ionizing radiations is ultimately used for the excitation of discrete states, for ionization and for giving to the secondary electrons kinetic energies less than the first excitation-level of the atoms or molecules present in the system[1].

When the kinetic energy of the charged particles is large compared with the ionization and excitation potentials of the atoms or molecules present, excitation (and ionization) will be distributed among all the atoms and molecules in the system according to their relative proportions. However, as the particles are slowed down, they are no longer able to excite those species the excitation potentials of which are greater than the kinetic energy of the exciting particles. Therefore, from a certain point, excitation (and ionization) will be confined to atoms and molecules with a sufficiently low excitation (and ionization) potential; these processes will go on as long as the kinetic energy of the charged particles is greater than the lowest electronic excitation potential.

A case which is of particular interest is represented by dilute aqueous solutions of many organic and inorganic compounds. It is well known[2] that water itself does not absorb light of wave-lengths greater than about 1800 A., as its first continuous absorption band stretches from 1430 to 1860 A. with a maximum at 1665 A. (~ 7·5 eV.). Therefore, in dilute aqueous solutions, at electron energies greater than about 7·5 eV., chemical effects will be due mainly to the action on the water ('indirect effect'), as most of the radiation energy will be absorbed by the solvent (water). In this region, there will only be a relatively small 'direct effect' on the solute, proportional to its concentration. However, the situation will be different when the exciting particles have energies less than about 7·5 eV., as in this region excitation of optical levels of substances with absorption bands in the nearer ultra-violet and in the visible region may become important.

Although it is difficult to give a detailed theoretical treatment of this effect, the action of charged particles should, according to Fermi's theory[4], lead to the excitation of atoms and molecules, and could produce an effect similar to the photo-excitation by a light quantum of corresponding energy. From Fermi's theory[4] the cross-section, q, for such an excitation process is given, to a first approximation, by:

$$q \propto [\int \alpha(\nu) d\nu]/v^2,$$

where $\alpha(\nu)$ represents the optical absorption coefficient for the frequency ν and v is the velocity of the particle; thus, this excitation cross-section is proportional to the optical transition probability and inversely proportional to the square of the velocity of the exciting particle.

It is obvious that the yield of this excitation effect is proportional to the concentration of the solute component under consideration. Therefore, this effect will, in general, lead to a dependence on the concentration of the solute, which is different from that arising through the interaction of the solute with the radicals formed by the 'indirect effect', that is, by the action of the radiation on the solvent.

Some estimate of the order of magnitude of the increase in the chemical yield due to this 'direct' effect can be made as follows: if one assumes that the energy (W) necessary to create an ion pair in liquid water is of the same order as in the gaseous state ($\sim$ 33 eV.), about three electrons will be produced per 100 eV. Under optimum conditions, that is, when each of these electrons would be capable of exciting one molecule, one may get an additional yield of three excited molecules per 100 eV., due to the low-energy electrons.

For example, with methylene blue (Mb) as solute, the three excited methylene blue molecules, (Mb*), could lead eventually, by reaction with a suitable acceptor (Acc), to three molecules of the corresponding semiquinone (MbH) similarly to the photochemical reaction[5], namely:

$$\text{Mb}^* + \text{Acc} \rightarrow \text{Mb}^- + \text{Acc}^+ ; \ \text{Mb}^- + \text{H}^+ \rightleftarrows \text{MbH}.$$

On the other hand, electronic excitation of a molecule such as hydrogen peroxide should lead to a dissociation resulting in an additional yield of ($3 \times 2 =$) 6 hydroxyl radicals, in conformity with the photochemical primary process in the ultra-violet, namely[6]: $H_2O_2 + h\nu \rightarrow 2OH$.

It is clear that these effects are not confined to aqueous systems and may be of considerable importance whenever one is dealing with any two- or multi-component system, containing a relatively high proportion of solute molecules or other components with absorption bands extending farther towards the longer wave-length region of the spectrum than those of the solvent or of some of the other components.

It also follows that, in the study of the chemical action of ionizing radiations in solution, extrapolation, for example, from more or less concentrated aqueous solutions to the behaviour of water itself, is not permissible without due consideration of such 'direct' effects on the solute.

I wish to thank Prof. R. E. Peierls for many valuable discussions.

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Heats of Formation of Gaseous Fluoro- and Fluorochloro-Carbons

THE heat of formation of carbon tetrafluoride was determined by von Wartenberg[1] by measurement of the heat of combustion of potassium in the gas to form potassium fluoride and carbon. We have repeated his work and made similar measurements for several other fully halogenated fluoro-compounds, for which previous experimental determinations were lacking. The general technique used was the same as that of von Wartenberg—in particular, the reaction chamber was of the same size and design as his, and the reaction was likewise initiated by striking a d.c. arc between a graphite rod and a quantity of potassium, filtered from oxide, contained in a nickel crucible. The ignition energy was, however, measured more reliably by recording the arc current and voltage simultaneously on a moving film by means of a double-beam oscillograph. The calorimeter was of the isothermally jacketed type, with kerosene as the calorimetric fluid, the heat capacity being determined electrically.

To minimize errors due to pyrolysis, an excess of potassium was used with each gas. The amount which had reacted was determined by volumetric analysis of the aqueous extract of the solid residue for chloride and/or for fluoride. Although the potassium was manipulated in argon so far as possible, it was also necessary to determine the amount of carbonate in the residue, in order to apply a small correction for heat evolved in the reduction of potassium dioxide by carbon.

In deriving the heats of formation (ΔH_f) from the observed heats of reaction, the values taken for the heats of formation of potassium fluoride and chloride were respectively − 134·5 and − 104·2 kcal./mole[2]. Also, since the carbon produced in the reaction was found by X-ray diffraction to be highly amorphous (contrary to von Wartenberg's statement), an assumed enthalpy decrease of 2·5 kcal./gm. atom was allowed for the transition to graphite[3].

Table 1 gives a list of the average values for ΔH_f for each gas at 25° C., referred to the elements in their standard states. For comparison, the U.S. Bureau of Standards values[2] for the related hydrocarbons and chloro-compounds are included in the table, together with some values derived from recently published heats of combustion of the chloro-compounds[4] (all referring to the gaseous state at 25° C.).

Apart from the case of fluorotrichloromethane, the reproducibility of the results was satisfactory;

Table 1

Fluoro-compound	ΔH_f, kcal./mole	Related compounds	ΔH_f, kcal./mole Ref. 2	Ref. 4
CF_4	− 218 ± 2*	CH_4	− 17·89	—
CF_3Cl	− 171 ± 1	CH_3Cl	− 19·58	—
CF_2Cl_2	− 112 ± 2	CH_2Cl_2	− 21	− 22·8
$CFCl_3$	− 70 ± 4	$CHCl_3$	− 24	− 25·0
		CCl_4	− 25 5	− 22·2
C_2F_6	− 303 ± 2	C_2H_6	− 20·24	—
$(CF_2Cl)_2$	− 213 ± 3	$(CH_2Cl)_2$	− 32	− 30·3
		C_2Cl_6	− 34	− 35·4
C_2F_4	− 162 ± 1	C_2H_4	+ 12·5	—
$CF_2 : CFCl$	− 126 ± 2	$CH_2 : CHCl$	+ 7·5	—
		C_2Cl_4	+ 6	− 3 6

* Cf. von Wartenberg's value, − 231 ± 3 kcal./mole ≡ − 229 kcal./mole when corrected to graphite.

but it is known that they are affected by several errors small in amount though difficult to evaluate; for example, the solid residues after combustion liberated small amounts of acetylene and olefin on treatment with aqueous alcohol, and in several cases the reaction vessel after the combustion was found by mass-spectrographic analysis to contain traces of gaseous fluoro-compounds other than the one under test. An indication that our results are accurate at least within 10 kcal./mole is that, according to the table, the heat evolved in the reaction $C_2F_4 + Cl_2 \rightarrow (CF_2Cl)_2$ should be 51 kcal./mole, whereas Lacher *et al.*[5] by direct measurement found 57·3 kcal./mole (accuracy 1–2 per cent). It may be noted also that the increments in ΔH_f for the replacement of a fluorine atom by a hydrogen atom are within the range (41–52 kcal./mole) which can be inferred from Swarts's measurements of the heats of combustion of various partially fluorinated organic compounds[6].

According to the above results, the C—C and C═C bond-energies in the fluoroethanes and fluoroethylenes tested must be considerably less than in ethane and ethylene respectively, if the C—F linkages have the same average energy as in CF_4.

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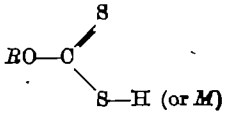
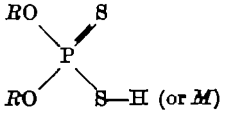
Adsorption of Alkyl Xanthate and Dithiophosphate on a Cleavage Face of Galena as revealed by Electron Diffraction

XANTHATES and dithiophosphate are the two principal collecting reagents in the flotation for sulphide minerals. They have structural formulæ



and



respectively, where *R* is an alkyl group and *M* an alkali metal or ammonium ion. It is generally accepted that the alkyl group may be standing upright on the mineral surface.

One of us has studied the interactions of alkyl xanthate solutions with both fresh and oxidized galena cleavage faces by electron diffraction[1] (galena : PbS, NaCl-type cubic[2] with $a = 5·92$ A.; cleavage face, {100}). With the latter faces the main interaction was the attachment to the surfaces attacked of the precipitated lead xanthate crystallites in fibre orientations[3]. With the former faces, including the slightly oxidized ones, the electron diffraction pattern shown in Fig. 1 was obtained with 100- or 500-mgm./l. solutions. It consisted of diffuse vertical streaks situated on vertically elongated galena spots at any azimuthal setting of the crystal to the electron beams. The pattern gradually changed into two haloes within a few days in air. The streak pattern was interpreted as due to monomolecular patches, presumably of xanthic acid, adsorbed on the sites of the lead atoms of the galena lattice[1]. With this mode of adsorption (Fig. 3*a*) the area occupied by an adsorbate on the galena face is $(5·92 \text{ A.})^2 \div 2 = 17·5 \text{ A.}^2$, a value very near the cross-section of an alkyl group in a solid paraffin[4], namely, $18·5 \text{ A.}^2$.

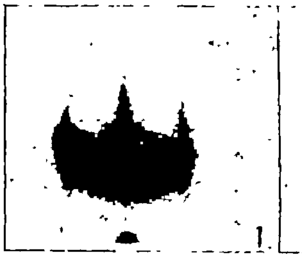


Fig. 1. A diffuse streak pattern obtained on a slightly oxidized galena cleavage face after reaction with aqueous *n*-butyl xanthate, 100 mgm./l.; beam parallel to cube edge

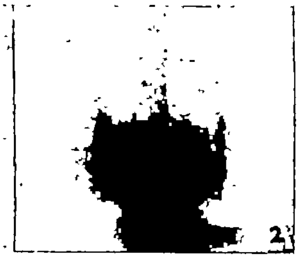


Fig. 2. A diffuse streak pattern obtained on fresh galena cleavage face after reaction with aqueous diethyl dithiophosphate, 10 mgm./l.; beam parallel to cube edge

With alkyl dithiophosphate, however, this mode of adsorption would not be expected, since the cross-section of its anion or its acid molecule may be approximately twice as large as the xanthate anion or xanthic acid molecule. In order to throw light on this problem, an electron diffraction investigation has been carried out on the interactions between a fresh galena cleavage face and diethyl dithiophosphate solutions in distilled water. The crystal specimen was 2 mm. × 2 mm. × 1 mm. in size, and 10 c.c. of the interacting solution was used in every case. The reaction time and temperature were 10 min. and 20° C., respectively.

With a 10-mgm./l. solution, a diffraction pattern (Fig. 2) was obtained three times out of six independent trials. Its characteristic feature was that, with the <100> incidence of electrons to the specimen surface, vertical streaks were observed just in between and just over the Kirchner–Raether lines of the galena cleavage face. With the <110> incidence they were observed just over the Kirchner–Raether lines alone. In the remaining three cases the streaks were weaker in intensity and the pattern as a whole resembled the cleavage pattern closely. With 20- or 5-mgm./l. solutions the streaks were still weaker. With solutions of concentration more than 20 mgm./l. or less than 5 mgm./l. they were not observed at all.

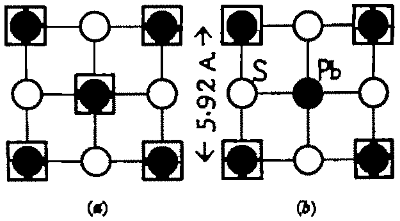


Fig. 3. Schematic representation of the mode of adsorption on galena face of xanthate (a), and dithiophosphate (b). Adsorbates are represented by squares

The interpretation of the present streak pattern may be that diethyl dithiophosphate, whether as acid molecule or as anion, has been adsorbed on the galena lattice with a mode drawn schematically in Fig. 3b. In this adsorption, lead atoms at the sites of the next nearest neighbours of any occupied lead atom on the galena face are occupied by the adsorbates. As compared with the case of xanthate (Fig. 3a) the area occupied by an adsorbate is twice as large in the present case. This may be attributable to the supposed difference in the areas of the cross-sections of dithiophosphate and xanthate, the former being twice as large as the latter.

That the present streaks were not due to surface anomalies of the cleavage face itself was shown by examining a number of randomly selected cleavage samples from the same crystal block from which specimens for the study of adsorption were obtained. In no instance was a diffraction pattern like that represented in Fig. 2 obtained from any portion of the cleavage faces. By the mere soaking of the cleavage face in distilled water containing no dithiophosphate but under otherwise the same experimental conditions, the present streak pattern was not obtained at all. Further details of this work, including interactions with oxidized surfaces, will be published elsewhere.

We are grateful to Mr. Sakano and Mr. Hosoi, of Mitsubishi Metal Mining and Metallurgical Laboratory, for the preparation of the reagents.

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Occurrence of μ-CaCO$_3$ in Boiler Scale

DURING small-scale experiments at the Fuel Research Station on the effect of treatment of boiler feed-water on the structure of boiler scales, several deposits were examined by X-ray diffraction. Most of the deposits contained calcium carbonate as calcite and calcium sulphate as anhydrite. In the deposit from one of the experimental boilers, the bulk of the carbonate, however, occurred as the rather unusual hexagonal form, μ-CaCO$_3$, or vaterite. This overlay a thin band of calcite. It is believed that this is the first occasion on which μ-CaCO$_3$ has been reported in such deposits.

There were no notable differences between the conditions of operation of the boilers producing a deposit of a normal type and those producing the deposit containing μ-CaCO$_3$. Periodic analyses of the feed-waters to the boilers showed no appreciable differences in the quantities of calcium, magnesium, sulphate, silicate, total dissolved solids, total hardness, or hydrogen ion concentration. It has not been found possible to explain the presence of this unusual type of carbonate deposit as due to variations in the main characteristics of the feed water, or in the conditions of operation of the boilers.

The occurrence of μ-CaCO$_3$, which is reported to be more soluble than calcite, agrees, however, with the decrease that was recorded in the total weight of the deposit in the boiler, and the accompanying increase in the dissolved solids in the water removed from the boiler. It would follow that while the μ-CaCO$_3$ was being deposited, the boiler water must have been supersaturated with respect to calcite. It is possible that this was caused by the fortuitous appearance in the feed-water of a substance or substances that repress the crystallization of the less-soluble forms of the carbonate. Samples of the feed-water to the various boilers were not examined for their minor constituents; but a comparative spectrographic analysis of the carbonate deposits gave results that were of interest. The most notable differences were that the deposits containing μ-CaCO$_3$ held larger quantities of lead, and smaller quantities of strontium, magnesium and silicon, than those which contained mainly calcite. There was no apparent difference in the phosphorus content of the two types of deposit.

This work forms part of the programme of the Fuel Research Board of the Department of Scientific and Industrial Research and is published by permission of the Director of Fuel Research.

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Influence of 'Surface Chilling' on the Detonative Behaviour of Cast Trinitrotoluene

IN an earlier communication[1], attention was directed to the influence of charge-cooling conditions on the detonation velocity of cast T.N.T. Since this effect is of considerable interest by virtue of its bearing on the various theories put forward to account for the initiation of the explosive decomposition at the shock wave front, and because of its importance in connexion with the study of marginal confinement effects in cast explosives, the following examples of its operation are presented.

Charge casings of lead, copper and steel were employed. The degree of 'surface chilling' was varied by heating the charge-casing prior to pouring in the molten T.N.T., and in one case further variation was obtained by slower cooling of the charge after casting. Special casting techniques were employed in order to avoid cavitation of the cast charges. The velocities of detonation obtained using the Dautriche method[2] are recorded in Table 1. The degree of confinement S expresses the number of grams of metal per sq. cm. of charge surface.

Table 1

Confining metal	Casing temp. (° C)	S (gm./sq. cm.)	Density (gm./c.c.)	Mean velocity of detonation (m./sec.)
Lead	20	6·6	1·60	6,820
	70	6·6	1·57	6,430
Steel	20	2·2	1·59	6,760
	83	2·2	1·57	6,480
Copper	20	3·3	1·58	6,795
	57	3·3	1·57	6,580
	90*	3·3	1·56	5,900

* Slower rate of cooling after casting

The velocity of detonation of cast T.N.T. under conditions of heavy confinement is therefore very dependent on the charge-casing temperature prior to filling and on the subsequent rate of cooling. In the usual method of casting into cold casings, the initial cooling at the periphery of the charge is very rapid by reason of the high heat capacity and thermal conductivity of the metal casing producing a finely crystalline peripheral layer.

Up to the present, the prevalent idea has been that conditions at the centre of the charge mainly determine the detonation velocity. While this may be the case in theoretical treatments involving the assumption of uniform charges, in practice, when dealing with cast charges where complete uniformity is difficult or impossible to obtain, it would appear to be the conditions existing at the surface of the charge which are the more important.

Thus, some workers, by a comparison of the detonation velocities of comparably confined charges using ordinary 'clear cast' and 'creamed T.N.T.' in which the crystal size was reduced by stirring while solidification was occurring, observed no significant difference and concluded that changes in grain size were without effect on the detonation velocity. This observation may be accounted for by the production of the finely crystalline peripheral layer as indicated above, so that further reduction in the crystal size of the interior of the charge has very little additional effect. Many other reported cases of 'anomalous' detonative behaviour in cast T.N.T. charges may be similarly explained in terms of different surface cooling-rates.

Similarly, in investigations on the influence of different types of metallic confinement on the detonation velocity of cast charges, the influence of the thermal properties of the casing also requires consideration, since they may introduce differences into the crystalline character of the charge periphery. If the appreciable differences in the thermal properties of the materials normally employed in this kind of work are considered, it would appear that this factor might often assume significant proportions. It has, however, so far received little attention.

The present experimental results serve to emphasize the importance of accurate crystallographic control in all work with cast explosives.

I wish to thank the Chief Scientist, Ministry of Supply, for permission to publish these results.

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[2] Dautriche, H., *C.R. Acad. Sci., Paris*, 143, 641 (1906).

Cathodoluminescence of Air, Quartz and Metal Films

THE luminescence of air and fused quartz under α-particle irradiation has been observed previously using a photomultiplier[1]. The luminescence spectra of these and other materials excited by 100-keV. electrons have now been studied with a quartz spectrograph. The electron beam was obtained from a discharge tube, fitted with a metal Lenard window, the specimens being placed in external contact with the window. This method of exciting 'scintillation' spectra is advantageous since the specimens can be readily inserted, the luminescence is much more intense than that excited by the α-particle sources used by other observers[2,3] and the self-luminosity of such sources[1,4] is eliminated.

The cathodoluminescence spectrum of air consists of a series of lines in the visible and near ultra-violet, similar to that excited by polonium-210 α-particles[2-4]. The spectrum of fused quartz consists of a continuum in the same spectral region. The quartz exhibits phosphorescence which persists for several minutes after the irradiation and is similar to that observed from fused quartz envelopes of hydrogen and mercury discharge lamps[5,6]. The superimposed air and quartz spectra, recorded when the quartz plate was separated from the Lenard window by a thin air layer, are reproduced in Fig. 1*a*. Fig. 1*b* shows the calibration mercury discharge spectrum.

Other observers[3,7] have reported luminescence of thin metal films bombarded by α-particles. An attempt has therefore been made to observe the similar light emission to be expected under intense electron bombardment, using thin foils of gold, silver, aluminium and tin. No luminescence of the metal foils has been found. When the metal foil was mounted on a quartz plate, the spectrum observed was identical with that from the quartz alone, apart from the reduction in intensity due to the incident energy dissipated in the foil. When the metal foil was mounted in air, the spectrum observed was identical with that from the air alone. In each case no luminescence was found unless the electron beam penetrated into the medium (quartz or air) beyond the foil.

These results suggest strongly that the previous observers[3,7] have been in error in attributing luminescence effects to thin metal and other films, due to their neglect of the luminescence from the air or from the quartz plates on which the specimens were usually deposited. A careful examination of their reports is fully consistent with this hypothesis

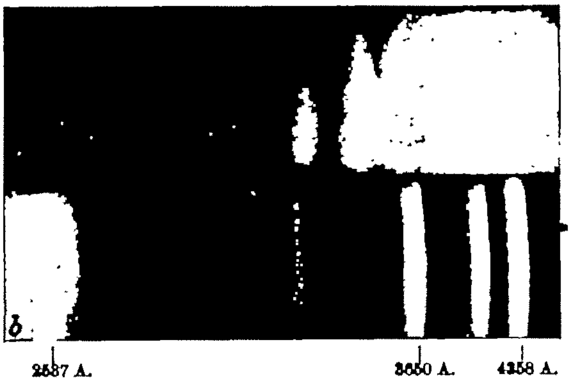

Fig. 1. *a*, Spectra of air and quartz; *b*, calibration mercury discharge spectrum

Richards and Cole[7] find that the thin-film 'luminescence' disappears when the α-particles are just unable to penetrate the film into the medium beyond (air). The 'luminescence spectra' of the aluminium, copper and gold films recorded by Norman *et al.*[3] appear identical with that of the quartz plate on which they were deposited. The latter can be seen clearly in the gap between two metal films on one of their photographs (spectrum *d*).

It is concluded that there is, as yet, no satisfactory evidence for light emission from thin films of metals and other 'non-luminescent' materials excited by ionizing radiation. A similar conclusion was drawn previously from the photomultiplier studies using α-particle irradiation[1].

One of us (W. A. L.) wishes to acknowledge his thanks to the South African C.S.I.R. for a research bursary and grant.

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Automatic Particle-sizing by Successive Counting

The development of automatic apparatus, generally employing optical scanning systems in conjunction with electronic counters, for determining the number and size of a population of small particles randomly dispersed in one plane has aroused considerable interest during recent years. Walton[1] has summarized some of the chief trends and methods used in the design and operation of such apparatus. Hawksley[2] has pointed out that, whereas counting can be carried out by relatively simple instruments, all proposals for methods of size determination have involved the measurement of pulse-heights or pulse-lengths from the records obtained from photoelectric scanning devices. He showed, however, that it is possible to derive a value for the mean diameter of the particles from a series of counts made with scanning spots of different sizes, so that sizing can be carried out with simple counting apparatus. He also implies that similar results could be obtained if the 'response-level' of the detecting device is altered during successive counts, but fails to follow up this suggestion.

In the course of designing an apparatus for the automatic counting of neps (small tufts of entangled fibres) in carded webs, we find that we have unconsciously elaborated Hawksley's suggestion, and as the technique involved is much simpler than that involving quantitative variation of the size of small scanning spots, it may prove to be of general interest.

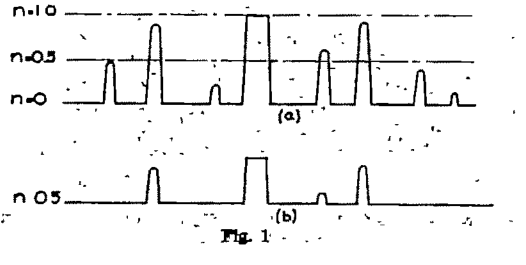

Fig. 1

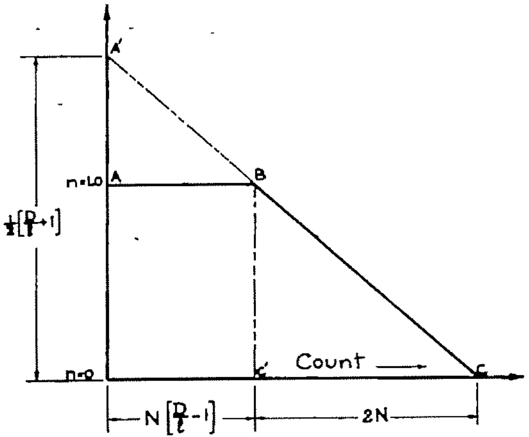

Fig. 2

The apparatus mentioned consists of two plate-glass disks 14 in. in diameter, between which the specimen to be examined is sandwiched. The disks rotate at fixed speed (30 rev./min.) and the area of the sample is scanned in spiral fashion by a photoelectric scanning head of the usual pattern moved by a lead-screw along a radius of the disks. The photocell output, after suitable linear amplification, is modified in the following manner before being fed to an electronic counter of conventional type.

In the ideal case, in which the sample scanned consists of a series of opaque circular spots on a uniformly transparent or translucent background, the amplified photocell output consists of a series of positive-going voltage pulses of varying heights, as shown in Fig. 1*a*. The smaller pulses are due to partial cut-off of the light by a particle, the highest ones to complete cut-off, and if the size of the scanning spot is small compared with the diameter of the largest particle, many of the particles will produce more than one pulse, so that the pulse number is in general greater than the total number of particles. This amplified signal is fed to a biased diode clipping circuit, which permits only pulses exceeding a certain amplitude to be passed on to the counter. The level at which clipping occurs is variable by adjustment of the diode bias, and is designated as n, varying from 0 to 1. At $n = 0$, no clipping occurs; at $n = 1$, the highest pulse is just clipped out, and no counts are registered. Fig. 1*b* shows, for example, the signal passed to the counter when $n = 0 \cdot 5$ in the case of the input signal shown at Fig. 1*a*.

It may easily be shown that

$$\frac{C}{N} = \frac{L + D - 2nL}{d + L},$$

where C is the total counts registered by the counter; N is the total number of particles present; D is the average diameter of the particles; n is the clipping level as defined above; L is the width of the scanned track (at right angles to the direction of scan); d is the width of the unscanned track left between adjacent scanned tracks.

This relation is subject to two assumptions, namely, (*a*) L is less than the diameter of the smallest particle present; (*b*) D is negligible compared with the total width of field scanned.

If the width of the scanning track and the pitch of the scan spiral are adjusted so that $d = 0$ (that is,

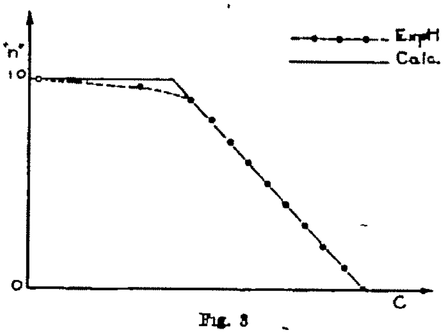

Fig. 3

the whole of the field is scanned, and not just part of it), then

$$C = N\left(1 + \frac{D}{L} - 2n\right).$$

Plotting the experimental count C against the clipping-level n results in a curve similar to the line ABC in Fig. 2. Here $AB = OC^1 = N\left[\frac{D}{L} - 1\right]$, $C^1C = 2N$, and if CB is produced to cut the n-axis at A^1, then $OA^1 = \frac{1}{2}\left[\frac{D}{L} + 1\right]$. Hence, by counting the specimen at successively increasing values of n and plotting the resulting relation, both the number of particles and their average diameter may, in theory, be determined.

Experimental tests carried out on 'ideal' specimens consisting of small punched cardboard disks of known diameter randomly distributed between the glass disks and scanned and counted in the manner described fully confirm the mathematical theorem. Fig. 3 shows a plot of a typical run, superimposed on the expected relation. The agreement is very good except for some rounding of the corner at B, but this does not interfere with the use of the curve in the manner described above.

The following table summarizes the results obtained with four different arrays of particles, of which two consisted of mixtures of particles of different sizes.

Actual array tested			Experimental values obtained			
Details of array examined	N (total)	$\bar{D}$ (in.)	N (total)	$\bar{D}$ (in.)	% error of N	% error of D
100 of diam. 0·1 in.	100	0·100	101·1	0·098 (7)	+1·1	−1·8
30 of diam. 0·1 in.	30	0·100	29·5	0·100 (2)	−1·6	+0·2
30 of diam. 0·1 in. 30 of diam. 0·1275 in.	60	0·113 (7)	61·2	0·110 (8)	+2·0	−2·5
10 of diam. 0·084 in. 10 of diam. 0·100 in. 10 of diam. 0·1275 in.	30	0·104	29·1	0·104 (8)	−3·0	+0·8

Width of scan track = 0·05 in.; scanned at 20 lines/in. (Each experimental value is the mean of five determinations).

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Effect of Vapours of Halogen Compounds on the Emission of Positive Ions from Platinum

It was observed by C. W. Rice in 1944 that the emission of positive ions from a platinum anode heated in air is increased very markedly when vapours of compounds containing halogens such as carbon tetrachloride, chloroform, 'Freon', sulphur hexafluoride etc., strike the anode surface[1]. We have studied this phenomenon, the Rice effect, and obtained the following results.

(*a*) The positive ion current, once increased, falls off again to its original intensity even though vapour of the halogen compound is continually supplied; and as W. C. White[1] observed, the effect of the vapour reappears only after air alone has been admitted for some time. (As halogen compounds carbon tetrachloride, chloroform and methyl chloride were used and they all gave similar results.)

(*b*) The Rice effect can be observed as long as the inherent positive emission, usually the alkali ion, from the anode persists; and the anode that has been freed from the alkali ion emission by flashing and become unable to give rise to the Rice effect regains its ability if a slight amount of potassium or sodium chloride is applied to its surface.

(*c*) If a small amount of the vapour of a halogen compound is mixed for a few seconds at a time with the air current passing by the platinum wire anode, the Rice effect can be made to occur many times successively with ever-decreasing intensity until it is entirely suppressed by some sort of surface contamination. The total amount of positive ions thus produced may amount to about one and a half times the total amount of alkali ions emitted from a fresh piece of platinum wire of the same length heated in an air current until it ceases to emit. The latter amount has been found to be substantially the same for every piece of the wire tested and independent of the temperature of heating. (In the case of alkali ion emission from platinum at 1,300° K. in the presence of oxygen, the ratio of the number of positive ions to that of neutral atoms is, according to the Saha–Langmuir–Kingdon's equation, so large that the number of positive ions cannot be increased materially by any increase in the electronic work function as a result of the adsorption of halogen.)

(*d*) For the Rice effect to occur, the presence of air or oxygen is indispensable, because the positive ion emission from the platinum anode in vacuum, far from being increased, is actually decreased if the halogen compound vapour alone is admitted.

(*e*) In the absence of oxygen, carbon tetrachloride vapour produces a considerable negative emission which persists even after the complete removal of the vapour; details of this effect will be reported in due course.

(*f*) The platinum anode surface on which the Rice effect has just taken place shows a 'leopard-skin pattern, presumably of carbon deposited from the halogen compound, and becomes mossy in a few days at room temperature in vacuum or in air. If the Rice effect has not occurred, due to the absence of oxygen or alkalis or to some unknown causes the platinum surface looks clean at first but becomes mossy as in the previous cases.

(*g*) Platinum as incandescent anode material is not essential to the Rice effect. Other oxidation resisting materials such as nichrome can also be used.

W. C. White[5] considers that halogen 'speeds up' the formation of alkali positive ions from alkali neutral atoms, for it has the highest electron affinity among the elements. His assumption is, however, contrary to the effects in paragraphs *c* and *d*.

We are rather inclined to assume that the Rice effect may be due to the production of some new species of positive ions in some way by a surface reaction between oxygen and vapours of halogen compounds which seems to be related to the presence of alkali ions.

The Rice effect is a significant observation in the field of positive ion emission, and the present work is now being continued in an attempt to find a clue to the study of some aspects in heterogeneous catalysis in gaseous reactions.

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Effect of Shoot Orientation on Leaf and Shoot Development

FACTORS influencing leaf shape are listed by Ashby[1] and include light intensity, length of day, mineral content of the soil and water supply. In the course of research on the behaviour of the rhizome of *Agropyron repens*, it was found that the form of the growing leaves and also the development of the rhizome was markedly affected when the orientation of the rhizome was changed, so that the gravitational force acted along the shoot in a basipetal direction instead of across it. Direction of gravity as a factor controlling leaf shape does not appear to have been reported previously.

One of the problems to be solved concerning the development of rhizomes is to elucidate the causes which eventually transform the tip of the subterranean rhizome into an orthotropic aerial shoot after a period of rhizome growth. In *A. repens* it was observed that aerial shoot formation is preceded by a change in the response of the rhizome to gravity, the tip becoming negatively geotropic and curving up into the vertical position. The change of shoot form which follows is marked by the replacement of the scale-leaves of the rhizome by a transitional series of leaves and ultimately by aerial foliage leaves.

It was found that the rhizome of *A. repens* could be induced to change prematurely into an aerial shoot, with the accompanying change of leaf form, by placing the rhizome tip so that it pointed vertically upwards. This was done with a number of young rhizomes, and it was found that the complete change generally took ten days. The first transitional leaf appeared after 4 or 5 days. As the rhizome terminal bud contains 4–5 developing leaves which emerge at 2–3 day intervals, it follows that the transitional leaves at least are formed by the modification of growing leaves which would normally have developed into scale-leaves.

This change could not be induced by placing the rhizome tip so that it was pointing vertically downwards. It is therefore clear that it is caused by gravity acting in a basipetal direction along the length of the rhizome, and is not a response to the multilateral stimulus of gravity. This was confirmed by the fact that detached rhizomes, which showed a similar behaviour to attached ones, did not change into aerial shoots when rotated on a klinostat in the horizontal plane about their long axes. The change from a rhizome to an aerial shoot in *A. repens* therefore seems to be the result of the fact that at the end of the summer the rhizome tip curves round so that it points upwards.

Further experiments revealed the fact that, while in the transitional state, young attached shoots could be made to revert to forming rhizome tissue again by returning the shoots to the horizontal position. When this was done, a series of leaves showing a transition in form back to the scale-leaf appeared. When first returned to the horizontal position, the shoots showed a strong negative geotropism, necessitating frequent adjustment to keep the shoot horizontal. This tendency disappeared as the rhizome form was resumed. Mature aerial shoots could not be made to revert to the rhizome form, suggesting that in the vertical position the course of development of the shoot apex eventually becomes permanently changed so that it can form only the organs of the aerial shoot.

These experiments have been repeated using the rhizome of *Sporobolus virginicus*, a common grass on the sandy beaches of the Caribbean. Similar results were obtained, though the response to change in position of the shoot was much slower than in *Agropyron repens*.

It is therefore apparent that in these two grasses the plagiotropic tendency shown by the rhizome serves not only to keep it below the soil surface, but also to preserve the form of the rhizome by preventing the development of aerial shoot organs.

Part of this work was carried out in the University of Sheffield, during the tenure of an award from the Department of Scientific and Industrial Research.

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Influence of Leaf Activity on the Composition of the Wood Cell Wall

NEARLY twenty years ago, Clarke[1] discovered a relationship between fibre wall composition, as revealed by botanical lignin reagents, and the variation in strength of home-grown ash (*Fraxinus excelsior*) timber. His subsequent observations on some three hundred other hardwoods demonstrated the wide application of this relationship and at the same time brought to light a marked difference between temperate and tropical species[2]. The latter were found to be more resistant to compression along the grain but weaker in impact bending-strength than the temperate hardwoods on a weight-for-weight basis; they also showed a much stronger reaction with the traditional lignin reagents. Comparison of timber grown in the tropics with that of the same or closely allied species grown under temperate conditions indicated that the kind of lignin reaction must be related to a geographical or climatic factor and not to generic constitution.

Recently, evidence has been found that the controlling factor in lignification (in the botanical sense) of the fibre walls is the illumination received by the leaves. The hypothesis originated during a survey of the variation in lignification of English ash, when it was noticed that the spring-wood zone of each annual ring consistently gave a poor lignin reaction irrespective of the degree of lignification in the remainder of the ring. It is known from previous work[3] that the spring-wood in ash is formed before the leaves have expanded, and this now suggested that whereas starch, or other stored food material, already present in the stem can suffice for cambial growth, lignification of the new fibres is dependent on some product associated with leaf activity. Further substance was given to the hypothesis by the observation that the spring-wood in the annual ring of wood next to the pith, by contrast with the spring-wood in subsequent rings, showed good lignification: this first annual ring corresponds with the terminal shoot, in which leaf development from the terminal bud precedes wood development.

Confirmatory evidence for the hypothesis was obtained from the following pilot experiment. A hood was placed over the upper portion of a coppice shoot of ash early in May 1953, shortly after the buds had burst and the leaves were no more than 2 in. long. A fortnight later, the hood was removed and the etiolated leaves exposed to normal illumination for a month. The hood was then replaced for another three weeks and finally removed in mid-July. Transverse sections, 12 μ thick, were taken at intervals along this stem and stained with safranine followed by fast green. These showed that the 1953 growth-ring in the hooded portion of the stem contained alternate zones of unlignified and lignified fibres corresponding respectively with the alternating periods of hooding and exposure of the leaves to light (Fig. 1). A control stem growing from the same stool, on the other hand, showed the usual pattern of lignin reactions, the 1953 extension shoot being lignified throughout, whereas the increment around the 1952 shoot was poorly lignified in the spring-wood and well lignified in the summer-wood.

In view of the observations recorded above, it seems reasonable to attribute the greater lignification of tropical timbers to the exposure of the tree crowns to more adequate solar illumination in the tropics.

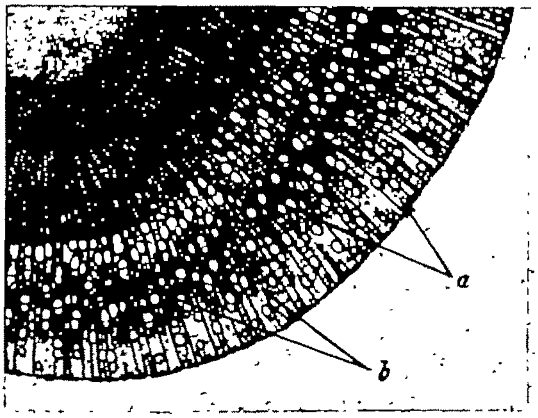

Fig. 1. Transverse section of experimental shoot of ash taken near tip of 1952 growth. Stained safranine, and fast green; photographed with green filter. The red-stained, lignified tissues appear darker than the poorly lignified (green-staining) portions. The 1952 growth-ring formed under normal illumination is well lignified throughout. In the 1953 ring the dark zones (a) correspond with periods when the shoot was exposed to normal sunlight, and the lighter zones (b) to periods when it was hooded. × 12

These findings point the way to research which may lead to a better understanding of the mechanism of woody growth. They should also give more precise direction to the investigation of relationships between environmental factors and timber quality, investigations which have been handicapped in the past, not only by the difficulty of distinguishing the effects of the various environmental factors, but also by the lack of any specific knowledge of the physiological mechanism through which such factors operate.

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Adventitious-Root Formation by Fungal Pathogen Metabolites as a Possible Mechanism of Disease Resistance

In a previous paper[1] it was demonstrated that adventitious-root formation, due to *Fusarium vasinfectum* metabolites, is confined to the wilt-resistant 'Ashmouni' cotton cut shoots, while the susceptible 'Giza 26' cotton variety fails completely to initiate any root development. The comparative readiness of a resistant variety to form adventitious roots in response to the metabolites of the specific fungal pathogen on host extract, and the failure of a susceptible variety to manifest such response, have been further tested and verified with other species of *Fusarium* as well as cotton and tomato varieties. The present work has been carried out in an attempt to elucidate the two following problems (*a*) the metabolitic potentialities of *Fusarium solani* (cf. Snyder and Hansen) to stimulate adventitious roots in wilt-resistant 'Karnak' and susceptible 'Giza 26' cotton varieties, and (*b*) the metabolitic potentialities of two tomato-wilt *Fusarium* species namely, *F. oxysporum* and *F. moniliforme*, to initiate adventitious roots in wilt-resistant 'Myco. 1' and susceptible 'North Dakota' tomato varieties.

Cotton cut shoots. Aqueous extracts, from two-week old 'Karnak' or 'Giza 26' cotton seedlings, were prepared and each extract was divided into two portions: one portion was autoclaved and the other cold-sterilized by Menon's technique[2]. *Fusarium solani* was grown on these differently treated extracts at 30° C. for 28 days, and the resulting fungal filtrate was further subdivided into two lots: one lot was left unheated and the other boiled for 15 min. Fresh healthy cut shoots, from four-week old 'Karnak' or 'Giza 26' cotton seedlings, were then inserted into differently treated filtrates. Control experiments were also made with either sterilized water or unconsumed seedling extract as the dipped medium. The treated cut shoots were left at ordinary laboratory temperature and examined regularly.

Unheated *Fusarium* metabolites, on cold-sterilized 'Karnak' seedling extract, have proved to induce adventitious-root formation in cut shoots of the same cotton variety; the interfascicular cambium (opposite the primary medullary rays) is stimulated to divide actively and produces a mass of meristematic cells which become later differentiated into an adventitious root (Fig. 1*a*). On the other hand, *Fusarium* meta

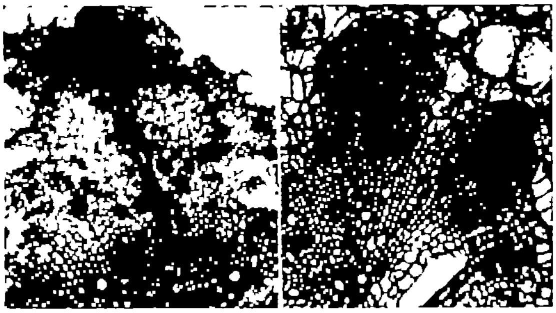
(a) (b)

Fig. 1. Transverse sections in treated cut shoots of: (a) 'Karnak' cotton variety in response to *Fusarium solani* metabolites (× 80); (b) 'Myco. 1' tomato variety in response to *Fusarium moniliforme* metabolites (× 66)

bolites on 'Giza 26' extract fail completely to induce any root initiation in its own cut shoots. The restriction of adventitious-root formation to *Fusarium* metabolitic potentiality on 'Karnak' extract, and its failure to produce such growth factor on the susceptible 'Giza 26' extract, have been further emphasized by similar cut-shoot experiments with different tomato varieties.

Tomato cut shoots. Cut shoots—from either the susceptible 'North Dakota' or the relatively resistant 'Myco. 1' tomato variety—were tested for their potentialities to produce adventitious roots in response to metabolites of two tested pathogenic Fusaria species (namely, *Fusarium oxysporum* and *Fusarium moniliforme*) on differently treated tomato extracts. 'Myco. 1' cut shoots were induced for adventitious-root formation in response to *Fusarium* metabolites (Fig. 1b); root initiation starts at an early stage, and the induced adventitious roots could soon be detected macroscopically. On the other hand, no detectable adventitious roots were observed in response to the insertion of the susceptible 'North Dakota' tomato cut shoots into *Fusarium* metabolites on their own extract. The thermostability of the growth metabolitic factor, responsible for root stimulation in 'Myco. 1' cut shoots, has been demonstrated by the comparable stimulatory effect of both autoclaved and cold-sterilized *Fusarium* metabolites.

The differential responses of host varieties to fungal pathogen metabolites, as demonstrated by the readiness of a resistant variety or the failure of a susceptible one to develop adventitious roots, might indicate that the initial fungal penetration—which has been proved to take place in both resistant and susceptible varieties—exerts an influence on the host vigour to some extent. The detection of a metabolitic growth factor in a resistant variety—as manifested by adventitious-root formation—might contribute to its resistance by: (a) the toxic effect of the fungal wilt-inducing metabolite is partially or completely eliminated by the opposing action of the associated metabolitic growth factor, and (b) the physiological function of the susceptible-variety roots ceases, either partially or completely, due to fungal infection and interference. On the other hand, induced adventitious roots—due to fungal metabolitic potentiality—enable the resistant variety to compensate for the physiological disturbance imposed upon the original infected primary roots and result in either postponing or interfering with the manifestation of the wilt symptoms. The further significance of this mechanism of disease resistance, and the elucidation of either one or the other of the two suggested possibilities, still require further investigation.

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A Colour Test for detecting Swollen Shoot Disease in Gold Coast Cacao

Hancock[1] reported a colour test for diagnosing swollen shoot disease in *Theobroma cacao* L.; the method consists of treating transverse stem sections with acidified methyl alcohol; but as the results require statistical analysis, it is of little practical value. Later, Lindner, Kirkpatrick and Weeks[2] described a staining technique for detecting viruses in the leaves of woody plants which involves extracting chlorophyll from the leaves and producing a colour reaction in the cleared leaves using normal sodium hydroxide and lactic acid.

The method of Lindner *et al.* failed to give definite indications of virus infections in cacao; but a modified technique using expressed sap has proved successful. 10 gm. of mature leaves, selected at random from all parts of the plant, are macerated with 25 ml. of distilled water and squeezed through muslin; 2 ml. of the extract is then heated to boiling point with an equal volume of normal sodium hydroxide. It is preferable to clarify the cooled samples by centrifuging at 8,000 r.p.m. for 2 min. The supernatant liquids are then made up to 6 ml. by the addition of further normal sodium hydroxide.

The colours developed are variable; but provided that strictly comparable leaf material from healthy trees of the same age and type as those under test is used as a control, infections can be diagnosed before any external symptoms are produced on the growing plant. Infected leaves produce a red-brown to crimson colour, and healthy leaves lime-green to greenish-brown.

This communication is published with the approval of the Director, West African Cacao Research Institute.

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Chlorophyll in Young Shoots of European Beech (*Fagus sylvatica*) in Winter

Chlorophyll *a* and *b* has been observed in the xylem rays and in the pith in young shoots of *Fagus sylvatica* and several other species of trees including *Populus*, *Alnus* and *Betula*. The chlorophyll is localized in chloroplasts in cells rich in starch. The possibility of chlorophyll being stored in the cells of the pith and xylem rays in winter could not be excluded; but the transport of chlorophyll within the plant would have to be demonstrated.

Extracts were made from bark, buds and xylem of *Fagus sylvatica*, and concentrations of total chlorophyll and chlorophyll *a* and *b* separately were de-

CHLOROPHYLL IN *Fagus sylvatica*

	Chlorophyll *a* plus *b* (mgm.)			
	per 100 gm. of fresh weight	per 100 gm. of dry weight	per 50 cm.² surface	*a*.*b*
Xylem	17	35	—	1·3
Bark	47	72	0·5–1·2	3·5
Young leaves in buds	85	73	—	2·2

termined in a Coleman spectrophotometer. The pigments were separated by paper chromatography according to the method described by Sironval[1]. The results are summarized in the accompanying table.

The rather low ratio of chlorophyll *a* to *b* in the xylem is of interest; it ranges from 1·1 to 1·6 in different preparations, the average being 1·3. The lowest ratio previously found was 1·4 (submersal green algae). As only 2 per cent of the light passes through the bark layer of young twigs of *Fagus*, of course no photosynthesis could be expected to occur in the xylem.

Although the total chlorophyll concentration in the bark is low as compared with that determined in leaves of the same plant exposed to sunlight (770 mgm. chlorophyll *a* and *b* per 100 gm. dry weight, or 3·2 mgm. per 50 cm.² surface[2]) the ratio *a*:*b* of 3·5 corresponds to the ratio normally found in photosynthesizing tissue. This is not surprising, since the bark of trees in the light is known to resynthesize the carbon dioxide released by respiration of living cells in bark and xylem.

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Blood Groups of Human Blood Platelets

In tables which they published recently, Stephanini and Plitman[1] described the existence of four blood groups in human blood platelets, while Harrington and his collaborators[2] describe the existence of eight such blood groups. Their research was based on the agglutination of platelets.

For our part, by absorbing anti-*A* and anti-*B* serums with highly concentrated suspensions of platelets, we were able to show the presence in these elements of the *A* and the *B* agglutinogens in persons belonging to the *A*, *B* or *AB* groups, while we found these antigens absent from platelets of the *O* type. However, such results were obtained only with platelet suspensions containing twenty million elements per c.mm., and after crushing these elements prior to the absorption of serums.

Controls were made with physiological liquid, serum and plasma, as well as with thick and thin suspensions of red cells, in order to prove that the absorption of antibody was not due to the presence of antigens dissolved in the serum or in the plasma, nor to the presence of red cells persisting in the platelet suspensions. The antibody absorbed by *A*, *B* or *AB* platelets is quite specific and sometimes reaches total absorption from the serums under study.

The serum, plasma and red cells used for the controls were always taken from the donor of the platelets.

Under these conditions, we conclude that: (1) human platelets do contain *A* and *B* antigens analogous to those of red cells; (2) these antigens seem to be located inside the protoplasm of platelets.

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Nutritional Availability of Cobaltic Oxide, Co_2O_3

Since Marston's pioneer work[1], numerous investigators have established that cobalt is a essential element in the nutrition of ruminants Sheep and cows reared on diets low in cobalt (les than 0·1 mgm./100 lb. of body weight/day) lose thei appetites, fail to gain weight, become anæmic, and finally become emaciated. The cobalt usually i added to the diet as cobalt chloride, cobalt sulphate or cobalt carbonate, in a mineral feed or in a sal block.

The possibility of using the cheaper, but relatively insoluble, cobaltic oxide, as a cobalt source seeme attractive. To answer the question of whether th cobaltic oxide would provide the cobalt essential fo ruminants, radioactive $^{60}Co_2O_3$, which was prepare in the United States Atomic Energy Commissio piles at Oak Ridge, Tennessee, was fed to lambs Three milligrams of cobaltic oxide containing 27 microcurie units of radioactivity per mgm. were fe daily to 75-lb. lambs for seven days. The animal were sacrificed on the eighth day. Muscle, blood an some of the internal organs were analysed for radioactivity with a scintillation counter. The results ar presented in Table 1. In another experiment a lam was given 10 mgm. of radioactive cobaltic oxide at single feeding and the tissues assayed for radioactivit forty-eight hours later.

Table 1. Concentration of Cobalt-60 in Tissues of Lambs fed Radioactive Cobaltic Oxide

Animal tissue	Cobalt-60 µgm./kgm. of wet tissue		
	1*	2*	3†
Blood	18	72	45
Liver	165	615	100
Heart	6	54	14
Lungs	25	150	12
Muscle	20	10	10
Spleen	68	100	80

* Animals fed 3 mgm. per day for 7 days.

† Animal fed one massive dose (10 mgm.) of radioactive cobalti chloride.

The cobalt of cobaltic oxide was definitely absorbe and distributed throughout the body of the animal The liver proved to be the site at which a large shar of the radioactive cobalt-60 assimilated was concentrated. The results compare favourably with th work of Rothery, Bell and Spinks[2], who fed 50 µgm and 500 µgm. of $^{60}CoCO_3$ to lambs daily ove periods ranging from 90 to 123 days, and with th report of Comar and Davis[3], who studied metabolism of cobalt chloride in rabbits, swine and young calve Approximately 80 per cent of the cobaltic oxide fe orally was found in the fæces, the other 20 per cen probably reacted with the hydrochloric acid in th digestive tract to form cobalt chloride, whic then provided cobalt in a form that was readily utilized.

This research project was supported by Morton Salt Company, Chicago, Illinois.

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Corpus allatum and Egg Production in Starved Milkweed Bugs

IN many insects, egg production requires special nutrition[1]. It has also been found, in most insects investigated, that the corpora allata are necessary for the normal function of the ovaries[2]. In the milkweed bug (*Oncopeltus fasciatus* (Dallas), Heteroptera, Lygaeidae), the ovaries of the female at the beginning of the adult stage are only slightly developed (Fig. 1*a*). When the female is kept in an incubator at 25° C. and fed on milkweed seeds and water, the ovaries may, after fifteen days, reach the size shown in Fig. 1*b*. Of fifteen females kept as described, nine had, at the age of fifteen days, already started oviposition, two more contained ripe eggs, while in four specimens the ovaries had only grown slightly. If the females are given only water and no seeds, they may survive for quite a long time, but no eggs are produced. After fifteen days, the size of the ovaries usually (ten specimens) is as shown in Fig. 1*c*, and only a slight growth has taken place.

At the same time, changes are observed in the incretory system. In the emerging female the corpus allatum is small (Fig. 1*a*, *ca*), but increases, as already shown by Novák[3], if she is fed. In the present material it increased to about twelve times the initial volume in fifteen days (Fig. 1*b*). In females given only water, the corpus allatum had, after fifteen days, increased only about 2·5 times (Fig. 1*c*). If the corpus allatum is transplanted from normally fed females in the oviposition period to females fed only on water, the latter will start egg production despite the lack of food. Of fourteen unfed females which thus received corpus allatum from fed females, eleven contained at later examination ripe eggs, two more showed a considerable growth of the ovaries, while only one specimen showed no reaction. Mostly two corpora allata were transplanted to each female, namely, at the age of five and ten days, and the specimen examined at the age of fifteen days; but when the transplantation was done only once, ripe eggs were still obtained. Fig. 1*d* shows the ovary of a fifteen-day old starved female which ten days earlier received the corpus allatum from a fed female. In most cases the corpus allatum was transplanted together with the corpora cardiaca and a fraction of the aorta. However, transplantation of only the posterior half of the corpus allatum with no traces of corpora cardiaca also resulted in egg development. When the females were kept alive for a sufficiently long period, they deposited eggs of normal size and shape. When the females were mated with normal males, the fertilized eggs developed to normal larvæ. In seven specimens muscles were transplanted as controls, but no changes in the ovaries were observed.

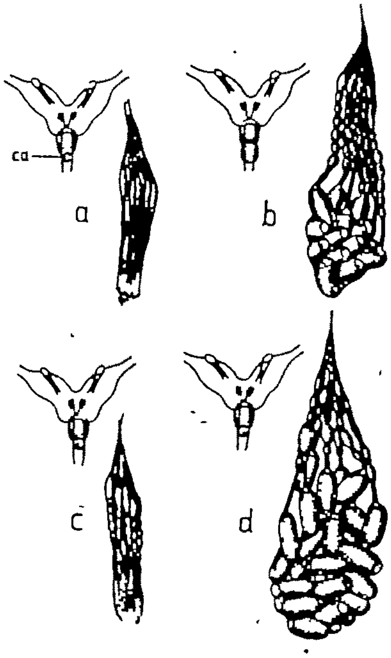

Fig. 1. The brain with the corpus allatum (*ca*) and the right ovary and lateral oviduct of females: (*a*) at the beginning of the adult stage; (*b*) 15 days old, fed; (*c*) 15 days old, starved; (*d*) starved, with corpus allatum transplanted from fed females

In the bug *Rhodnius*, also, fasting influenced both the corpus allatum and egg production[4], whereas in *Tribolium* and *Chrysopha* starvation prevented the normal development of the ovaries but not the growth of the corpora allata[5]. The two results of normal food supply, namely, growth of the corpus allatum and egg production, may in the milkweed bug be explained by presuming a primary influence on the corpus allatum, which then starts to function and secondarily induces egg development.

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Direct Observation of Hapten–Antibody Equilibria

IF the bivalency of antibodies, for which there is now considerable evidence, is accepted, it is to be expected that the addition of bivalent hapten to solutions of purified homologous antibody would bring about a linear association of alternating antibody and hapten molecules. The equilibrium extent of this association should be dictated solely by the value of the free energy of formation (ΔF°) of a hapten–antibody bond and the concentration of the two reacting species. Hence a determination of the extent of association would provide the value of ΔF°, and if this were done as a function of temperature the values of the entropy (ΔS°) and the heat (ΔH°) of bond formation would be available as well.

Light-scattering measurements on very dilute mixtures will yield the weight-average aggregate weight since the deviations due to non-ideal behaviour are negligible. The free energy of formation can be calculated in the following way. Let H_0 and A_0 be the initial concentrations of hapten groups and antibody sites respectively and p be the equilibrium fraction of hapten groups reacted. Then the equilibrium constant, K, for the reaction of a hapten group and an antibody site to form a hapten–antibody bond is given by

$$K = \frac{pH_0}{(1-p)\,H_0\,(A_0 - pH_0)}\,.$$

If the reactions are reversible, then equilibrium is established when the mixture is in its most probable state, and using the analysis of Goldberg[1] it can be shown that to a good approximation

$$\frac{M_w}{M_A} = \frac{1 + p^2r}{1 - p^2r},$$

where M_w is the weight-average aggregate weight, M_A is the molecular weight of the antibody, and $r = H_0/A_0$. Thus, from the measurement of the ratio M_w/M_A in a mixture of known concentration of hapten and antibody, p may be evaluated and K and hence ΔF° determined.

In addition to these expectations the dynamic character of the equilibrium should be reflected in the shift of the M_w/M_A ratio upon dilution and upon addition of further amounts of hapten or antibody. Moreover, the value of the ratio should approach unity upon the addition of monovalent hapten. Our observations on several purified antibody preparations using two haptens have verified these predictions and have permitted a determination of the thermodynamic quantities.

The systems studied have been rabbit antiarsanilic antibody, most of which was prepared by the method described by Campbell and Lanni[2], and terephthalanilide-*pp*′-diarsonic acid (T) and adipanilide-*pp*′-diarsonic acid (A). Some results are summarized in Table 1. Unless otherwise specified, the temperature is 25° C.

Table 1

Antibody Pool No.	Antibody conc. (gm./dl.)	Hapten	r	M_w/M_A	ΔF° (k.cal.)
IV	0 040	T	4 3	1·43	−7·59
		T	0·89	1·58	−7 58
		T	0 18	1·14	−7 52
		A	0 95	1·51	−7·49
		A	4 8	1·38	−7 55
X + XI	0 090	T	1 01	1·72	−7 44 (35° C.)
		T	1·01	1 90	−7 35
		T	1 01	2 02	−6·95 (5° C.)

From the results shown here and others the value of ΔF° is found to be $-7{\cdot}5 \pm 0{\cdot}1$ k.cal./mole of hapten–antibody bonds formed under the conditions pH 8·0 borate buffer, ionic strength 0·15 at the temperature 25° C. This average includes two haptens and different preparative procedures applied to two different antisera pools. At equimolar concentration of hapten and antibody, this means that 59 per cent of the antibody exists as 'monomer' (an antibody molecule combined with zero, one or two hapten molecules), 28 per cent as 'dimer', and 10 per cent as 'trimer', when the total antibody concentration is 0·04 gm./dl.

This result is in good agreement with the values obtained for a similar system by Eisen and Karush[3] and Lerman[4], who employed equilibrium dialysi measurements using monovalent haptens.

Applying the van 't Hoff relation to the K valu determined at different temperatures, we obtai approximate values of $\Delta H^\circ = -2{\cdot}4$ k.cal./mol (exothermic reaction) and $\Delta S^\circ = +17$ e.u./mol These values show that the entropy gain constitut the major driving force of the reaction, and, as i the case of a similar observation for the associatio of insulin molecules[5], this suggests that water mol cules are displaced from charged groups when th hapten–antibody bond forms.

In addition to the extension of the results sum marized here, current work is concerned with th detection of heterogeneity of the bonds as might b displayed by deviations of plots of M_w/M_A versu concentration from the relation predicted for a singl ΔF° value, the exploration of the rate of reactio and the extension of the method to acid solutio of specific precipitates.

This investigation is part of a study made possib by a grant from the Rockefeller Foundation. W greatly appreciate the help of Prof. W. C. Boy (Boston University), particularly in the problem antibody preparation, and expect to publish with hi other aspects of this investigation in the near futur

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The Marshes of the Medway Estuary in Romano-British Times

J. P. T. BURCHELL (*Nature*, May 1, p. 832) appea to be taking a somewhat short-sighted view by den ing the existence of an ancient pottery site on t Upchurch Marshes of the Medway Estuary.

Investigations carried out by us in recent yea have shown that potting was at least one of th industries carried on in this region during the fir and second centuries A.D. and probably also in t immediate pre-Christian era. This is borne out b the number of wasters (overbaked and distorted pot found on the mud flats, the appearance of whi precludes the possibility of importation from th opposite coast of Gallia Belgica. The absence of kil has in the past been taken as evidence against th existence of potteries. We believe that the olde gritty wares, which fragment rather than warp faulty firing, were fired on level ground under pil of straw and brush-wood, in the same way as ma primitive native wares in modern Africa, which th resemble in type and material. Belgic terra nig certainly blisters on faulty firing, and we have fou numerous good examples. We have also excavat several structures which may well be kiln flues. may also be significant that the modern Upchur potteries, situated about five miles from the mars used, until quite recently, the local estuarine clay.

In view of Francis W. Reader's report of the Red ills Exploration Committee[1], the possibility of salt-anning must be considered. It seems to us rather nlikely that this industry was carried out on the te in Roman times, since the water is now only rackish and loaded with silt, and we have biological ndence that the situation in the first and second nturies A.D. was similar, and indeed that the water ay even have been less saline. We agree that the arshes were inundated, and by plotting the dates finds we have been able to demonstrate the order which various areas became covered by the sea. e fail to understand how any industry involving e use of fire could have been carried out on "the ter-tidal surface of the marsh clay" as Mr. Burchell iggests.

The Ordnance Survey maps of the area (6 in. : mile) are misleading, in that they imply that the arious sites occupy a very extensive tract, whereas, fact, the occupation sites are of very limited extent ad distributed along the banks of ancient creeks[2]. he structural remains are similar to those found on e foreshore of the Thames at Tilbury[3]. We believe at most of the finds have remained *in situ*, and at only in certain areas and in recent times have rosion and redeposition occurred, as evidenced by the istribution of waterworn sherds.

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Devon,

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J. *Roman Studies*, **43**, Roman Britain, p. 126.

Royal Commission on Historical Monuments, Essex, S.E., p. 80.

MR. J. P. T. BURCHELL, in *Nature* of May 1, p. 832, as made some statements on this subject with hich I cannot agree. The archæological evidence btained from the Upchurch Marshes over a period nearly a century leaves no doubt that the area pported a flourishing potting industry throughout e first and into the early decades of the second ntury A.D. While there is little evidence to suggest intensive occupation of the Milfordhope or Slay-lls Saltings after the Antonine era, there can be no nying that adjacent sites, notably at Otterham reek, were inhabited and producing pottery well rough the third century.

It would be unwise to be dogmatic with regard to e extent of the potting industry in the later Roman riod ; but it is certain that in the first century e output far exceeded local requirements. A few rge storage jars have been traced to London, but would seem that the bulk of the products were anufactured for distribution in the south-east of itain, large numbers of vessels having, for example, en found at Richborough.

It does not follow that we can still accept the bel 'Upchurch Ware' as referring to certain types pottery. The Medway sites produced a wide riety of wares, the majority being common forms at were copied by potters up and down the untry for so long as the shapes remained popular. is therefore the fabric of the vessel rather than its rm that may suggest the place of manufacture.

Mr. Burchell appears to base his archæological evidence on his Samian potters' stamps. It should be pointed out that the number of fragments of Terra Sigillata from the sites is minute compared with that of the coarse sherds. While it is true that most of the Samian fragments are of second century date, this fact cannot seriously be weighed against the overwhelming evidence of the other material.

The evidence on which the above statements are made is both long and complex and clearly cannot be discussed here. However, a research report is to be published in the next volume of *Archæologia Cantiana*. This, following Mr. John H. Evans's invaluable paper on the "Archæological Horizons in the North Kent Marshes" in the present issue of that journal, should do something to clarify an archæological problem that has too long remained unanswered.

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May 12.

Classification of the Terrestrial Heteroptera (Geocorisae)

FOLLOWING Dufour[1], the Heteroptera can be divided into three series : Geocorisae (land bugs), Hydrocorisae (water bugs) and Amphibicorisae (water-surface bugs). Reuter[2] divided the Heteroptera into seven series. One of these, Hydrobiotica, included most of the families of Dufour's Hydrocorisae and Amphibicorisae as well as Saldidae ; the Geocorisae were split into five series, and the other series contained Corixidae only. China[3] followed Reuter with some modifications ; he did not consider Geocorisae a homogeneous group. Börner[4] recognized three primary divisions of Geocorisae : Reduvioidea, Cimicoidea and Pentatomoidea. In the first he included Ochteridae, Saldidae and Enicocephalidae and in the last the Tingidae.

Recent work, carried out by us independently, together with some work by earlier authors, leads to the conclusion that most of the families of Geocorisae fall naturally into two groups ; the evidence is as follows :

(1) Tullgren[5] erected a group, Trichophora, which included families from three of Reuter's series and the Piesmidae ; hitherto the latter had been placed in a superfamily with the Tingidae. The group was characterized by the presence of ventral trichobothria and a basic type of pretarsal pseudoarolia (Tullgren's arolia). Although the Holarctic Aradids are without pseudoarolia, some New Zealand (Myers and China[6]) and Neotropical (Wygodzinsky[7]) species possess pseudoarolia with a basal sclerite, that is, of the Trichophoran type. Southwood finds a similar structure in *Aneurus*. (The term pseudoarolia is used here for the structures below the claws and does not imply homology with those of other orders or those of the Miridae).

(2) Singh-Pruthi[8] demonstrated the presence of two basic types of male genitalia in Heteroptera : a Pentatomoid type occurring in three of Reuter's series (Lygaeoidea and allies, Aradoidea, Pentatomoidea-Coreoidea) and in the Saldidae ; a Reduvioid type occurring in the remaining bugs. Contrary to Singh-Pruthi, Leston finds the male genitalia of *Piesma*, and Southwood that of *Aneurus*, to be of Pentatomoid form.

(3) Leston, from a study of wing venation and areas, confirms Tullgren's Trichophora with the addition of Aradoidea, demonstrates the venational similarity of Tingidae and Reduviidae, shows two related patterns of venation in Reduvioidea and Cimicoidea respectively (including Joppeicidae within the latter) and places Ochteridae and Gelastocoridae in close relationship with Hydrocorisae. Preliminary studies suggest that the Saldidae possess modified Trichophoran venation; Enicocephalidae have a unique venation among land bugs suggesting only that of the wings of Hydrocorisae.

(4) Pendergrast, from a study of the female reproductive organs, concludes that the spermatheca of the Aradidae and Saldidae is of the same type as that found in most Trichophora (including Piesmidae). The spermathecae of Tingidae do not show affinities with this group, but rather with those of Reduviidae and Phymatidae. Gelastocoridae and Ochteridae are clearly close to the Hydrocorisae.

(5) Leston[9,10] noted that eggs of the Tingidae resembled those of the Cimicoidea and were of a different type to those of Piesmidae. Following this, Southwood has shown that there are in fact two well-marked egg types in terrestrial Heteroptera: that characteristic of the Trichophora and Aradoidea and that of the Reduviidae, Phymatidae, Tingidae and Cimicoidea. Enicocephalid eggs, as described by Carayon[11], appear unique among the land bugs. The Trichophora and Aradoidea also agree in the possession of a similar type of egg burster, while hatching spines or ridges occur in all groups.

(6) Southwood has found that the two types of accessory salivary glands described in the Heteroptera by Baptist[12] also support these groups. These structures in Piesmidae and Aradoidea resemble those found by Baptist in the Pentatomidae, Coreidae, Neididae, Lygaeidae and Pyrrhocoridae.

It is proposed to erect two groups within Geocorisae, basing them nomenclatorially on genera and thus following Evans's[13] precedent in Homoptera.

Pentatomomorpha: male genitalia of Pentatomoid form or related thereto; ventral trichobothria (or multiple setose areas) present; hind-wings with radius and media distally separated and subcosta never well developed; fore-wings without a costal fracture; spermatheca single, median, usually with a spermathecal duct, muscular pump and an apical sperm storage bulb; eggs with micropylar processes, these consisting of a central canal (for sperm passage) surrounded by a spongy or porous layer (for respiration); operculum usually absent, but when present without deep follicular pits and not differing greatly in structure from the rest of the chorion; eggs probably never embedded into plant tissue at oviposition; egg burster a single structure situated on the vertex of the embryonic cuticle; accessory salivary glands of tubular type.

Cimicomorpha: male genitalia of Reduvioid form or related thereto; ventral trichobothria absent; hind-wings with radius and media distally fused and subcosta often well developed; fore-wings usually with a costal fracture; true spermathecae absent in Cimicoid families but in Reduvioidea and Tingidae they are paired, laterally placed, usually very thin cuticular sacs, without a pumping apparatus and probably not homologous with the median spermatheca of Pentatomorpha; eggs with micropylar apparatus consisting of canals running in the rim of the chorion surrounding the operculum, which is always present; as shown by Beament[14], micropylar canals of two types, true micropyles (for sper passage) and pseudomicropyles (for respiration), b one type may be absent; operculum strong differentiated from rest of chorion, with deep follicul pits; eggs often inserted into plant tissue; medi egg burster absent; accessory salivary glands vesicular type.

The Pentatomorpha contain Pentatomoidea, Cor oidea, Lygaeoidea (= Neidoidea Reuter), Aradoide Piesmidae and probably Saldoidea (Saldidae a Leptopodidae), but the last-named superfamily certainly far from the main Pentatomorpha ste The Cimicomorpha contains Reduvioidea, Tingida Cimicoidea and Joppeicidae. We follow Blöte[15] considering Scotomedidae (= Velocipedidae) a su family of Nabidae, and Carayon[16] in placing th family in Cimicoidea. Dipsocoroidea are probab allied to the Cimicomorpha. Enicocephalidae a apparently Geocorisae, but the hind-wing venati suggests a distant relationship with Hydrocorisa they are, however, being studied elsewhere. Lack material has precluded any study of Leotichidae.

From our evidence it seems that certain famili sometimes treated as Geocorisae must be remov from this series: Gelastocoridae and Ochteridae a Hydrocorisae. Hence, although recently adopted Poisson[17], the series Telmatobia of Esaki and China must be abandoned, and this already has been do by China[3]. The placing of Mesovelidae and Hebrid in the Amphibicorisae, as done by most authors, supported by the present evidence.

Some families or individual genera do not posse all the basic characters of either series: many ha reduced venation (for example, Dipsocoroidea) or a apterous (for example, Cimicidae, Polyctenidae); true spermatheca is absent in *Aneurus* (Aradoidea ventral trichobothria are lacking in Saldoidea.

For details of the internal anatomy of Cimicoid and other matters we are indebted to Dr. J. Carayo Entomologie Agricole Coloniale, Paris.

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May 20.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, July 12

hysical Society (at the Royal Institution, 21 Albemarle Street, odon, W.1), at 2.30 p.m.—Prof. C. Kittel (University of California): icrowave Experiments in the Physics of Solids".*

Monday, July 12—Friday, July 16

niversity of Liverpool (in the Department of Zoology, The iversity, Liverpool)—Symposium on "The Comparative Endo- inology of Vertebrates".

Monday, July 12—Saturday, July 17

ociety of Chemical Industry (at Liverpool)—73rd Annual eting.

Tuesday, July 13—Saturday, July 17

Physical Society (joint conference with Bristol University d the Institute of Physics, at the University, Bristol)—"Physics the Solid State".

University of Glasgow (in conjunction with the International nion of Pure and Applied Physics and Unesco, at the University) Conference on "Experimental and Theoretical Nuclear Physics". airman: Prof. P. I. Dee, F.R.S.

Thursday, July 15—Saturday, July 17

Royal Meteorological Society (in the Department of Natural ilosophy, The University, Drummond Street, Edinburgh)—Summer eting.*

Friday, July 16

Biochemical Society (in the Department of Biochemistry, Queen's iversity, Belfast), at 11 a.m.—Scientific Papers.

National Institute of Agricultural Botany (at Huntingdon ad, Cambridge), at 2.15 p.m.—Annual General Meeting.

Friday, July 16—Wednesday, July 21

Joint Commission on Electron Microscopy International uncil of Scientific Unions (at the London School of Hygiene d Tropical Medicine, Keppel Street, London, W.C.1)—International nference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or ore the dates mentioned:

Research Demonstrator in Physics—The Registrar, University llege, Leicester (July 16).

Agricultural Economist (graduate, preferably with qualifications economics and horticulture or agriculture)—The Registrar, Wye llege, near Ashford, Kent (July 17).

Assistant Lecturer (preferably with some experience in microbiology or plant biochemistry) in Botany—The Secretary, Birkbeck llege, Malet Street, London, W.C.1 (July 17).

Farm Demonstrator (with a degree in agriculture and farming perience), for duties which will include practical instruction on the iversity Farm to undergraduate and postgraduate students—The cretary, School of Agriculture, Cambridge (July 17).

Research Fellow in Pure Mathematics—The Registrar, The iversity, Edgbaston, Birmingham (July 17).

Demonstrator (Grade III) in Physiology—The Registrar and cretary, The University, Bristol (July 19).

cientific Officer (honours graduate, and preferably with postduate experience in genetics) at the Plant Breeding Station—e Secretary, National Vegetable Research Station, Wellesbourne, rwick (July 19).

W. T. Henley Fellow (with a good degree in electrical engineering physics) for research work in electrical engineering—The Registrar, een Mary College (University of London), Mile End Road, London, 1 (July 19).

Assistant Lecturer in Geology—The Secretary, Queen's Univery, Belfast (July 20).

Lecturer (Grade II) in Zoology, at University College, Ibadan—e Secretary, Inter-University Council for Higher Education in the onies, 1 Gordon Square, London, W.C.1 (July 21).

Research Zoologist (with an honours degree in zoology), to work the pests of sugar beet—The Secretary, School of Agriculture, mbridge (July 24).

Scientist, Grade III (with a good honours degree in chemistry or ysics), in the Coal Survey Laboratory, Leeds—The National al Board, Establishments (Personnel), Hobart House, Grosvenor ace, London, S.W.1, quoting TT/800 (July 28).

Lecturer in Crystallography in the Department of Geology, cturer in Mathematics, and a Lecturer (preferably with some perience in plant design and operation) in Chemical Engineering, the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 delaide, July 30).

Lecturers (with a good honours degree in electrical engineering) Electrical Engineering—Head of the Electrical Engineering partment, City and Guilds College, London, S.W.7 (July 30).

Assistant Lecturer (preferably with a special interest and qualifications in parasitology) in Agricultural Zoology—The Registrar, The University, Leeds (July 31).

Assistant Lecturer (with an honours degree in agricultural chemistry or chemistry) in Agricultural Chemistry—The Registrar, The University, Reading (July 31).

Assistant (with an honours degree in history or archæology, and prepared to take a special interest in prehistoric archæology) in the Hunterian Museum—The Secretary of University Court, The University, Glasgow (July 31)

Chair of Chemistry—The Secretary, The University, Aberdeen (July 31).

Lecturer in Astronomy—The Secretary, The University, Edinburgh (July 31).

Lecturer in the Department of Botany at the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, July 31).

Professor of Geophysics—The Director, Institute of Astronomy, Helwan, Egypt (July 31).

Research Associate (with a good honours degree and some research experience) in the Luminescence Laboratory of the Department of Physics—The Secretary, The University, Birmingham 15 (July 31).

Senior Research Officer (with a university honours degree in fuel technology, or equivalent qualifications, and research experience in fuel technology) in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, to investigate ash deposition and clinkering phenomena in connexion with the combustion of Australian coals—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 480/107 (July 31).

Lecturer (preferably with special qualifications in plant morphology) in Botany, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, August 2).

Chair of Pathology and Chair of Bacteriology, at University College, Ibadan, Nigeria—The Secretary, Senate Committee for Higher Education in the Colonies, Senate House, London, W.C.1 (August 3).

Lecturer in Plant Physiology at Auckland University College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Auckland, August 10).

Assistant Lecturers (with a special honours degree in the relevant subject) in Botany, Geology, Physics and Philosophy—The Secretary, Bedford College, Regent's Park, London, N.W.1 (August 27).

Plant Pathologist (with a good degree in botany, including mycology, and preferably with postgraduate research experience or equivalent training in plant pathology or mycology), for research on fungal diseases of hops and fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (September 1).

Anglo-Iranian Oil Company Student for the study of gaseous reactions in the Chemistry Department—The Registrar, Imperial College, London, S.W.7.

Assistant Entomologist, Senior Scientific Officer or Scientific Officer grade, in the Bee Research Department, for work on bee breeding and the pollination of crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Assistant Experimental Officers (2) (with a pass degree in science, H.N.C., or equivalent qualification) in the Department of Scientific and Industrial Research, Intelligence Division, for abstracting and technical information work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A118/54A.

Demonstrator in Botany—The Registrar, Wye College (University of London), near Ashford, Kent.

Engineers and Physicists, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

Head of the Chemistry and Metallurgy Department, Head of the Engineering Department, and Head of the Building Department, at Flintshire Technical College—The Director of Education, County Education Offices, Mold, Flintshire.

Head (with sound practical experience and teaching ability) of the Agricultural and Horticultural Departments, and Farm Manager—The Principal, Studley College, Warwickshire.

Information Officer, Senior Experimental Officer grade (with H.S.C. in science or mathematics, or equivalent) in the Department of Atomic Energy, Risley, to take charge of a Headquarters Library Information Section—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 620.

Laboratory Technician (with experience in microscopic work and photography) in the Physiology Department—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Officer (with a degree in agriculture or botany, or equivalent) for Oil and Legume Crops, and Assistant Regional Trials Officers (2) (with a degree in botany or agriculture, or equivalent), to conduct trials on plant breeders' materials at a northern and an eastern sub-station—The Secretary, National Institute for Agricultural Botany, Huntingdon Road, Cambridge.

Physicist (with an honours degree in physics) to carry out fundamental investigations into new methods of casting steel by continuous processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Radiochemist, Principal Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in chemistry, and some years research experience on the analysis and assessment of radioactive substances) for fundamental research work on radioactive materials—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 154/WGH/2.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or physical chemistry, or equivalent qualifications, and several years postgraduate experience), to supervise and participate in the activities of a group investigating application of engineering technology to the manufacture of explosive components—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 107/WGB/2.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Institution of Professional Civil Servants. Annual Report for the year 1953. Pp. 40. (London: Institution of Professional Civil Servants, 1953.) [145

National Coal Board: Scientific Department. Proceedings of a Colloquium on the Hydraulic Transport of Coal, held by The National Coal Board in London on November 5th and 6th 1952. Pp. vi+75. (London: National Coal Board, 1954.) [145

Institution of Metallurgists. The Microscopy of Metals: Lectures delivered at the Institution's Refresher Course 1953. Pp. 132. (London: Institution of Metallurgists, 1954.) 15s. 6d. [145

Department of Scientific and Industrial Research. Research on Food Preservation in the United Kingdom. Pp. iv+56. (London: H.M. Stationery Office, 1954.) 2s. net. [145

Industrial Diamond Trade Index and Yearbook for 1954. Pp. 122. (Hammersmith, London: N.A.G. Press, Ltd., 1954.) 2s. 6d. [145

Department of Scientific and Industrial Research. Report of the Hydraulics Research Board, with the Report of the Director of Hydraulics Research for the year 1953. Pp. vi+52+8 plates and 4 maps. (London: H.M. Stationery Office, 1954.) 1s. 6d. net.

Publications of the Thoresby Society. Fourth Report, 1953: Kirkstall Abbey Excavation. Pp. 51–66+plates 7 and 8. (Leeds: Thoresby Society, 1954.) 1s. [145

Disposal of Waste Waters from Industrial Premises. (FBI Handbook.) Pp. iv+36. (London: Federation of British Industries, 1954.) 2s. 6d. [185

Institute of Physics. Thirty-third Annual Report. Pp. 24. (London: Institute of Physics, 1954.) [215

Royal Sanitary Institute. Annual Report of the Council for the year 1953. Pp. 26. (London: Royal Sanitary Institute, 1954.) [215

Ministry of Health. Memorandum on Measures for the Control of Mosquito Nuisances in Great Britain. Revised 1954. Pp. 28 (2 plates). (London: H.M. Stationery Office, 1954.) 1s. 3d. net. [215

Philosophical Transactions of the Royal Society of London. Series A—Mathematical and Physical Sciences. No. 916, Vol. 246, 13 May 1954: Uniform Polyhedra. By Prof. H. S. M. Coxeter, M. S. Longuet-Higgins and J. C. P. Miller. Pp. 401–450+6 plates. (London: Cambridge University Press, 1954.) 25s. [215

World Calendar News—Bulletin of the British Section of the World Calendar Association International. No. 1, May 1954. Pp. 4. (London: World Calendar Association, British Section, 1954.) [215

Department of Scientific and Industrial Research. Report of the Road Research Board, with the Report of the Director of Road Research for the year 1953. Pp. vi+90+15 plates. (London: H.M. Stationery Office, 1954.) 5s. net. [255

British Drug Houses, Limited. Report and Accounts, 1953. Pp. 16. (London: British Drug Houses, Ltd., 1954.) [265

The Staffing of Grammar Schools: a Survey of the Staffing of 66 Grammar Schools in the North West of England, with special reference to the Teaching of Arts, Science and Mathematics. By W. H. Egner and A. Young. Pp. 20. (Liverpool: At the University Press, 1954.) 2s. [265

Ministry of Agriculture and Fisheries. Memoirs of the Soil Survey of Great Britain—England and Wales. The Soils of the Wem District of Shropshire (Sheet 138). By H. Crompton and D. A. Osmond. Pp. vii+80+4 plates. (London: H.M. Stationery Office, 1954.) 10s. 6d. net. [285

Memorandum by the National Smoke Abatement Society to the Committee on Air Pollution. Pp. 16. (London: National Smoke Abatement Society, 1954.) 1s. [285

International Committee for Bird Preservation—British Section. Annual Report for 1953. Pp. 48+2 plates. (London: International Committee for Bird Preservation, c/o British Museum (Natural History), 1945.) 2s. [285

Council for the Preservation of Rural England. Twenty-Eighth Annual Report 1953–54. (Vol. 16, No. 2.) Pp. 64+4 plates. (London: Council for the Preservation of Rural England, 1954.) [285

The American Outlook in Foreign Affairs. By The Rt. Hon. Sir Oliver Franks, G.C.M.G., K.C.B., C.B.E. (Twelfth Montague Burton Lecture on International Relations.) Pp. 14. (Leeds: University of Leeds, 1954.) 6d. [315

Report of the Rothamsted Experimental Station for 1953. Pp. 228. (Harpenden: Rothamsted Experimental Station, 1954.) 7s. 6d. [315

Other Countries

Geological Survey of South Africa. Annexure to Volume 56: Gondwanaland and the Distribution of Early Reptiles. By S. H. Haughton. (Alex L. du Toit Memorial Lecture—No. 3.) Pp. 30. (Johannesburg: Geological Society of South Africa; South African Association for the Advancement of Science; South African Geographical Society, 1954.) [145

Union of South Africa. Department of Commerce and Industries: Division of Fisheries. Twenty-Third Annual Report, for the year ended December, 1951. By Dr. J. M. Marchand. Pp. 182. (Pretoria: Government Printer, 1953.) [145

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Brookhaven Symposia in Biology No 6: Abnormal and Patholog Plant Growth. (Report of Symposium held August 3 to 5, 19 (BNL 258 (C-19)). Pp. vii+303. (Upton, N.Y.: Brookhaven Natio Laboratory, 1954.) 2.10 dollars. [

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New Zealand Forest Service Information Series No. 16: Brand the Beeches in Bush and Mill. Pp. 8. Information Series No. Beech Timbers: Properties and Uses of Nothofagus Species. J. S. Reid. Pp. 36+4 plates. (Wellington: Government Print 1953.) [

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Bulletin of the Bingham Oceanographic Collection, Peab Museum of Natural History, Yale University. Vol. 14, Article 3: Character and Significance of Sound Production among Fishes of Western North Atlantic. By Marie Poland Fish. Pp. 109. (New Hav Conn.: Peabody Museum of Natural History, Yale University, 19 1.65 dollars. [

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University of Illinois Engineering Experiment Station. Repr Series No. 53: Progress Reports of Investigations of Railroad R and Joint Bars. By R. E. Cramer and R. S. Jensen. Pp. 40. 30 ce Bulletin Series No. 420: The Influence of Temperature and Rate Strain on the Properties of Metals in Torsion. By Clyde E. Work Prof. Thomas J. Dolan. Pp. 109. 1 dollar. Bulletin Series No. 4 Almost Sinusoidal Oscillations in Nonlinear Systems, Part 3: Transi Phenomena. By J. S. Schaffner. Pp. 39. 40 cents. Bulletin No. 4 The Properties of Feldspars and their use in Whitewares. By Joseph Kyonka and Prof. Ralph L. Cook. Pp. 84. 60 cents. Bulletin No 4 Engineering Properties of Chicago Subsoils. By Prof. Ralph B. P and William C. Reed. Pp. 62. 1 dollar. (Urbana, Ill.: University Illinois, 1953 and 1954.) [

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FINANCIAL CONTROL OF RESEARCH FOR NATIONAL DEFENCE

IN a fourth special report from the Select Committee on Estimates for the session 1953–54 (No. 176. London: H.M.S.O., 6*d.* net) are given the departmental replies to the Committee's seventh report of the session 1952–53 on rearmament. A memorandum by the Treasury, commenting on the recommendation of this latter report that the Treasury should carefully consider the possibility of introducing a system of block grants to certain Ministry of Supply and Admiralty research establishments, at least on an experimental basis, states that the Treasury is unable to accept the recommendation if it implies making block grants to selected establishments to spend entirely at their discretion over a period of years. Such a system, it is urged, apart from other difficulties, would conflict with the fundamental need for the co-ordination of the whole research and development programme for Great Britain, which can only be effected centrally. Taking the proposal to mean that for certain establishments a system of financial programmes should be adopted extending over a number of years in place of the present system of annual estimates, the Treasury points out that, although the long-term financial provision is in principle advantageous, it is nevertheless essential that government expenditure be kept reasonably flexible and subject to regular review in the light of changes in the strategic and economic situation of the country. The irrevocable commitment of defence expenditure for a long period of years, if on any large scale, would be hard to reconcile with this requirement, and this applies to the adoption of a block grant system even if the activities provided for in the grant continue to be subjected to co-ordination and control by the Department.

While the Treasury is obviously concerned with the possibility that the proposal would prejudice such departmental control and also stimulate similar claims elsewhere, the memorandum maintains further that such a system would be contrary to the fundamental requirements of a properly conceived research and development policy. The annual defence research and development programmes, it is pointed out, are carefully built up (and co-ordinated by the Defence Research Policy Committee) under a system of priorities which is designed to ensure so far as practicable that development is in step with defence requirements. Such decisions on priorities can be taken only at the centre, where the complete picture can be seen. Again, in view of the shortage of scientific workers and technicians and the ceiling on Civil Service non-industrial numbers, the allocation from time to time of the available man-power to establishments requires most careful consideration; and the Treasury maintains that this can only be done at the centre, as university graduates are recruited. If, on the other hand, the recommendation may be taken as advocating long-term financial programmes giving stability over a number of years, the Treasury agrees that planning in this way has advantages in the field of research and development, as in others, and it claims that, within the limits necessarily imposed by considerations of Parliamentary control, these advantages have not been overlooked in the formulation of current practice.

While the force of some of the Treasury's argument will readily be admitted, there is little indication that the Treasury appreciates sufficiently the two fundamental points involved—the extent to which effective scientific investigation demands freedom from time control if waste is to be avoided, and the consequences which flow from the interlocking of defence research and civil research at the present time. On the first point, the Select Committee on Estimates, in its third report for the session 1946–47 dealing with expenditure on research and development, commented pointedly that certain weaknesses revealed by its inquiry were due rather to an attitude of mind than to defective organization. It also remarked that the rigid application of a particular administrative code to certain types of research work might cause considerable waste of money and effort and jeopardize the success of a costly project, besides creating an atmosphere alien to the conduct of first-class research; and it suggested that methods of controlling and accounting for expenditure need to be applied with a clear recognition of their implications. A system which produces economies and is eminently sound when applied to normal administrative expenditure may not have the same beneficial results when applied to certain types of research. The nature of the Treasury's reference to the difference between the universities and defence research establishments in the present report indicates a failure to appreciate this fundamental point that the time span for effective control of a research project is determined primarily by the nature of that project and not by administrative considerations.

On the question of the interlocking of defence research and civil research, it is unfortunately true that the impracticability, for security reasons, of making a sharp separation between expenditure incurred essentially for civil purposes and that on defence, makes it almost as difficult as when the Estimates Committee of 1946–47 reported on the possibility of determining whether expenditure on fundamental and applied research is distributed in the best proportions between the main lines of civil and military research. The continued need for security in certain fields, however, makes it the more imperative that there should be no unnecessary secrecy, that the maximum possible information should be given to Parliament, and that no methods of controlling expenditure which are likely to cause waste of scientific effort should be tolerated for administrative reasons. It should be remembered that, as has been recently pointed out in *The Economist*, in counting the high cost of defence to the modern economy, as much as 30 per cent of the nation's research resources, in which first-class men are much scarcer than money, gives a true measure of the long-term cost pre-empted for defence, rather than the 10 per cent of the national income commonly taken as going into defence.

Another memorandum included in this report is by the Ministry of Supply. This relates to the recommendation that every assistance should be given to the Radar Research and Development Establishment and the Telecommunication Research Establishment of the Ministry of Supply and to the Admiralty Signal and Radar Establishment, in order to secure and maintain an adequate staff of scientific workers, so as to preserve the all-important factor of continuity in research. The Ministry of Supply and the Admiralty entirely agree with the Select Committee as to the need for continuity in research, because research provides the only sound basis for future development. They consider that longer-term research should not be crowded out by shorter-term development requirements, or be permitted to fluctuate unduly with every change in financial circumstances. They further agree with the Select Committee that every effort is needed to attract staff of the high quality needed for research at the Establishments, and to this end they are constantly seeking to perfect their relations with the universities; but while staffing difficulties will persist as long as there is a shortage of highly trained electronic scientists, such difficulties are regarded as unlikely to cause a serious break in the continuity of research. The Ministry of Supply and the Admiralty question, however, the wisdom of laying down as a principle that any branch of research and development should be wholly exempt from the effect of financial limitations applying to research and development as a whole. Nevertheless, while not accepting this part of the Select Committee's recommendation, they agree that, because electronics is a young branch of science with great potentialities and because equipment in many other fields is dependent upon it, it deserves a measure of special consideration and protection.

These points are made in connexion with two government establishments for which it may be claimed that special considerations apply. Nevertheless, on the general question, there can be little doubt: research for national defence is for the most part like other forms of scientific research, and the imposition of administrative time-limits on investigations is not in the interest of true economy in the utilization of the limited resources in materials and man-power.

SIR HUMPHRY DAVY

Humphry Davy

'Pilot' of Penzance. By Prof. James Kendall. Pp. 166+7 plates. (London: Faber and Faber, Ltd., 1954.) 10*s*. 6*d*. net.

SIR EDWARD THORPE'S life of Humphry Davy has long been out of print and unobtainable, and so Prof. James Kendall's breezy sketch of the 'Pilot' of Penzance will be welcomed by many readers. Davy is one of the most romantic figures in the history of science—a fascinating human problem—and Prof. Kendall was an ideal choice to write this short life, with his intimate knowledge of the period, his sympathy with Davy and his fresh and lively style. The book is intended, as he says, for the younger generation, and it is in the main a study of Davy's character and personality rather than of his scientific work. Thorpe's shrewd appraisal of Davy's great contributions to chemistry is often quoted, and no doubt the scientific reader will be tempted to read again some of Davy's own papers which stand so well the test of time. The layman will learn from the book much of the significance of Davy's discoveries explained in simple language unembarrassed by technical detail.

There can be few great investigators whose scientific work has been so greatly influenced by the accidents of daily life and by their human qualities. Prof. Kendall tells so well Humphry Davy's romantic story—the country boy with his love of sport that was one of the lasting passions of his life, with the gift of words and the power to hold an audience, self-centred and dreaming of fame. Then came his apprenticeship to a surgeon-apothecary and his reading of Lavoisier's "Chemistry" which awakened so swiftly his native genius for experiment. This and his chance friendships with Gregory Watt and Davies Gilbert led to his appointment by Beddoes at the Pneumatic Institute at Clifton just before his twentieth birthday. There he spent two years in the brilliant and amazingly mature research which so nearly cost "the intrepid investigator" his life when he was breathing various gases to study their effects.

At the age of twenty-three he went to the Royal Institution and was soon to become "the idol of London". Self-taught, free from conventional views, brilliant as an experimenter and observer, Davy had an intuitive sense of the significant and of the wider bearings of his discoveries. Nine years later he was acknowledged as the outstanding chemist of Europe. With his gift of exposition and his infectious enthusiasm he had made science fashionable, and the sequel was his marriage to the wealthy widow, Mrs. Apreece. Prof. Kendall deals feelingly with that marriage, so unfortunate for science, and with the contrast between Davy's warm affection for his sisters and his mother and the coolness that soon arose between him and his ambitious wife, a catcher of 'lions'. Davy's resignation on his marriage of his professorship at the Royal Institution marked the end of his systematic research, though there were brilliant episodes like his discovery of the principle of the safety lamp. It was an uncongenial union, there were faults on both sides and Prof. Kendall is scrupulously fair.

One of his most interesting chapters is the "Retrospect", in which he examines the frailties of Davy's nature in his relations with his brother scientific workers, notably Berzelius, Dalton and Faraday. Davy could be jealous of rivals, being anxious to be the central figure and disliking criticism. He never really forgave Berzelius for his outspoken criticisms of "The Elements of Chemical Philosophy". He had been right when Berzelius had been wrong; but Berzelius was generous in his admiration of "le plus grand chimiste de son siècle". Davy's unfortunate experience with rash speculations in early youth made him wary of hypothesis all his life, and it was a tragedy that he just failed to see the significance of Dalton's atomic theory. As Kendall says, "His near-misses, indeed, are as momentous as his direct hits".

The incidents with Faraday, his "Greatest Discovery", in the years when he was stricken and ill are best forgotten in Faraday's comment to Dumas, standing before Davy's portrait in the Royal Institution: "He was a great man, wasn't he ?"

The interest and charm of the book spring from Prof. Kendall's intimate and affectionate sketch of Davy as a human being. It is full of little touches that show his close acquaintance with the great mass of Davy documents and with the writings and thoughts of his contemporaries. It is the intimacy of the picture that carries conviction and gives a true understanding of a life of genius.

HAROLD HARTLEY

MESON PHYSICS

Meson Physics

By Robert E. Marshak. (International Series in Pure and Applied Physics.) Pp. viii + 378. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 64*s*.

Mesons

A Summary of Experimental Facts. By Alan M. Thorndike. (International Series in Pure and Applied Physics.) Pp. viii + 242. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 47*s*.

THE appearance of these two books is timely, for the past few years have seen great advances in the subject of meson physics. Prof. R. E. Marshak has surveyed the most important results of meson experiments, with particular emphasis on their theoretical significance, and Dr. A. M. Thorndike has undertaken the difficult task of summarizing the experimental facts. Both books are concerned mainly with results obtained since the Second World War and cover work done up to the summer of the year 1952.

In view of the fact that the theoretical side of meson physics is discouraging and the experimental side exciting and stimulating, it might have been expected that Marshak would have found his task difficult and Thorndike relatively easy. The impression gained from reading the two books side by side is just the contrary. Marshak succeeds in marshalling the experimental facts brilliantly, and he skilfully uses just those parts of theoretical meson physics which illumine the experimental results. In so doing, he captures much of the drama of the great enterprise which is modern particle physics. By comparison, Thorndike's treatment of similar facts seems dull and ordinary. The reason for the difference is undoubtedly that Dr. Thorndike is imbued with a sense of fairness to all whose work has contributed in any way to the advancement of the subject. The result is often a detailed description of work long since superseded, and a sense of confusion in the mind of the reader as to what the really important advances in the subject have been. The correct selection of the significant facts and their presentation in a form which gives them proper emphasis is probably the most important function of the writer of a text-book. There are many examples of incorrect emphasis and poor selection in Thorndike's book: limitation of space allows only the following examples. The first is the "λ-meson", a hypothetical particle proposed to account for the unexpectedly large penetration of certain thicknesses of matter by the particles in extensive showers. This hypothesis was abandoned by its principal authors at the Como conference on cosmic rays in 1949. The second concerns the distinction drawn between supposedly different sorts of π-mesons: the "pi-meson" (defined on p. 58 as the "meson producing a pi–mu decay"), and the "π-meson" (defined on p. 58 as the "meson of mass about 280 m_e discovered by Powell"). A similar distinction is made between the "mu-meson" and the "μ-meson".

The first four chapters of Marshak's book are devoted to a discussion of the behaviour of charged and neutral π-mesons at non-relativistic velocities, the special contributions made by experiments on the artificially-produced π-mesons being especially well brought out. The next two chapters deal with the capture and absorption of slow, light mesons and the peculiar properties of the μ-meson in relation to the π-meson. A link is made here between the results from the large accelerators and cosmic rays. There follows a clear presentation of the evidence relating to the nuclear interaction of fast π-mesons and the production of π-mesons. The old topic of plural versus multiple production is then gone into in some detail. Finally, Marshak surveys recent work on the new types of charged and neutral heavy mesons (now termed K-mesons), and V-particles with masses greater than the proton mass (now termed hyperons). This chapter is surprisingly good considering the state of knowledge of these particles when the book was written.

Thorndike's book opens with a discussion of the evidence for the existence of mesons and their properties, followed by good descriptions of the artificial production of mesons and the decay of the various forms of light meson. The book concludes with such topics as the positive excess, the energy spectrum, geomagnetic effects, and cosmic rays at sea-level and high altitudes. Each chapter has a detailed list of references.

The printing and production of both books are well up to the high standard of other books in the same series.
G. D. ROCHESTER

SCIENCE AND THE POTATO

The Potato in Health and Disease

By Dr. Tatham Whitehead, Dr. Thomas P. McIntosh and William M. Findlay. Third edition, revised and enlarged. Pp. xv+744+40 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 60s. net.

It is not without significance that more books have been written anent the potato than all the other table vegetables put together. Indeed, I know of no single book in Britain devoted to any other specific staple of our vegetable dietary, always excluding the cereals, other than Oldham's well-known volume on the family of the Brassicae and allied cruciferous crops.

I do not propose to discuss at length the causes which underlie this curious monopoly of interest excited by the potato; but, whatever they be, the three authors of this book have reacted to them with ever-increasing enthusiasm and in almost overpowering volume. I doubt whether they do justice to their own perspicacity when they assess the cause of the potato's universal appeal as being the generosity of its yield, even under the least promising conditions. On such a gross material basis, a parsnip or a turnip could stake a competitive claim. The ascendancy of the potato rests,—like that of bread, on th fact that it satisfies as a food and never cloys a a diet.

The volume under review is no newcomer. It firs appeared under the sole authorship of Dr. T. P McIntosh in 1927 and contained 264 pages. Later Dr. McIntosh was joined by Dr. T. Whitehead an Mr. W. M. Findlay, and together they published i 1945 their well-known book, "The Potato in Healt and Disease", which had by then grown to 400 pages The same trio of authors have now compiled a partl rewritten and greatly enlarged new edition extendin to 744 pages.

Among the new features are chapters on breedin and animal pests, machinery as applied to potat cultivation, and a long dissertation on the relation o viruses to the plants they infect.

As I traversed this rather formidable work, th thought occurred to me more than once—Am reviewing a collection of treatises or an encyclopædia Whatever be the correct answer as conceived by th authors, of one thing I am quite sure: it is no mer text-book which it has been my task to evaluate Conflicting thoughts, such as these, of necessity evok a challenge in the mind of the reader: "To whom have the authors addressed their book?".

An architect who sets out to build a homely villa and ends up by erecting an edifice which from on angle suggests a palace and from another a highl efficient chain-store, must not be surprised if hi efforts evoke a welcome less warm than its individua parts would appear to deserve.

Of one thing I am confident: this work is n student's text-book, and I am no less assured that i is not likely to prove a vade-mecum to the farmer though it may serve the interests of the intelligen specialist cultivator. It will find, however, withou question a place, and a dignified one, in my library and doubtless in that of most senior workers, whethe engaged in research or advisory work. Its hom will be among the reference books, the section o my library which, with advancing years, I mos frequent.

I have intimated that this work suggests a collection of treatises. Let us consider one outstandin example, the description of varieties. Beside innumerable references in the text, the subject i dealt with in an appendix of fifty-three pages. No it so happens that I wrote a book on potato varietie in 1926. It has long been out of date; but th individual descriptions are at least as informin better set out and what is of real importanc accompanied by a short history of origin, and a li of synonyms in each case. How pleased I shoul have been had the authors of the recent work re-edite and improved it, for the student would then have handy volume which he could take with him in th field, needing neither a trailer nor a kindly colleagu to carry and manipulate it.

The writers, naturally alive to the importance o eelworm, have devoted thirty-six pages to its exposition. The chapter is a painstaking piece of wor planned on encyclopædic lines, and as such it is no difficult to point to a few errors of commission an omission. Thus, Ellenby's valuable work has no always been correctly reported; for example, hi hatching inhibitor is not located in the larvæ but i the cyst. His studies on the effect of mustard o hatching were made with mixtures of mustard potato, turnip–potato, etc., and compared wit hatchings in potato excretion alone. Prof. A. F

Todd's hatching factor is eclepic, not ecleptic acid. Of omissions I will refer only to the 1950 publication of the Dutch worker, M. Ootenbrink, which would seem to show that, under strict supervision in regard to both increase and decrease of cysts in the soil, a controlled potato culture can be maintained in infected land. Another 'treatise-like' section is that devoted to virus disease. In the main the data on the relation of virus to plant, and the nature of the virus particle, are derived from F. C. Bawden's book on "Plant Viruses and Virus Diseases", and duly acknowledged. Would it not have been wiser to refer readers to Bawden's well-written book and leave it at that?

The value of the work is greatly enhanced by its good index, and its full bibliography in which there are remarkably few important lapses. It is unfortunate that one of them should be a special favourite of mine, namely, my discovery in 1909 of blight resistance. In conclusion, it can be said that this work gives the reader a just and comprehensive account of the importance of the potato as a subject of scientific inquiry, in which respect it probably has no rival.

R. N. SALAMAN

VALVES AND TELEVISION RECEIVER DESIGN

Data and Circuits of Television Receiver Valves

(Philips' Technical Library; Electronic Valves Series: Book IIIC). By J. Jager. Pp. xi+216.

Television Receiver Design

Monograph 1: I.F. Stages (Book VIIIA). By A. G. W. Uitjens. Pp. x+177.

Television Receiver Design

Monograph 2: Flywheel Synchronization of Saw-Tooth Generators (Book VIIIB). By P. A. Neeteson. Pp. x+156.

(Eindhoven: N. V. Philips' Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd.; New York: Elsevier Press, Inc., 1953.) 21s. each volume.

THESE three volumes form part of a series on "Electronic Valves" in the Philips' Technical Library. They may also be regarded as companion volumes to the book on "Television" in the same Library (see *Nature*, 172, 471; 1953). Although in the experimental stages of television development conventional radio and amplifying valves were used, the mass-production of television receivers has created a demand for valves specially designed to meet the requirements of the various stages of such receivers.

The first volume gives complete details, with characteristic curves, of the series of television receiving valves developed by the Philips organization during the past two or three years. Considerable technical information is given of the function of each type of valve and of the circuit arrangements in which it can be used. Similar information is given for three types of cathode-ray tubes, or "direct-viewing picture tubes" as they are termed, made for use in television receivers. In later portions of the book, more detailed technical descriptions are given of some special circuit arrangements; and the book concludes with a complete design of a television receiver developed for the reception of vision and sound programmes according to the 625-line standard of the International Radio Consultative Committee (C.C.I.R.) now in use in various European countries.

The second volume deals with the intermediate-frequency stages of a television receiver, bearing in mind that such stages may operate at any frequency between 10 and 100 Mc./s. The book is largely analytical in nature and describes the special problems of design encountered in obtaining response and amplification over a wide band of frequencies, while at the same time the noise-level is kept down to the minimum attainable.

In television reception, the picture is built up by making the electron beam scan the fluorescent screen of the cathode-ray tube. The method of scanning now generally adopted consists of rapid horizontal movements of the beam across the picture, with flyback between the lines at a much higher speed; and then superimposed on these is a much slower vertical movement for the field or picture scan, with again a more rapid fly-back at the end of each field. These scanning movements are controlled by the voltages produced by a saw-toothed generator, the oscillations of which have to be synchronized with the appropriate signals sent out by the transmitter for the purpose. The third volume under notice describes in considerable detail the principles and circuit arrangements of these saw-toothed generators and the application of the so-called 'flywheel synchronization' technique in television receivers. While some portions of the book are of an analytical nature, the mathematics involved is very straightforward and will be easily followed by the prospective designer.

The production of all three volumes is of a high standard, and the engineer and scientist engaged in the design and development of television receiving technique will find them most useful in connexion with their work.

R. L. SMITH-ROSE

LECTURES ON GENERAL PATHOLOGY

Lectures on General Pathology delivered at the Sir William Dunn School of Pathology, University of Oxford

Edited by Sir Howard Florey. Pp. xiii+733. (London: Lloyd-Luke (Medical Books), Ltd., 1954.) 63s. net.

THE subject-matter of this volume has been contributed by no less than ten authors, and like all books written under such conditions it lacks a logical sequence. For example, the chapter on healing occurs some 340 pages after those on inflammation. The work is well written, easy to read for those with some previous knowledge of pathology, and the illustrations are excellent and well chosen. To each chapter is appended a carefully selected bibliography.

The book is a real scientific work and, as such, is a contribution to the subject worthy of the Sir William Dunn School of Pathology, Oxford, from which it has originated. The patient and his diseases, however, have rather been neglected. It sheds light on many controversial problems in general pathology, as each of the authors has freely expressed his opinion as a result of his own experimental work in the field in which he is an expert. Unfortunately, as Sir

Howard Florey states in the preface, the volume does not cover the whole field of general pathology, though the subjects of each lecture have been carefully selected. The value of the book, however, would have been enhanced if some chapters on neoplastic disease could have been included, and it is hoped that in any future edition this omission may be rectified.

A praiseworthy endeavour has been made to give short historical reviews of each of the subjects discussed. At places the review is too condensed and becomes merely a list of names, meaningless to the average student, as, for example, on p. 23, where Ribbert, Senftleben, Councilman, Marchand, Hohnfeldt and Maximow are all mentioned in a single line, only three of these being referred to elsewhere in the text. It is to be regretted in a book where historical accuracy has been the keynote that the primary lung focus (p. 662) should be referred to as the "Gohn focus" when it was originally described by Parrot forty years before Gohn's treatise on the subject appeared. In a volume where so much attention has been given to detail, it would be easy for any reviewer to find points to criticize. In Fig. 24 on p. 97, the fibrous tissue encapsulating an abscess would be better described as granulation tissue. In the chapters on inflammation of mucous membranes, many pages have been devoted to the secretion of mucus; but the all too common catarrhal inflammation of the respiratory tract is dismissed in two short paragraphs. The chapter on degenerative changes is disappointing, and the description of amyloid change and the accompanying plates are particularly poor. On the other hand, the lectures on immunological problems are masterly expositions of the subject, as also are those on inflammation.

This is a book which should be read by every serious student of pathology, in particular those working for higher degrees. Many an older pathologist, too, will derive benefit and may have to sacrifice some of his long-cherished ideas about even the simplest pathological phenomena. It is not a book that can be advised for the average student commencing the study of the subject, as the complexities of an already difficult subject are not made any simpler. In these days of overcrowded curricula in medical schools, the student has to acquire his knowledge quickly and easily, and it would be difficult for him to do so from the present volume.

John W. S. Blacklock

SPIDERS OF BRITAIN

British Spiders

Vol. 2. By G. H. Locket and A. F. Millidge. Pp. vii+449. (London: Ray Society, 1953.) 30*s*.

THIS volume completes the survey of the spiders of the British Isles, begun by the authors, G. H. Locket and A. F. Millidge, several years ago, so that now for the first time since John Blackwall's historic folios of 1861–63 (also Ray Society publications) a guide to all the native species is generally accessible. The congratulations which were offered when the first volume was reviewed (*Nature*, 168, 714; 1951) may here be unhesitatingly repeated.

The arrangement of the descriptive matter follows exactly the plan of the earlier part of the work, and therefore shows the same combination of clearness and conciseness with practical helpfulness that was so conspicuous there. In brief, when the identifying of a species is easy, the authors waste neither time nor space; when it is difficult, fuller treatment and comparative tables come to the reader's aid. The illustrative drawings, which are the work of both are remarkable for their uniform clarity. They are well reproduced and are, perhaps, one of the outstanding features of the book.

This second volume, which is larger than its predecessor, describes seven families and 369 species There are, again, illustrations of the genitalia of both sexes of every species, accompanied by such othe diagrams and dichotomic keys as are necessary. The distribution of all species is also given—broadly in geographical, and more precisely in ecological terms.

Among the seven families described are the Agelenidae, which includes the ordinary spiders to be found in dwelling-houses, and the Argiopidae, which are familiar because they spin orb-webs. These pages will interest any reader; but the serious student i likely to turn first to the treatment of the Linyphiidae —the dominant British family of 245 of the smalles spiders in the land. He will find a most impressive key to the one hundred genera by which the family is represented in the British Isles; and although it composer, Dr. Millidge, writes of it with modes reference to its fallibility, it is at the same time true that never before has the captor of a Linyphiid been able to turn to so complete and authoritative a guide as is published here. Only those who have tried to steer a course through the complexities of this family can fully appreciate the nature of Dr. Millidge's very considerable achievement.

Two other points should be mentioned. One is a valuable practical hint—the fact that an obscure epigyne can be made more distinct by soaking the specimen in phenol containing 10 per cent of alcohol The second is the fact that the book ends with a check list of the 581 species and subspecies recognized as British. It is interesting to compare this number with the 566 recorded by Dr. W. S. Bristowe as lately as 1939; and if it may be added that the authors have in their collections several species even more recently found, it is seen that the day of complete knowledge of the British spider fauna is not yet. It is, in fact most significant to notice how high is the proportion of species described as 'rare' or 'very rare', or fo which but one locality is known, or but a few captures have been reported.

It is permissible to glance at the impression made by the two volumes together and to appraise the work as a whole. It is seen to be a first-rate piece of systematic, descriptive writing, which brings the task of naming a spider within the capacity of any careful naturalist. This is a state of affairs which has neve existed in Britain until now; and the beginner, the general naturalist or the ecologist is far less dependent on the personal help of the expert than he was. I this view of the position is correct, then the appearance of this work is an event of great importance.

Yet it would be wrong to regard the publication of the book as the end of a phase in British arachnology. It is rather the beginning of a period in which we may expect a rise in the number of those who take a permanent interest in spiders, and a long overdue increase in the attention paid them by professional zoologists. There are few animals more worthy of study, and a growth in active arachnology would be the reward, apt and appreciated, which th authors so amply deserve.

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SOME CONCEPTS OF ETHOLOGY

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ETHOLOGY is a convenient word to denote behaviour study in the widest sense, and if used in this way ecology, ethology, bionomics and axonomy can be regarded as the four divisions which ogether comprise the study of the whole living animal as distinct from anatomy, physiology, embryology and genetics (with all their included subdivisions such as histology, cytology, biochemistry, etc.), which constitute the study of its parts and of its development. The term ethology has recently come into much more general use than before as a result of new theories primarily concerning instinct, which are due in the first place to the work and writing of Konrad Lorenz[1-3]; but it would be a great mistake to confine its use solely to the work of those who are known to base their studies on any particular theoretical scheme, whether of Lorenz or another. The word is potentially much too useful to be restricted in this way. Nevertheless, wide as the eal meaning of the term is, there is little doubt that the present popularity of behaviour study is in fact largely due to the stimulating and clarifying effect of Lorenz's theories; and it is interesting to consider how some of the essential concepts in this field have fared during the fifteen years or so since[1-3] his scheme was first put forward in its definitive form.

The essential elements of Lorenz's formulation are as follows:

(1) The division of behaviour into a flexible appetitive behaviour and the relatively rigid consummatory act.

(2) The assumption that the fixed action pattern of the latter is generating some specific action potential (a term which now includes the essentials of the original action specific energy concept of Lorenz and in effect supersedes it). This brings back in a new form the concept of internal drive, o resuscitating the essential idea of instinct.

(3) The concept of the 'innate releasing mechanism' which assumes there to be within the central nervous ystem a series of mechanisms of a particular type which effectively inhibit or block all discharge of activity unless the animal encounters the right nvironmental situation or stimulus to remove or elease the block.

These and other considerations led almost invitably to the hierarchy scheme of Tinbergen[4], ccording to which there are a number of tiers or evels within the total organization which makes p an 'instinct', and incorporated in each level re one or more innate releasing mechanisms. On the receptor side these are in some way attuned to the biologically right stimuli or situations in the environment—as, for example, the appearance of the exual partner or the specific prey—and are, as it were, unlocked by the appropriate environmental eleasers and only by them, thus allowing behaviour o proceed to the levels below, only in the biologically right situation. These lower levels in their turn incorporate blocks which, while they remain unmoved, prevent action of these lower centres proceeding. So long as such lower centres remain blocked the action potential will therefore be diverted into the type of action known as appetitive behaviour, which is 'directive' in that it tends to bring the animal into the kind of environment where the appropriate releaser is likely to be encountered.

Finally, to make clear that this scheme is not one of innate or inborn behaviour only, it should be mentioned that although Lorenz regarded the learning abilities of animals as mainly operative in the sphere of appetitive behaviour, his theory is by no means an anti-learning one; indeed, besides accepting the categories of learning already usually assumed, he found it necessary to propose a new one—imprinting—to effect, in certain special cases only, the required rapid adjustment between the simplified or skeleton organization which constitutes the releaser and its correlate, innate releasing mechanism, and the more elaborate or detailed pattern to which the individual animal has to respond.

The immediate attractiveness of this scheme lay first in its apparent avoidance of the vitalistic approach—for the objective of the animal is no longer the attainment of the final biological goal or result (which it is, of course, inconceivable in most cases that it could know about) but rather the performance of the rigid consummatory acts themselves. Besides thus providing a physiologically reasonable system in place of an obviously untenable vitalistic one, this system at once showed some other tremendous advantages. In particular, it stressed the fact that evolutionary relationships are often expressed even more clearly by similarities and differences in behaviour than they are by structures and morphological characteristics, and so the theory provides an excellent approach to the taxonomic analysis of behaviour. Moreover, the very fact that these behaviour patterns are so constant as to be taxonomically valuable makes it inconceivable, at least in so far as the invertebrates and the majority of the non-mammalian vertebrate groups are concerned, that learning can be playing a significant part in their production. It seems apparent that within the insects, for example, countless thousands of instances of specific behaviour (such as acts related to pupation which are performed only once in the life of the individual) cannot possibly be the sole expression of anything that can by any conceivable definition be called learning. Nor, to take another example, is there evidence that the olfactory selection of hosts by hymenopterous parasites or other insects is primarily learned. On the contrary, in *Nemeritis* Thorpe and Jones[5] (misquoted by Lehrman[6] to give the exact opposite of the true meaning) found the choice to be preponderatingly inborn and only to a relatively minor degree modified by learning.

Finally, Lorenz's idea of internal drive held back by the block or inhibitory action of the innate releasing mechanism system until the right releaser is encountered at once attracts the field naturalist and especially the field ornithologist, for it supplies a ready explanation for a vast amount of puzzling behaviour—displacement and vacuum activity—which it seems otherwise extremely difficult, if not impossible, to interpret.

It appears that the most fundamental concepts at the base of these theories of animal behaviour are centred around the idea of internal drive ; but before discussing this central problem it will perhaps be as well to consider one or two of the criticisms which have recently been directed against these current theories of instinct.

First, it has been objected that there is an unwarranted dualism in instinct theory. Thus Kennedy[7] in effect says that all behaviour is, in fact, reflex and that all evidence for any internal drive is spurious. He argues that the current objection to the universal employment of the term reflex among behaviour students is due to the fact that they have an out-of-date picture of reflex which is "a wooden caricature of reality". But he himself clings to its use because he regards it as the sole behaviour concept which embodies the principle of determinism—which, if it means anything, is tantamount to saying that it is rigid. The whole matter is, in fact, a quibble. If the term reflex is regarded as implying relative or absolute rigidity, then it is still useful to behaviour students (as it is to physiologists) in certain restricted contexts. If, on the other hand, it simply means 'response'—then it is better to say so and to drop the term reflex. It is significant that Pavlov[8], who did in fact widen the use of the term so that it became practically meaningless, nevertheless handicapped his followers by his retention of it and by his contention that instincts are "nothing but" reflexes. He urged (as Kennedy says) that the investigation of instincts is the "next important task", but none of his followers heeded this. The reason is not far to seek : the idea of the reflex did not alone provide them with the concepts necessary for the work, and it was, as I think all critics admit, the coming of Lorenz's formulation which was the signal for the great modern development of analytical work on instinct. This was not so much because the ideas contained in it were new—actually none of them was entirely new—but it was rather because here was a new system which facilitated and invited experiment and, by the way in which it is articulated, directed attention to those points in the vast and varied phenomena of instinct where experimental analysis was both profitable and immediately practicable. It has also been argued[6] that present-day instinct theory often blinds those who use it to the evidences of adjustment by learning which their animals display. It may indeed be possible to point out occasional relevant instances of animal learning which some modern workers on instinct have missed because of their concentration on the latter field ; though it would also be possible to point to examples where such theories have actually inspired research on learning. But it would be far easier to name scores of workers who have missed the whole field of instinctive behaviour because of their obsession with the learning process. It is largely because of this that the work of those modern schools of comparative psychology which are based exclusively on the theory and investigation of learning is only too often virtually useless to the zoologist, and it is the failure of such schools which has thrown into relief the immediate relevance for the naturalist of so much of modern instinct theory. To say either "all behaviour is learned" (as Hebb[9] or Lehrman[6] appear in effect to do) or "all behaviour is reflex" is at the present time as stultifying for research as it would be to say that all behaviour is innate. It may, of course, be possible so to extend the definition of the terms 'reflex', 'learned' and 'innate' in such a manner that such statements are virtually true ; but when this i done the terms themselves thereupon become practically useless, for such statements give a spuriou simplicity and uniformity to what is, in fact, highly complex.

Kennedy argues that it is for social reasons tha the dualistic approach which he finds so reprehensibl has lingered in biology, psychology and philosophy long after it was abandoned in physics and chemistry To me it appears to be rather for epistemologica reasons : and may it not be that dualism is stil necessary in biology simply because living organism are different from non-living ones ? Directiveness o purposiveness, whatever anyone may say, is characteristic of living systems ; and Sommerhoff[10] ha recently made a brilliant and courageous, although consider ultimately unsuccessful, attempt to expres the essential directiveness of organisms in purely physical terms. Until this has been done convincingly and without any room for doubt, there is no justification for denying the place of dualism in biology

Lehrman[6] takes objection to a number of idea which he claims workers upon instinct hold, but som at least of these objections appear to be due to misunderstanding. He himself apparently starts ou with the idea that all behaviour must be learned— conclusion surely only possible to one who has confined his studies to certain very special cases amon mammals, and difficult to maintain even then Moreover, he finds difficulty in accepting the abundant evidence that complex behaviour patterns ar inherited because he is unwarrantably thinkin of such inheritance as involving some sort of preformationist doctrine of the instinct being itsel within the germ plasm. This would indeed be a unjustifiable reification ; but I am not aware of any ethologist ever having implied any such thing. Wha modern instinct theorists mean when they speak of motor pattern or an innate releasing mechanism bein inherited or inborn is that it is genetically 'coded' an so determined in the sense that the behaviour is constant, even though the environment may be relativel inconstant and may contain no stimulus adequate fo the determination itself. They do not mean, and neve have meant, any such absurdity as the statemen that "the organism is independent of its environment". On the other hand, Lehrman seems to oppos reification where it is not only useful but eve necessary. Crude isomorphism is rightly suspect : w need not, for example, suppose that the engram of cube is itself cubic. But his objections would seem t lead to the rejection—as unjustifiable reification an isomorphic preconception—of the basic assumption of neurophysiology that there is to be expecte within the central nervous system a system o organization sufficiently similar in certain essentia relations to the observed behaviour to be able t serve as a code ; and this is all that instinct theor need imply. It is exactly in this sense and i this sense only that the behaviour of embryon tissues and their constituents (such as blastomere histoblasts and the cells of imaginal buds), where th problem of organization is presented most vividly may be said to be inherited. Lehrman thus appear essentially antiphysiological, although utterin appeals for more physiology. The term innate, however, is admittedly liable to cause confusion in tha it incorporates three different strands of meaning (1) internally co-ordinated, (2) inborn, and (3) drive from within. The first applies to practically a behaviour ; (2) may apply equally to instinct an reflex, while (3) appears to be especially characteristic of instinct.

This brings us to the problem of drive and consummatory act, which must be considered more fully since it is in many ways central to the whole subject. Tolerably objective definitions of these two terms have been given as a result of an international conference[11] at which a number of behaviour students representing the most varied aspects and methods of approach to behaviour study were present; but critics are apt rather conveniently to overlook this admittedly provisional attempt of ethologists to be as objective as possible. We may therefore give three of these definitions here:

Drive—the complex of internal and external states and stimuli leading to a given behaviour.

Appetitive behaviour—the variable introductory phase of an instinctive behaviour pattern or sequence.

Consummatory act—an act which constitutes the termination of a given instinctive behaviour pattern or sequence.

The term 'drive' in its earliest usage in behaviour literature probably meant little, if anything, more than a state of internal activity or disequilibrium of the central nervous system or of internal organs in their turn stimulating the nervous system. So long as the meaning was itself restricted it was unobjectionable enough even to the avowed opponent of 'instinct'. So early as 1911, however, Ladd and Woodworth[12] were using the term to cover the mechanism by which activity was internally governed and directed along certain channels, and so no sooner had the term 'instinct' been abandoned by psychologists and behaviourists than we find 'drive' taking its place and standing for just those ideas which had led to the rejection of the former term. Later Woodworth[13] pointed out that habit mechanisms, in any event in human beings, may become drives and implied that since, in his view and that of many earlier writers, habit and instinct had much in common, the co-ordinating mechanism of the behaviour pattern itself might be generating the drive.

In the late 'thirties, Lashley[14] and Lorenz[1–3] realized independently that the aspect of instinct which would be most profitable for study was not specifically the drive itself, central though that idea is to the whole field, but rather the internal system of co-ordination of special behaviour patterns on one hand and the special receptive sensory mechanisms on the other. In fact they concentrated their attention on the whole specific sensori-motor organization of the behaviour patterns, considering the complex and stereotyped action system to be more fundamental to the subject than any immediate question of drive; and both these workers proposed that a study of these mechanisms themselves might throw light on the problems of drive and motivation. Lashley in effect suggests that all cases of motivation might well turn out to be the result of the activities of specific co-ordination mechanisms and that general drive is really nothing more nor less than the partial excitation of a very specific sensori-motor mechanism irradiating to affect other systems of reaction. We thus arrive at something very like the concept of specific action potential which, in the form of action specific energy, was to play such an important part in Lorenz's system. Lashley's ideas, penetrating though they were, perhaps aimed at little more than supplying some general directions for future experiments and theorizing, whereas Lorenz's contribution was to produce a thoroughgoing theoretical system of behaviour more comprehensive than any which had preceded it.

The idea of a relatively rigid consummatory act is thus a theoretically fundamental one, and it brings with it the methodologically invaluable distinction, which had in fact been made years before by Sherrington[15], between appetitive behaviour and consummatory act (pre-current and consummatory responses, as Sherrington called them). While this separation into two categories probably continues to be as useful as it has ever been, it has now become abundantly clear that the distinction is not a hard and fast one. Much appetitive behaviour contains consummatory acts of what might be termed the minor grade, and the work of Hinde[16] (to whom I am indebted for much useful discussion of such problems) on the behaviour of the great tit (*Parus major*) and that of Hinde, Thorpe and Vince[17] on the following responses of young moorhens (*Gallinula chloropus*) show quite conclusively that in these cases appetitive behaviour and consummatory act vary in degree of rigidity and flexibility; no absolute distinction can be made between them. Both are to some extent spontaneous in that they show evidence of internal activation, both are stereotyped to some degree and show some rigidity, and both are to some extent flexible. Thus the classic examples of appetitive behaviour and consummatory act can be regarded as the two ends of a series, ranging from extreme variability and plasticity on one hand to almost complete fixity on the other. Moreover, much appetitive behaviour consists in a process of searching which can be described as locomotion with a particular orientation. Since it may often happen that the conclusion of the appetitive behaviour is the finding of a particular object or attainment of a particular situation (that is, a particular perceptual set) and not necessarily the performance of a particular act, so similarly it is sometimes a perceptual set or locomotion with a particular orientation thereto which turns out to be consummatory. So we can be fairly clear that not all drive arises from the co-ordination mechanism of a specific consummatory act. Moreover, since many consummatory situations or perceptual sets are extremely general, some drive at least must also be generalized, suggesting as in the system of Tinbergen[4] an effect coming from higher centres; these higher centres being, according to much evidence, the ones most closely and directly linked in activity with levels of hormone production; and so once more we seem to be approaching the concept of some entity flowing down pre-formed channels. Although, of course, for the sake of simplicity the organization of the appetitive behaviour is entirely omitted from Tinbergen's scheme, so that the hypothetical channels are only shown as leading from the appetitive behaviour to the consummatory act, there is no doubt that appetitive behaviour is no less complex than the latter, and that if such pathways are present in the one they must also be present in the other. Consummatory situations are clearly demonstrated if we analyse carefully the process of, say, the building of a complex domed nest by a bird such as the long-tailed tit (*Aegithalos caudatus*). Here we cannot escape the conclusion that in addition to an elaborate series of releasers (probably most of them visual patterns) which determine the way in which the various individually rather simple building actions are employed to construct the nest, there are other situations which are themselves consummatory. They may well be thought of as specific 'inhibitors' activating what might be called 'innate inhibiting mechanisms', in that they bring to an end a particular series of actions which result in a particular part of the nest construction, but do not necessarily themselves initiate the next stage in behaviour. So here, too, we see that the goal of such sections of behaviour is not the consummatory act by itself, but at least as much the experience of having constructed a particular object, or having achieved a particular situation. Bastock, Morris and Moynihan[18] have also pointed this out with reference to both birds and fish.

In view, then, of these conclusions, what can we think about the origin of the drive in such situations? Since it is not related to a particular act or act sequence, it cannot properly be regarded as arising from the co-ordination mechanism of that act. Again, if we look at the recent literature on behaviour we are continually being confronted with the terms aggressive drive, fighting drive, fleeing drive, etc. Here again in many cases we cannot find a specific consummatory act which is sufficient by itself to complete the behaviour sequence. In aggression, the pattern of attack or of fighting may, it is true, be a consummatory act in a sense, but it is often a pattern which can be used in a number of different situations, and it only becomes consummatory for a certain piece of behaviour when it takes place in a certain situation. So here again it is a situation which is consummatory at least as much as the act. When we consider the fleeing drive the position is even more clear, as was seen by Wallace Craig[19] in his discussion of aversions; it is very doubtful in many cases whether there is a specific consummatory act terminating a fleeing drive. In such situations, as, for example, in bird behaviour, the act of recognizing a rival fellow member of the species, of expressing antagonism or dominance to it or of fleeing from it, must all in part be consummatory, although they do not in by any means all cases lead to a particular act, and it becomes difficult to describe the actual situation except in terms involving the self and another member of the species recognized in relation to the self. The outcome of these considerations is that in order for there to be any flexible working towards a goal situation of whatever kind, there must be some schema of the act and the releasing situation together, as, for example[20], the learning of song by a chaffinch (*Fringilla coelebs*), where the 'goal' seems to be a descending series of notes of 2·5 sec. duration of a certain degree but quite unspecified kind of complexity. This schema, inborn or learned, but usually a combination of both, appears to be generating 'potential'. Hayes, Russell *et al.*[21,22] see this clearly and they suggest, purely for purposes of illustration, that if we were able to introspect an innate releasing mechanism while its output was still below the release level, we should be aware of a goal. For a specific drive ('act-available-message-set' in the information theory terminology of these authors) the schema must be relatively precise, while for a superordinated drive ('animal-available-message-set') coming from a 'higher' region of the hierarchy system it must be far more general.

But whether the climax of the behaviour is a specific or a general situation, the concept of appetitive behaviour is crucial for the problem of drive. Where it is relatively stereotyped and consists of random or unoriented locomotion, as in klinokinesis, it raises few difficulties. But where it is more variable and has to be precisely directed or oriented, some important problems arise. In order to account for the flexible directiveness which is the most characteristic feature of appetitive behaviour—that is, in order to account for the appearance of purpose displayed—there are two possible alternatives. One can assume a very great variety and complexity of pre-formed pathways, each of which is as a result of evolutionary selection, directive in the sense that all well-designed machines are directive, and which serve as possible alternatives. Certain of these would then come to be preferred by a trial-and-error process as a result of reinforcement by the attainment of a releasing situation and the ensuing consummatory act. Besides this, one can suppose a 'directiveness' of a more subtle kind in the sense that progressive approximations to the 'ideal' releasers are perceived and so reinforced, with the result that the animal, by means of a real but extremely short-term purposiveness and anticipation, succeeds in steadily sharpening the configuration of the innate releasing mechanism. Thus by gradually building up its own releasers, the appetitive behaviour as a whole becomes, in effect, welded into a directional unit which gives an overall impression of purpose much greater than the apparent sum total of the minute gleams of purposiveness which are supposed to have played their part in its development in the individual.

It is evident that the first alternative must be very widely operative in animal behaviour. The question is how far is the second concept necessary. It seems that to account adequately for all varieties of appetitive behaviour it is necessary to assume that not only are the fixed action pattern and the inhibitory mechanism by a feed-back device together generating some motivation for the next phase, but that also some short-term purpose in the superordinated drive itself must be postulated. The concept of appetitive drive as nothing more than a completely non-directive 'force' rigidly confined within a previously co-ordinated system of conduits together with the specific action potential of a consummatory act seems inadequate to cover the great variety of behaviour observable. Many biologists will no doubt object to the introduction of such a concept as purpose into their subject and, of course, there are great fields of biology in which, however directive the organization and activities may appear, the concept of purpose is either definitely redundant or, to say the least, is of doubtful utility. Sommerhoff tries to solve the problem by separating 'purpose' (as subjective adaptation) from 'purposiveness' (as objective adaptation) and claims that his system of directive correlation is all that is necessary for the objective description of purposiveness in living organisms. But here he seems to fail; for, as Scriven[23] shows, on Sommerhoff's analysis some machines would be classed as living beings and some living organisms (including some human beings) would be classified as nothing more than machines. So we still lack a satisfactory set of terms and concepts which will serve for the description of all examples of directively correlated animal behaviour and thus we still require the concept of purpose. In using such a term we, as biologists, need not, of course, come to any conclusion as to the relation between mechanism and mental events. If we decide, as the result of experiment, that the behaviour of an animal gives reasonable evidence of purpose as distinct from directiveness, we mean that its behaviour cannot be fully or reasonably explained by mechanisms at present known to be operating within the body of the animal—although if we can point to a sufficient mechanism, that does not necessarily mean that true purpose is absent. As Agar[24] says, it is the task of biologists to investigate such mechanisms down to the most minute detail; but while the assumption and investigation of mechanisms is an essential method of biology, it is hard to conceive as a really fundamental explanatory principle in a biological philosophy. On the other hand, as Woodger[25] has indicated, it is doubtful whether the causal efficacy of purpose can be proved in the sense that all other explanations are excluded. "It is always possible to defend microscopic mechanisms in principle . . . by making your mechanism complicated enough and by postulating enough sub-mechanisms to meet all contingencies. It cannot then be refuted, but neither can it be verified."

But, purpose apart, Kennedy has objected to the ethologists' use of many other much more orthodox terms which he regards as subjective. He ignores the definitions above referred to, and appears to argue that the use of many of these terms is inadmissible in that in employing them ethologists have abandoned all pretence of being objective and are back in the jungles of subjectivistic animal psychology. Tinbergen does indeed claim that the particular value of his system is that it is objective, and in this he is undoubtedly right. When compared with much of the naturalistic comparative psychology which was not infrequently met with prior to the publication of Lorenz's main papers, its objectivity is plain and is certainly an inestimable advantage. But there is a danger lest objectivity come to be thought of as the sole requirement of a system of behaviour study. Of course, although all concepts are ultimately subjective in origin, it is usually possible to restate them in more or less objective terms and thus to clothe them with whatever degree of respectability may be required by the climate of scientific opinion at the moment. Actually, to me, the great merit of the behaviour theory of Lorenz—for much of the development of which Tinbergen is responsible—is that, in fact, as the writings of both these authors show, it combines both objectivity and subjectivity and (in the first place by distinguishing flexible and inflexible behaviour) helps one to specify where each has its rightful place and each its dangers. Sommerhoff's failure in his main task shows in, I think, a particularly dramatic fashion that both subjectivity and objectivity are necessary in the scientific study of life and that a biology which succeeds in being purely objective (however successful it may be in parts of its field) must fail to provide a full biological philosophy—just as surely as a purely subjective biology must, of course, fail. In other words, subjective concepts derived from introspection are among the essential tools for the study of life, and the only hope for a complete biology is to combine subjective and objective in the right proportions, using each approach with due circumspection and adequate safeguards, as it is required. All our concepts, in whatever field, are of course in the last resort subjective in that they are the conscious expressions of our own experiences. Although, as stated above, there are wide fields of biology where it is possible, and indeed essential, to achieve a very high degree of objectivity, there are many sections of ethology concerned with the modifiable behaviour of the higher animals where we sometimes simply cannot progress without concepts of a high degree of subjectivity. Polanyi[26] has said that science does not require that, in the study of man and society, we attempt always to remain detached observers; "On the contrary, the part played by personal knowledge in science suggests that the science of man should rely on greatly extended use of personal knowing". I would add that the same applies to certain fields of biology other than those which deal exclusively with man. But we have above all to beware of falling into the trap—which has so frequently caused the downfall of past students of living matter—of supposing ourselves objective when, in fact, we are being subjective. First and all the time we must know precisely where and to what extent we are using and relying upon subjective concepts. It is essential to avoid confusion here if biology is to deal adequately with the vast theoretical problems that confront it.

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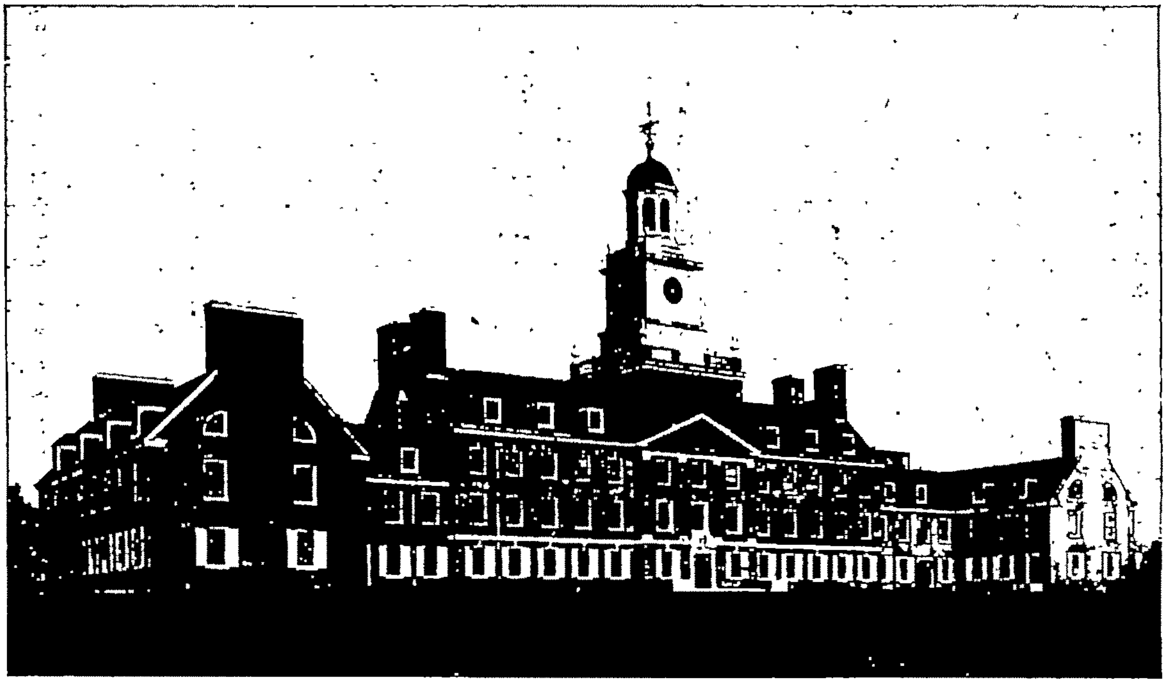
INSTITUTE OF MICROBIOLOGY, RUTGERS UNIVERSITY

THE newly completed building of the Institute of Microbiology of Rutgers University, New Brunswick, the State University of New Jersey, was officially opened on June 7, addresses being given by Dr. A. J. Kluyver, of the Technical University, Delft, President L. W. Jones, of Rutgers, and Dr. Selman A. Waksman, director of the Institute. Following the opening ceremony, a two-day symposium on "Perspectives and Horizons in Microbiology" was held.

Rutgers University is the eighth oldest Colonial college in the United States; it was given a charter as Queen's College in 1766 by King George III, and the Institute of Microbiology is one of its newest divisions, the decision to create the Institute having been taken by the trustees of the University in 1949. Dr. Waksman and his colleagues of the Department of Microbiology of the University's College of Agriculture have discovered a number of antibiotics, the



Institute of Microbiology, Rutgers University

most notable being streptomycin, for which Dr. Waksman gained the Nobel Prize in Physiology and Medicine for 1952, and the establishment of the Institute is a direct result of the royalties paid by manufacturers of streptomycin to the Rutgers Research and Endowment Foundation. The Foundation decided to dedicate these royalties to microbiology, and the Institute will be devoted primarily to research in the various fields of microbiology, which will be treated as a fundamental science, although certain practical applications will not be overlooked. The staff of the Institute will investigate micro-organisms from the point of view of occurrence and classification, cytology and genetics, physiology and biochemistry; it will also probe the relationship between microbes and higher forms of life, including man, his domesticated animals and plants. Concomitant with these basic studies, other divisions of the Institute will examine some of the practical applications, such as production of antibiotics, vitamins and enzymes, and some of the fermentation processes.

In view of the necessity of training a large number of microbiological investigators, the staff will also carry out a certain amount of advanced-level teaching, instruction being given to about twenty-five graduate students and several post-doctoral Fellows. It is hoped that the Institute will serve as a gathering place for seminars and conferences on microbiological subjects as well as a depository for microbiological cultures of theoretical or practical importance. It will collaborate with government, medical and industrial agencies in the development of important projects in the field.

The Institute is on the new University Heights campus at present being developed as the science centre of the University, and is situated on a slight rise in the ground overlooking the University golf course. Following a traditional pattern, the new edifice adheres to the Georgian Colonial architecture that dominates many of the University's buildings, being a four-story red-brick building, flanked by two wings, 82 ft. deep by 42 ft. wide, the whole enclosing a central area approximately 150 ft. long by 50 ft. deep. The overall length of the building is 302 ft. The central part of the first and second floors contains teaching and research laboratories and is constructed of removable metal partitions. The laboratory area for the most part is divided into units 10 ft. wide, so that laboratories of any desired width in units of 10 ft. can be established. The central area on the first floor will be devoted to teaching and to graduate student research. It includes a large and a small teaching laboratory, classrooms, a microbiological museum and several research laboratories. The lecture hall seats two hundred persons and is in the right wing of the first floor.

The centre and right wing of the second floor is the principal area of research occupied by the research staff of the Institute. In most instances, offices for the scientists are connected to the laboratories. In addition to the research laboratories, this area includes a number of special instrument rooms, warm rooms, sterile rooms, cold rooms, a radioisotope room, a photography suite, a sterilizing and washing room and solvent extraction rooms. The right wing over the lecture hall is devoted to animal experimentation and contains four temperature-controlled animal rooms, an autopsy room, a sterile room, an instrument room and an incinerator room.

Approximately half the left wing is devoted to the pilot plant, where fermentation processes can be carried out on a large scale. It contains a number of fermenters ranging in size from one to three hundred gallons, and it is two and a half stories high. The remainder of the left wing is given over to a solvent extraction room, a maintenance shop and storage rooms. The library reading room, seminar rooms and administration offices are on the third floor. There is room for approximately seven thousand volumes in the library, the stacking area being immediately above the reading room. The fourth floor is used for a conference room, dining room and kitchen. The total cost of the building was approximately 3,050,000 dollars. The equipment is valued at approximately 150,000 dollars.

The Institute is a co-ordinate division of the University, and as director Dr. Waksman is responsible solely to the President and Trustees of the University. The staff includes the following: *Associate Professors*, Dr. V. Groupe (virologist), Dr. W. J. Nickerson (physiologist) and Dr. Ruth E. Gordon (taxonomist); *Assistant Professors*, Dr. H. Lechevalier (microbiologist) and Dr. Waclaw Szybalski (geneticist); and six investigators holding the rank of instructor. In addition to the director, the administrative staff has provision for a vice-director, who has not yet been selected, an executive secretary, an editor-librarian and six secretaries. The technical staff includes several research associates and assistants, and twelve to fifteen laboratory, technical and maintenance workers.

DEDICATION OF THE LABORATORY OF OCEANOGRAPHY, WOODS HOLE

THE new Laboratory of Oceanography at Woods Hole, described in *Nature* of May 29, was opened ceremonially on June 21 by Rear Admiral F. R. Furth, U.S.N., Chief of Naval Research. He said that although most of what the Navy requires from oceanography is too specialized to have much effect on the development of the subject, it is their intention to support oceanographic research in such a way that military requirements would do as little as possible to hinder its systematic progress. Admiral Furth's speech, and that of the Assistant Secretary of the Navy, James H. Smith, who is responsible for research, showed that the U.S. Navy, having demanded such a large share of the potential of the Woods Hole Oceanographic Institution during the War, and now finding itself unable to relinquish its claim, is adding an associated Laboratory of Oceanography large enough to allow the Institution and its work to regain much of its former academic character: there will again be space and facilities for more systematic study of outstanding basic problems and opportunities for visiting scientists.

The Navy speakers emphasized that a greater understanding of the physical processes in the oceans is essential to the solution of some problems bearing on amphibious, surface and submarine warfare, and for the best use of weapons, instruments and methods employed at sea. They regarded the opening of the new laboratory as a major landmark in the Navy's continuing oceanographic programme.

Dr. Detlev W. Bronk, president of the U.S. National Academy of Sciences, stressed the "spiritual value of the oceans which arouse yearning to see and to know". He showed that the action of the Navy Secretary, Gideon Welles, in 1863, in creating a commission on research, had indirectly fostered the National Academy, and that the Office of Naval Research, which is responsible for the new Laboratory of Oceanography, is a lineal descendant of the commission. He maintained that oceanography gives useful emphasis to the unity of all sciences, and that it does much to encourage international unity and amity. The new laboratory, he said, would be a challenge to achievement, fostering the spirit of adventure as well as yielding much of practical value. He believed that the laboratory's contributions in time of war were made possible by its earlier achievements in time of peace, and he thought that the significant time for research is not the time of immediate emergency.

Speeches of welcome to the new laboratory were made by representatives of the State of Massachusetts and the township of Falmouth. A message from the U.S. Naval Chief of Staff expressed high hopes for the continuing alliance of science with the Navy.

The inauguration of the new Laboratory of Oceanography was followed by a convocation on oceanography which proved wide in scope and penetrating in detail. A summary made at this stage can scarcely escape injustice to the many speakers, and the following notes give no more than a rough guide; the papers and discussion will be published by the National Research Council.

On the first day, emphasis was given to the need for team-work between specialists in physics, chemistry and biology, to ensure that those who specialize in one aspect of the subject are aware of the problems and advances in adjacent aspects. One example given was that a knowledge of the physics and chemistry helps to indicate the most productive areas in the oceans: a particular instance quoted was that the distance of the most productive region for cod fisheries off the coast of northern Norway depends on physical conditions which can be forecast. The importance of studying oceanic circulation was urged; its problems have been shown to be increasingly difficult as more observations are made, and it was generally agreed that much more effort than has been available in the past would have to be devoted to direct measurements using ships, telemetering buoys and submerged recorders, as well as to theoretical work and model experiments.

It was pointed out that although the basic principles which govern water movements have been known for more than a century, there are still difficulties such as turbulence, or random movements on various scales, which prevent us from understanding how the basic principles govern water movements in Nature. It was shown that a statistical approach to the theoretical treatment can be made where the analysis is too difficult and the data inadequate. Other speakers showed what oceanography might do for navigation, coastal engineering and other marine industries. It was urged that the efforts spent on using the sea and in protecting lives and human interests against it warrants an understanding of its behaviour as detailed as might be gained with the help of modern discriminating and refined scientific methods and techniques as well as by simple observation and reasoning.

The second day was devoted to the discussion of work bearing on the productivity of the oceans and the distribution of marine organisms. One of the chief contentions, that the amount of organic production in tropical and subtropical parts of the oceans is strictly dependent on the physical conditions, the supply of phosphate and nitrate from below being far more important than the varying illumination from day to day in such regions, had to be continued as an informal discussion in the evening. The main outcome seemed to be a resolution for wider repetition and extension of the work recently done by pioneers in the quantitative approach to the problem. In the consideration of possible links between climatic changes and oceanic productivity, a mechanism was outlined by which the decline in nutrient resources and fisheries in the western part of the English Channel might be explained by climatic changes over the far northern Atlantic Ocean. The available data indicated that the understanding of variations in a fishery may well require a knowledge of the deep-water circulation of the ocean as well as a study of the shelf on which the fish live.

Oceanographic and fisheries surveys of the subtropical and tropical regions of the central Pacific Ocean were used to show that fisheries exploiting the populations of the high seas could profit by guidance from recognizable features of the water circulation just as fishermen in marginal seas have been guided by topographical features. Bottom-living animals were not neglected: emphasis was laid on the uniformity and small number of species living on level sea bottoms as compared with the fauna of rocks, reefs and vegetation, which afford a greater variety of microclimates to their inhabitants. It was made very clear that team-work used to map the level sea floor communities would be a very profitable way of widening our knowledge of marine ecology. The last paper on this day, by Dr. George Wald, of Harvard University, on "The Ocean and Organic Evolution", had the most appreciative audience of the whole convocation. He discussed the ideas of Oparin[1] and extended them with the help of his own studies of retinal pigments and the muscle chemistry of the vertebrates and invertebrates.

The third day was devoted to submarine geology and the relations between oceanography and meteorology. The geological papers dealt largely with the structure of the ocean basins and sedimentation problems. Evidence of the existence of a sharp change in density in the rock about a mile below the sea bottom was given particular consideration. Other topics were evidence of growth of the oceans and atmosphere during geological time and of the changing conditions for plant and animal growth. The dredging of cretaceous shallow-water fossils from the summits of 6,000-ft. deep sea-mounts in the Pacific Ocean and a marked increase in the deposition of calcium carbonate since the middle of the cretaceous period were used as evidence that some 3,000–4,000 ft. depth of water has been added to the ocean since that time.

The discussions on oceanography and meteorology emphasized the similarity of the theoretical treatment needed for oceanic and atmospheric circulation. Prof. Palmén showed how recent studies of the budget of angular momentum in the atmosphere have suggested a new approach to the whole question of transfer of momentum from the atmosphere to the ocean. He demonstrated that the pressure forces produced by the differences in height of the water-level on the east and west sides of the continents provide a more effective mechanism than that of frictional forces at the bottom and the coasts. He gave numerical values of the sea slopes required to provide the necessary momentum transfer. This and following papers dealing with the role of inertia and stratification in the question of transfer of energy, and other aspects of transfer of energy between the ocean and atmosphere, were so specialized as to cause the convocation to end on a rather sober note, largely due to the conviction that the detailed study of such difficult topics is as essential for oceanography as for meteorology, so that oceanography cannot remain the rather light-hearted subject which it has been for the past hundred and fifty years.

The meetings were held in the lecture theatre o the Marine Biological Laboratory, and there was some pleasantry about what took place "on the other side of the street". Visitors to Woods Hole could not help being greatly impressed by the possibilities which exist in the neighbourliness of the Marine Biological Laboratory, the Oceanographic Institution the new Laboratory of Oceanography, and the laboratory of the Fish and Wildlife Service, for exchange of ideas and co-operation. It was a remarkable experience to hear so much about marine research and to enjoy the company of so many marine scientists, and like many other visitors from Europe I am grateful to the National Research Council and the Office of Naval Research for making this meeting possible.

G. E. R. DEACON

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[1] Oparin, A. I., "The Origin of Life" (Macmillan, New York, 1938).

OBITUARIES

Prof. H. Stanley Allen, F.R.S.

HERBERT STANLEY ALLEN was born in Bodmin Cornwall, on December 29, 1873. The fifth son of Rev. Richard Allen, a Methodist minister, he was always proud of being "Cornish by birth". He received his early education at Kingswood School, Bath, where he won various scholarships and prizes was a senior prefect, and took first place for all England in the London Matriculation and, a year later, in the Cambridge Senior Local Examination. He was a contemporary of Prof. T. M. Lowry and a few years junior to Prof. A. E. Taylor.

In 1893 he entered Trinity College, Cambridge, and in 1897 gained a first class in the second part of the Natural Sciences Tripos. After a short time in a temporary post as assistant lecturer in Aberystwyth, he returned to Cambridge to take up research work under Prof. J. J. Thomson. From Cambridge he went to Renfrew in 1900 to take charge of Lord Blythswood's Physical Laboratory, and it was while living in Renfrew that he met Miss Jessie Macturk, whom he married in 1907. Their family consists of a son and a daughter. He joined the staff of the Physics Department at King's College, London, in 1905 and soon became a senior lecturer in physics. For his work there on the photo-electric effect he received the degree of D.Sc. in 1909.

Allen returned to Scotland in 1920 and served, first as a lecturer and later as a reader, on Prof. C. G. Barkla's staff in the University of Edinburgh. In 1923 he was appointed professor of natural philosophy in the United College of St. Salvator and St. Leonard in the University of St. Andrews. His first activity in St. Andrews was directed towards the reconstruction and enlargement of the Physics Laboratory which, after reconstruction, was formally opened by Sir William Bragg in 1925. His early researches covered a variety of subjects including photo-electricity, X-radiation, radioactivity, the Zeeman effect and spectroscopy. In St. Andrews his main interests were the quantum theory and spectroscopy, particularly the band spectrum of hydrogen.

His first text-book, "Photo-electricity", based on lectures he delivered at King's College, London, and published in 1913, contains an account of his own work, especially that on photo-electric fatigue. "The Quantum and its Interpretation" (1928) was, to quote his own words, "not a treatise on the quantum theory but an attempt to deal with the baffling problem of the nature of the quantum". Although no mean mathematician, he was never content with a purely mathematical representation of phenomena. Wherever possible, he tried to present a picture in terms of a 'model', and he endeavoured "to take a middle course between a mathematical and a purely descriptive treatment". His "Electrons and Waves" (1932) is devoted to the dilemma of particles versus waves. Allen and Moore's "Text Book of Practical Physics", first published in 1916, after frequent reprinting, is now in its third edition, and his "Text Book of Heat", written jointly with R. S. Maxwell, appeared in 1939.

He was elected a Fellow of the Physical Society in 1906 and of the Royal Society of Edinburgh in 1920. He served on the Council of both those Societies and was awarded the Makdougall–Brisbane Medal by the Royal Society of Edinburgh. He was admitted to the fellowship of the Royal Society in 1930, and this honour he shared with his brother, Edgar Johnson Allen, who was for many years director of the Marine Biological Laboratory at Plymouth. When he retired from the chair of natural philosophy in 1944, the University of St. Andrews elected him professor emeritus and conferred on him the degree of LL.D.

Prof. Allen was naturally shy and retiring, and only those privileged to know him most intimately realized the depth of kindness which lay behind his quiet dignity of manner. His junior colleagues gained much from his advice and encouragement, and his students will always remember him for his lucid style as a lecturer. Every lecture which he delivered was thought out with care and presented with the utmost precision and clarity. His whole life was devoted to the search for truth. There are many who mourn his death, which took place at the home of his daughter on April 27. D. Jack

Prof. J. P. Hill, F.R.S.

Prof. J. P. Hill died suddenly on May 24, in his eighty-first year. His first scientific paper was published in 1892; his most recent four years ago; and only three days before his death he was discussing with the librarian of the Zoological Society the placing of the illustrations of Part 7 of his series of papers on the development of the Monotremata, a paper that is now in the press. His span of active scientific work thus covered a period of more than sixty years. There can be few scientists who have enjoyed so long and so fruitful a life of research.

James Peter Hill was the son of Scottish parents. After attending the Royal High School in Edinburgh, he joined the Royal College of Science in London, before returning to Edinburgh, where he studied zoology under Cossar Ewart. His first appointment, in 1892, was as demonstrator in biology in the University of Sydney. From this office he was promoted, in 1904, to the post of lecturer in embryology. In 1906 he returned to England, to occupy the Jodrell chair of zoology and comparative anatomy in University College, London. He relinquished this appointment in 1921, to take up a chair of embryology and histology, which was specially created for him as part of the reorganization of the Department of Anatomy in University College that was carried out by Elliot Smith with the support of the Rockefeller Foundation. He retired from this post in 1938, when he reached the age of sixty-five. He was elected to the Royal Society in 1913, and was awarded the Darwin Medal in 1940. He was an honorary member of several foreign academies of science.

The scientific circle to which J. P. Hill was introduced as a young man in Sydney included the late Prof. J. T. Wilson, who afterwards became professor of anatomy in Cambridge; Sir Charles Martin, who was later professor of experimental pathology in the University of London; and the late Sir Grafton Elliot Smith, who had already begun his now classical studies of the morphology of the vertebrate brain. Hill's first research interest was in the Enteropneusta, but he very soon turned his attention to the embryology of the monotremes and the marsupials, a subject which remained his chief interest throughout his long career. His first paper in this field, published in collaboration with Martin, was entitled "A Platypus Embryo from the Intrauterine Egg". This proved to be the start of a systematic study of the embryology of the duck-billed platypus, which he carried out mainly in collaboration with J. T. Wilson. He also investigated the process of fertilization in monotremes, and the manner of formation of the corpus luteum, the phases of development of which he was able to correlate with the functional stages of the reproductive cycle. In addition, he devoted himself to the problem of the placentation of *Perameles*, showing that this animal has an allantoic placenta, and to the systematic study of the morphology and development of the urogenital organs in the Marsupialia. When he returned to England his attention became partly transferred to the embryology of Eutheria, and particularly to the development of the primates, including man. One of the most important of his publications is his 1932 Croonian Lecture of the Royal Society, on "The Developmental History of the Primates". This monograph provides what is now rightly regarded as the classical account of the blastocyst, of the manner of implantation, and of the formation and structure of the placenta in all the main subdivisions of primates.

Vol. 82 of the *Journal of Anatomy*, published in 1948, was dedicated to J. P. Hill. Prof. D. M. S. Watson, in a foreword, describes J. P. Hill as a general zoologist of wide interest and encyclopædic knowledge; and as a man of delightful and unique personality. He also provides a picture of an enthusiastic teacher; and of a scientist whose quality was not only revealed in his own writings, but also in the work of his research students. For his influence extended not only to his collaborators—J. Brontë Gatenby, Thomson Flynn, E. A. Fraser, A. Subba Rau, to name only a few—but also to numbers of others who, under his guidance and stimulus, undertook research on embryological subjects. J. P. Hill also did much to encourage the work on sex hormones that was proceeding in University College in the later 'twenties and early 'thirties.

It has been said of him that he was too meticulous a scientist, and that he carried a passion for certainty to such lengths that he would wait unnecessarily long to dot the 'i's' and cross the 't's' of his discoveries. A passion for certainty is, however, a fault in the right direction. If it led Hill to withhold from publication certain observations which might well have been published, we can find compensation in the fact that what he did record is of lasting value.

Those who knew him and whom he stimulated will never forget the slightly quizzical look over the half-lenses of his spectacles as he discussed the merit of some particular series of observations. Shortly before he died, he wrote in a letter: "I am getting very old and decrepit, and though I am still trying to do a little work it is becoming more and more of a labour". Perhaps he was physically decrepit; but intellectually he was unimpaired. At the age of eighty-one he had shown neither any sign of reduced interest in scientific work nor any tendency to lower the standards which had guided him through a career of meticulously accurate observation and single-minded purpose.

S. Zuckerman

NEWS and VIEWS

Physical and Inorganic Chemistry at Belfast: Dr. C. Kemball

Dr. Charles Kemball, who has been appointed to the chair of physical and inorganic chemistry in The Queen's University of Belfast, in succession to Prof. A. R. Ubbelohde (see *Nature*, April 17, p. 710), is a Fellow of Trinity College and demonstrator in physical chemistry in the University of Cambridge. Educated at Edinburgh Academy and Trinity College, Cambridge, he later became associated with Sir Eric Rideal in the Department of Colloid Science at Cambridge, first in research for the Ministry of Supply and afterwards in more academic studies. Here the pattern of his later work took shape, and his early studies of the surface chemistry of mercury and the thermodynamics of adsorption and monolayers fostered an interest in chemisorption and surface catalysis which has culminated in his well-known studies of the deuteration of hydrides at metal surfaces. Using the mass spectrograph, Dr. Kemball has thrown light on the fundamental aspects of surface reactions, and his papers show him to be a master of clear exposition. During 1946–47 he was awarded a Commonwealth Fellowship and worked in the United States with Sir Hugh Taylor at Princeton University; on his return to Cambridge he continued his research in the Department of Colloid Science. In 1949 he moved to the Department of Physical Chemistry as demonstrator and also became junior bursar of Trinity College. As a teacher Dr. Kemball is well liked by his students and, though his departure is a great loss to chemistry at Cambridge, he carries with him the best wishes of his colleagues for success in his new work.

Automatic Control and Computing at the National Physical Laboratory: Mr. R. H. Tizard

A new Division at the National Physical Laboratory, which has been formed by the amalgamation of the Electronics and the Control Mechanisms Sections, is to be called the Control Mechanisms and Electronics Division. The field to be covered by the new Division is the automatic control of industrial, administrative and experimental operations and the development of techniques and equipment for data processing and computation. An industrial example of such mechanisms is the automatic control of machines producing precision components in large quantities. Not only are the operations speeded up but also personnel can be released from the boredom of repetitive work. It is hoped that this trend will not be confined to the factory floor but that many routine office operations will also be carried out by suitable machines. The new Division is represented on a small group formed to study this subject. This group also includes representatives from the Organization and Methods Division of the Treasury and from the Ministry of National Insurance. The new Division is developing automatic or semi-automatic equipment to digest test records and similar material and produce it in the form of graphs or typescript ready for immediate use. Many of the techniques employed are electronic in the sense that thermionic valves are used, but the terms of reference exclude radio and acoustic applications. Thus the Control Mechanisms and Electronics Division is interested in the application of all forms of light electro-mechanical devices to special problems. Mr. R. H. Tizard, of the Metrology Division of the Laboratory, has been appointed officer-in-charge of the new Division.

Liaison Officers at the National Physical Laboratory: E. I. Brimelow and A. J. Garratt, M.B.E.

The application by British industry of results of research from the National Physical Laboratory is fostered by direct contact between the research workers at the Laboratory and individuals in industry, as well as by contributions to the scientific and technical press. It is, however, felt that much more could be done in the way of bridging the gap between the research laboratory and industry. To meet this need E. I. Brimelow and A. J. Garratt have been appointed liaison officers to work with industry. Mr. Garratt is a physicist and an honours graduate of the University of London. He was in the Civil Service from 1940 until 1951, first with the Ministry of Supply (Armament Research Establishment) and later with the Festival of Britain Office as staff physicist. More recently, he has held an appointment in industry and is a scientific adviser to the B.B.C. Television Service. Mr. E. I. Brimelow is a metallurgical engineer and an honours graduate of the University of Liverpool. He was for eight years from 1936 engaged in research at the Royal Aircraft Establishment, Farnborough, on materials for use in aircraft. After two years in industry as a metallurgist and research and development manager, he joined in 1949 the Chief Scientific Adviser's Division of the Ministry of Works, where he remained until transferred to the Building Research Station (Department of Scientific and Industrial Research) in 1950. He has also served on various technical committees of the British Standards Institution and on advisory committees of the Ministry of Supply.

Sir Richard Owen (1804–92)

The first anatomist of his age and one of the greatest of all times, Sir Richard Owen was born at Lancaster one hundred and fifty years ago, on July 20, 1804. He studied anatomy at Edinburgh under John Barclay, worked as prosector with John Abernethy at St. Bartholomew's Hospital, London, and at the age of twenty-two became a member of the Royal College of Surgeons of England, in the neighbourhood of which he set up practice. He was soon to become one of the most distinguished truants from medical practice, and it was at the College that he began his career as comparative anatomist by cataloguing the Hunterian Collection under William Clift, whose daughter he married and whom he succeeded as conservator of the Museum. His "Memoir on the Pearly Nautilus" won him election to the Royal Society in 1834, and two years later he was appointed the first Hunterian professor of comparative anatomy and physiology at the Royal College of Surgeons, being elected in 1843 as one of its original three hundred Fellows. In 1856 Owen became superintendent of the Natural History Department of the British Museum and was responsible for the building of the present Museum at South Kensington. An indefatigable worker and a prolific writer of such monumental works as "The Anatomy and Physiology of the Vertebrates" (3 vols., 1866–68), his anatomical interests ranged from parasitic worms and brachiopods to the primates; as a palæontologist he revelled in the reconstruction of extinct animals, and he introduced into comparative anatomy the conceptions of homology and analogy. His numerous honours included the Copley and a Royal Medal of the Royal Society, the Gold Medal of the Royal College of Surgeons, the Prix Cuvier of the French Academy, and the K.C.B. in 1884. Tall and ungainly, with a massive head and prominent glittering eyes, Owen was inclined to be overbearing and jealous. He died on December 18, 1892, aged eighty-eight.

Higher Technological Education in Great Britain

In a statement in the House of Commons on July 13, Mr. R. A. Butler, Chancellor of the Exchequer, stated that he has now approved plans for the development of higher technological education in Britain outside London. The University Grants Committee was asked last year to consult with the universities and colleges concerned, and as a result of the Committee's recommendations, Mr. Butler announced that the main developments outside London will be in Glasgow, Manchester, Leeds and Birmingham, at institutions already in receipt of recurrent grants from the University Grants Committee. These plans, and those already announced for the Imperial College of Science and Technology, London, will necessitate an increase in the funds available to the University Grants Committee, for both recurrent and non-recurrent purposes, in the last three years of the quinquennium 1952–57 covered by the present grants. Referring to the Bradford Technical College, Mr. Butler stated that the University Grants Committee had been unable to include this institution in its recommendations because of the necessity of limiting the number of university institutions concerned with higher technological education.

Insecticide and Fungicide Research Services in Great Britain

The Fungicide and Insecticide Research Co-ordination Service, an interdepartmental service the Secretariat of which used to be accommodated at the offices of the Agricultural Research Council, has recently been dissolved and the following alternative arrangements made. The "Insecticides Abstracts and News Summaries" will in future be issued from the office of the Colonial Products Laboratory, Imperial Institute Building, South Kensington, London, S.W.7, under the direction of Dr. R. A. E. Galley. They will be compiled with the view of meeting the needs of Colonial research workers, to whom distribution will for the time being be restricted. The analytical work formerly carried out at Woolwich will in future be done at Long Ashton Research Station, near Bristol, under the direction of Dr. J. T. Martin. The Insecticides Standing Conference, the interdepartmental body formerly responsible for co-ordination of work on insecticides and fungicides and for the Fungicide and Insecticide Research Co-ordination Service, is to be reconstituted as a smaller interdepartmental Committee on Insecticides and Fungicides, the secretarial arrangements for which will be undertaken by the Agricultural Research Council.

Hydrogen in the Manufacture of Steel

More than eighty years ago Thomas Graham, who was then Master of the Mint, observed that hydrogen forms a substantial proportion of the gases which are evolved when ferrous materials are heated in vacuum. It was not, however, until some fifteen or twenty years ago that the great importance of this gas began to be fully realized. In the solidification of the ingot, and right through to the final user, hydrogen can exert a distinctly detrimental effect, of which the steelmaker is now fully aware and takes proper precautions to avoid. Blow-holes in steel ingots, hair-cracks in forgings, and blisters in thin sheets are examples of the dangers which may arise from excessively high hydrogen contents, while the ductility of the material as measured by the reduction of area falls progressively as the hydrogen content rises. In the *Review* issued by Murex, Ltd., Rainham, Essex (1, No. 13, 305; 1954), K. C. Barraclough provides a very useful, critical summary of existing knowledge regarding the effect of hydrogen on steel, in which a substantial amount of original data is also incorporated. The determination of the hydrogen content is by no means an easy matter in view of the fact that only rarely does the amount of this gas in steel exceed 0·001 per cent, and the method used in the Brown–Firth Research Laboratories, Sheffield, with which the author is connected, is described in detail. Methods of collecting the samples, and typical values for steels of different qualities and made by different processes are given, and the effects of heat-treatment on the hydrogen content, and therefore the mechanical properties, are discussed for a number of different materials. Mainly as a result of the work of Prof. J. H. Andrew and his collaborators, it is now well known that the 'hair-cracking' of steel ingots and forgings is intimately connected with the hydrogen content, and this question of outstanding importance both to the maker and the user is considered in some detail.

Absorption by Leaves from Nutrient Sprays

The ability of the leaves of barley, brussels sprout, french bean, tomato and sugar-beet to take up nitrogen, phosphorus and potassium from nutrient solutions applied as sprays has been reported by G. N. Thorne (*J. Exp. Bot.*, 5, 37; 1954). The plants, which were grown in pots of soil and sprayed, usually daily, with the nutrient solutions and a spreader, had higher nutrient contents and dry weights than control plants sprayed with water and the spreader only. The absorption of nutrients by the leaves was not restricted to plants with a very low nutrient supply to the roots. An increase in nutrient content occurred with high or low levels of nutrient supply to the roots and was approximately proportional to the concentration of spray and to its frequency of spraying. The nitrogen content of sugar-beet plants was increased equally by spraying with solutions supplying ammonium sulphate, calcium nitrate or urea in equivalent concentrations. It was observed that nutrient uptake from solutions sprayed on leaves influenced uptake by the roots, so that the additional amounts of nutrient contained in sprayed plants may be greater or smaller than the amount absorbed from the spray by the leaves.

Triploid Dactylorchid Hybrids

PROF. J. HESLOP-HARRISON (*Ann. Bot.*, N.S., 17, 63 and 539; 1953) has reported on the cytology of some triploid dactylorchid hybrids. During meiosis in naturally occurring triploid hybrids between the diploid *Orchis fuchsii* Druce ($2n = 40$) and the two tetraploids, *O. purpurella* Steph. and *O. praetermissa* Druce ($2n = 80$), there is a regular formation of twenty bivalents and twenty univalents. Since the two tetraploid species themselves show typical 'diploid' behaviour in synapsis and fertility, they are considered to be allopolyploids, and the hybrid pairing to be allosyndetic. The implication is therefore that both tetraploids are amphidiploids of which *O. fuchsii* has been one progenitor. It is suggested that varieties of the polytypic diploid *O. latifolia* L. sec. Pugsl. may have been the other progenitors. A feature of interest in the microsporogenesis of both parents and hybrids is the close synchronization of nuclear events in the pollen massulæ, which behave as physiological units throughout meiosis and pollen-mitosis. In the triploids, although numerous dysploid nuclei are produced, none dies prematurely, probably because of mutual compensation within what is, in effect, a common cytoplasmic matrix.

Earthquakes during April

DURING the month of April twenty-seven strong earthquakes were recorded, including seven shocks of magnitude 6 or greater. The greatest had magnitude 7½ but only did minor damage in western Mexico on April 29 (epicentre at lat. 29½° N., long. 112½° W.). The shocks of deepest focus occurred on April 5 on the Argentine–Bolivia–Chile borders (epicentre at lat. 23° S., long. 67½° W., depth of focus 150 km.) and on April 13 in Catamarca Province, Argentine (epicentre at lat. 27½° S., long. 66° W., depth of focus 200 km.). All other earthquakes had intermediate or shallow foci. The greatest damage was done by the earthquakes in central Greece, beginning on April 30 (see *Nature*, May 29, p. 1024). Minor damage was done at Watsonville and Gilroy by an earthquake on April 25 in central California. Several of the shocks were felt, including one on April 4 in the south-west Alps near Onstmettingen, Tailfingen and Pfeffingen, one on April 5 near Rastatt (both with Modified Mercalli scale intensity 5), and one on April 25 near Friuli (Italy).

University of London: Appointments

THE following appointments have been made in the University of London: Prof. R. M. Barrer, professor of chemistry in the University of Aberdeen, to the University chair of physical chemistry tenable at the Imperial College of Science and Technology; Dr. C. Domb, lecturer in mathematics in the University of Cambridge, to the University chair of theoretical physics tenable at King's College; Dr. J. A. C. Knox, lecturer in King's College, London, to the University chair of physiology tenable at Queen Elizabeth College; Dr. D. R. Wilkie, Locke Research Fellow of the Royal Society, to the University readership in experimental physiology tenable at University College; and Dr. M. J. Wise, lecturer in geography in the London School of Economics and Political Science, to the Sir Ernest Cassel readership in economic geography tenable at that School.

Ramsay Memorial Fellowships for 1954–55

RAMSAY MEMORIAL FELLOWSHIPS for research in chemistry have been awarded for 1954–55 to the following: J. R. Anderson, British Fellowship at the University of Cambridge; G. A. Sim, Glasgow Fellowship; Dr. J. A. Davies, Canadian Fellowship at the University of Leeds; G. Moralli, French Fellowship at King's College, Newcastle upon Tyne; Dr. C. Alfonso, Spanish Fellowship at the University of Birmingham; Dr. H. Jucker, Swiss Fellowship at King's College, London; and Dr. O. R. Rodig, United States Fellowship at the University of Manchester. The following Fellowships have been renewed for a year: G. T. Rogers, British Fellowship at the University of Cambridge; Dr. K. Saito, Japanese Fellowship at University College London; W. G. Hanger, New Zealand Fellowship at the University of Cambridge; S. Amer, Spanish Fellowship at the University of Cambridge; and R. H. Doremus, United States Fellowship at the University of Cambridge.

Salters' Company: Awards for 1954–55

THE Court of the Salters' Company has elected G. Hetherington to be a Salters' Fellow for the year 1954–55 and has extended the fellowship held by P. P. Manning for a second year. Mr. Hetherington, who held a Salters' Scholarship during 1953–54, has been working in the Chemistry Department at King's College, Newcastle upon Tyne, on the chemistry of nitryl fluoride; Mr. Manning has been carrying out research work in the Chemistry Department of the University of Leeds on chemical kinetics of cyclic monomers forming linear polymers, and theoretical studies on the polymerization of olefines. The following have been elected Salters' Scholars for the year 1954–55: C. P. Brown (University of Nottingham), M. McLeman (Imperial College of Science and Technology, London), A. D. Shipman (University of Bristol), H. Spoel (University of Oxford), and W. L. Wilkinson (University of Cambridge).

Inter-African Soils Conference in Léopoldville, Belgian Congo

THE second Inter-African Soils Conference will be held in Léopoldville, Belgian Congo, during August 9–15. A number of specialists in agronomy, soil science and conservation, not exceeding eighty in number, will be present at the Conference as delegates of the participating countries and, in addition, there will be some representatives from interested organizations. The work of the Conference will be divided into three sections: the characterization, classification and mapping of African soils; physical, chemical and biological research concerning these soils; and soil conservation. In general, a review will be made of the work accomplished following the recommendations of the previous Conference, held in Goma. The stability and agricultural characteristics of African soils and the formation of hardpan and lateritic crusts will be considered, and in the sessions on soil conservation and utilization the following topics will be discussed: various causes of erosion; means and methods used in the control of erosion;

utilization of agricultural, sylvicultural and pastoral soils; traditional systems of agriculture; possibility of utilization and transformation of shifting cultures; large-scale trials of agricultural mechanization; fertilizers and amendments; improvement of swampy soils. The evolution of the arid zones in Africa will also be discussed. Immediately after the Conference, the Fifth International Congress of Soil Science will be held in Léopoldville, and after this Congress a number of excursions will be made in the Belgian Congo. Further information regarding the Conference can be obtained from the Inter-African Bureau for Soils at 57 rue Cuvier, Paris 5e.

Optical Conferences in Italy

Two conferences of optical interest are being held this September in Italy, the first being an international symposium on infra-red radiation at the University of Parma during September 3–7. This is being sponsored by the International Union of Physics, the International Commission for Optics and other bodies in Italy, and will commemorate the hundredth anniversary of the death of Macedonio Melloni, the founder of infra-red studies at Parma. Further particulars of this meeting can be obtained from Prof. G. Polvani, president of the Italian Physical Society, Via Saldini 50, Milano. The second conference will be in Florence at the National Optical Institute of Italy during September 10–16, and will be on "Problems in Contemporary Optics". The subjects to be discussed are optics and information, non-classical focusing devices, optical problems of television, optical surface manufacturing, three-dimensional optics and retinal problems. Details of this meeting can be obtained from Prof. G. Toraldo di Francia, Instituto Nazionale di Ottica, Arcetri-Firenze.

Autumn Meeting in Switzerland of the Institute of Metals

The autumn meeting of the Institute of Metals will be held this year in Switzerland during September 6–14, by invitation of the Société Swisse des Constructeurs de Machines and the Association Suisse pour l'Essai des Matériaux. The meeting will open in Zurich on September 6 and then will move to Montreux on September 11. On the morning of the first day the Institute of Metals (Platinum) Medal for 1953 will be presented to Dr. Georg Masing (Göttingen), and then two papers on grain refinement will be read and discussed. The rest of the meeting will be devoted to excursions to various places of interest in Switzerland, including a large number of engineering and metallurgical works. All arrangements for booking accommodation in Switzerland should be made before July 31 through the Post-Order Department, Thos. Cook and Son, Ltd., Berkeley Street, London, W.1, quoting *POD/S/22222*.

Announcements

The Dr. W. S. Bruce Memorial Prize for 1954, commemorating Dr. W. S. Bruce, the Scottish explorer and scientific investigator in polar regions, has been awarded to Dr. R. M. Laws, of the National Institute of Oceanography, for his investigations in the South Orkney Islands and South Georgia, particularly in the biology and life-history of elephant seals. The committee of award is appointed by the Royal Physical Society of Edinburgh, the Royal Scottish Geographical Society and the Royal Society of Edinburgh.

The trustees of the Ciba Foundation have appointed Prof. F. G. Young, professor of biochemistry in the University of Cambridge, and Prof. A. Haddow, director of the Chester Beatty Research Institute, London, to the executive council of the Foundation to assist its scientific work.

Mr. Fred Smith, of Wm. Smith and Co., Ltd., Cliffe Dyeworks, Bruntcliffe, succeeds the late Mr. F. L. Goodall as president of the Society of Dyers and Colourists. Mr. Smith has been associated with the Society for more than forty years, being a vice-president since 1939, and for his exceptional services he was awarded in 1947 the Society's Gold Medal.

Dr. H. T. Openshaw, formerly Purdie lecturer in chemistry in the University of St. Andrews, has been appointed head of the Chemical Division of the Wellcome Research Laboratories, Beckenham, in succession to Dr. D. W. Adamson, who last year became research director of the Wellcome Foundation, Ltd., and director of the Wellcome Research Laboratories (see *Nature*, 172, 654; 1953).

The following have been appointed to lectureships in the University of Sheffield: E. J. Sarginson (civil engineering) and J. R. Metcalf (mining).

Owing to illness, Sir Geoffrey Taylor was unable to deliver the thirty-eighth Guthrie Lecture before the Physical Society last March. He will now give it on September 24 in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7, at 5 p.m., his subject being "Diffusion and Mass Transport in Tubes". The Lecture will be open to the general public.

The Oliver Memorial Fund is offering an award of £50 to a British subject for original work or services in connexion with research, organization or the donor aspect of blood transfusion. Applications or information directing attention to suitable candidates must be submitted before August 31 to the honorary treasurer of the Fund, F. W. Mills, c/o National Provincial Bank, Ltd., Holborn Circus, London, E.C.1.

The Textile Institute, 10 Blackfriars Street, Manchester 3, will hold a conference on "Fibre Friction" in Ghent during September 9–13, this being the first conference that the Institute will have held outside Great Britain since 1928. It is noteworthy that the Institute's first overseas meeting was in Ghent during 1913. For the present conference, the Institute has received the co-operation of the Centre Scientifique et Technique de l'Industrie Textile Belge, the University of Ghent and the organizers of the Ghent International Trade Fair, which will be in progress at the time. Seven papers will be read by British, Belgian and Dutch scientific workers.

A symposium on "The Vegetation Types of India" will be held by the Indian Botanical Society in Baroda during December 31–January 1. Among the types of vegetation of the different regions of India to be discussed will be forests, grasslands, aquatic vegetation, mangrove, desert vegetation, and vegetation of other habitats such as sand dunes, silted banks, eroded and barren areas. The ecological accounts will be given under the following headings: climate, geology and soils, biotic features, floristic composition, succession and climaxes. Copies of papers for the symposium should be submitted before September 1 to Dr. R. Misra, Department of Botany, University of Saugar, Sagar, India, from whom all further information can be obtained.

ECONOMIC SURVEY OF THE BRITISH EAST AFRICAN TERRITORIES

THE population of Kenya, Uganda and Tanganyika has increased in two decades from less than twelve to nearly twenty million, and continues to increase by some three to four hundred thousand a year. Against this background the expenditure of £10 million a year on development under the 1947–56 development programme seems a relatively small sum. These points are brought out by a recent survey of economic conditions in East Africa proper together with Zanzibar, Somaliland, Aden, Mauritius and Seychelles*. The survey forms part of "An Economic Survey of the Colonial Territories, 1951" which is designed to provide a convenient summary account of conditions in overseas territories similar to those published at roughly annual intervals before the Second World War, and last issued in 1940 ("An Economic Survey of the Colonial Empire (1937)", Col. No. 179). The present survey does not, however, attempt to cover the decade 1937–47. It is concerned mainly with post-war developments, pre-war figures being quoted only as a basis for comparison. Six volumes have so far been published since February 1952: Vol. 1, Central African and High Commission Territories (Col. No. 281–1); Vol. 3, West African Territories (Col. No. 281–3); Vol. 4, West Indian and American Territories (Col. No. 281–4); Vol. 6, Mediterranean and Pacific Territories (Col. No. 281–6); Vol. 7, Products of the Colonial Territories (Col. No. 281–7); and the present volume. A final volume yet to appear, on the Far Eastern territories, will complete the first comprehensive post-war survey. Although referring nominally to 1951, each volume has been kept up to date by the inclusion of relevant statistics available at the time of publication. The whole series will provide an admirable datum from which to assess progress during the second half of the current development programmes at the end of 1956.

In conformity with the general plan, Vol. 2 treats each territory independently under four main headings: general background, productive activities, finance and trade, and development. The first section in each case is more important than the heading suggests and includes a brief description of geographical features, a full discussion of population data and problems, and a summary of the main facts relating to social, political and economic conditions and legislation, transport and communications. The second is not confined to commercial activities but offers much valuable information, supported so far as possible by statistics, on such topics as subsistence agriculture and domestic industries. The work of the East African High Commission and the East African Currency Board which concerns Kenya, Uganda and Tanganyika collectively, and the external trade of the three countries, are discussed separately in an appendix.

A large part of the report is devoted to commercial production, trade and finance, but the authors rightly emphasize that the overwhelming majority of the population of the mainland territories live directly off the land by subsistence cultivation and nomadic pastoralism. Since responsibility for the future stability of East Africa will presumably sooner or later rest with this majority instead of with the sixty thousand or so European settlers, their welfare is a matter of first importance. It is encouraging to find that a substantial proportion of the revenue derived from increased commercial output, Colonial Development and Welfare funds and other sources has been used for combating the various problems resulting from increasing population and consequent shortage of productive land. So far as can be estimated, the total cultivated area amounts to only about 10 per cent of Uganda, 5 per cent of Kenya and 3 per cent of Tanganyika; but owing to pests, deficient or uncertain water supplies and other difficulties, there is little hope of solving the problem by extension of the cultivated area alone. On the contrary, spontaneous attempts by peasant cultivators to achieve this end by keeping temporary plots under cultivation for longer periods at a time, clearance of woodland and encroachment on marginal land have led to loss of fertility and aggravated the menace of soil erosion. Already in Kenya some 600,000 acres of the Highlands are estimated to be in need of protection. It is difficult to judge from the survey how much progress has been made; but there are some indications. In the Central Province of Kenya 81,000 acres are now terraced, and the Forestry Department is undertaking extensive afforestation schemes, the present target being 6,000 acres of new softwood plantations a year. In Uganda 45,000 acres are being developed as a source of commercial softwoods; but these together with protective measures elsewhere will help to mitigate the losses due to soil erosion.

Progress is also reported from all three High Commission Territories in the campaign to encourage Africans to abandon the primitive practices of shifting cultivation and fragmentation of holdings through inheritance, in favour of permanent cultivation of small holdings varying from five to thirty acres, and family group farms. The Kikuyu are settling in increasing numbers; more use is being made of mechanical ploughs and other equipment loaned by government centres in Tanganyika; and strip cultivation is spreading in Uganda. The effects of more elaborate measures for rehabilitation of land (for example, the Sukumuland Scheme in Lake Province, Tanganyika) are cumulative and cannot be fairly assessed at this early stage of development. Before leaving the subject, it is worthy of note that subsistence production of both maize and groundnuts in Uganda is estimated to have increased two and a half times between 1938 and 1951, far in excess of the increase of population even if a considerable margin of error be taken into account.

On the commercial side a net improvement in the balance of visible trade of the High Commission Territories is reported for 1952, Kenya's £29·6 million excess of imports over exports for that year being more than compensated by the surplus exports of Uganda (£23·4 million) and Tanganyika (£10·5 million). Notable increases have been effected in the production and export of tea and wattle-bark from Kenya; sisal, coffee and cotton lint from Tanganyika; cotton (due mainly to the Abyan irrigation scheme in the Western Protectorate) from Aden; and sugar from Mauritius. In the last-named Colony attempts to broaden the basis of the economy have met with little success, sugar production having reached a new peak of 515,000 tons in 1952 compared with the pre-war peak of 320,000 tons in 1938. Industrial development in East Africa has continued to expand for the dual purpose of supplying the home market with consumer goods (capital and producer's goods accounted for more than half the retained imports in 1951) and for social ends—to absorb some of the surplus labour created by the continued drift into the towns. Other developments await improvement of communications. The production of copper at Kilembe in south-west Uganda is due to commence this year, but large-scale output cannot be expected until the 215-mile railway extension from Kampala, already proceeding west of Mityana, has been completed. The importance attached to development of communications may be gauged from the fact that the East African Railways and Harbours Administration ranks as the largest industrial undertaking in the High Commission area, with a staff of more than 32,000, of whom 857 are Europeans.

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* Colonial Office. An Economic Survey of the Colonial Territories, 1951: Vol. 2, The East African Territories. (Col. No. 281–2.) Pp. 203. (London: H.M.S.O., 1954.) 22s. 6d. net.

In the survey as a whole, comparatively little reference has been made to pre-war figures which would have made it easier to review post-war progress in comparative terms. On the other hand, the appendix contains a useful supplement on trade in which an attempt has been made to compare conditions before and after 1949 when trade statistics for the High Commission Territories were placed on a common basis. This includes a detailed analysis of the direction of trade in leading commodities for the three countries, similar to those given for Aden, Zanzibar and Mauritius earlier in the survey.

It would be futile to attempt to summarize the findings of a report of this scope in the brief space of a review. There can be no question that it is a highly competent and valuable basic document for all who are concerned with East African affairs. Such deficiencies as there are mainly arise from the inadequacy of statistical data relating to the activities of 90 per cent of the inhabitants. It seems likely, for example, that the annual rate of natural increase of the African population of Kenya (1½–2 per cent), Uganda (1–1½ per cent) and Tanganyika (1–2 per cent) may be under-estimated. According to the present survey and the survey for 1936 (Col. No. 149), the total population of the three territories increased from some twelve million to nearly eighteen million during the twelve-year period 1937–48, corresponding to a natural increase of nearly 5 per cent a year. Allowing for immigration, which at the peak of the post-war influx into Kenya reached 59,000 in 1951, and a higher than average figure for the Indian minority, the overall rate of natural increase among the African population prior to the 1948 census must have been well in excess of 2 per cent. In any event, at least a temporary acceleration rather than a decline in the rate of increase must be expected as current expenditure on the development of medical services takes effect. Without attaching undue importance to figures which can be no more than rough approximations and which are stated in the survey in carefully guarded terms, one hopes that the magnitude of the population problem has not been under-estimated. The next census will no doubt shed more light on the subject. At present large sums are being spent on what may be termed basic development (hydrological and other surveys, research, training and education), as distinct from more publicized industrial ventures like the Owen Falls scheme, with consequences that remain to be foreseen. Meanwhile, here are food for thought and data for research in abundance.

A. J. Hunt

UNESCO ADVISORY COMMITTEE ON ARID ZONE RESEARCH

The Advisory Committee on Arid Zone Research of the United Nations Educational, Scientific and Cultural Organization (Unesco) held its seventh session during May 4–7 in Paris. The meeting was attended by members from Australia, India, Italy, Mexico, Syria, Turkey, the United Kingdom and the United States and, as on previous occasions, by representatives from various Specialized Agencies of the United Nations Organization and from international scientific and engineering bodies, and by French members of the Arid Zone Panel of Honorary Consultants. The principal recommendations made by the Committee were as follows.

Symposia and reports. It was proposed that the secretariat should explore the possibility of holding a small symposium in 1955 on human and animal ecology in arid zones, which would enable the proceedings of such a symposium to be published in conjunction with reports on this subject that are being obtained. With regard to the symposium on problems related to arid zone research, sponsored by the American Association for the Advancement of Science, which is to be held in New Mexico during April 27–28, 1955, it was proposed that Unesco should make a grant to assist travel of scientists attending the symposium and also that the Arid Zone Research Committee should hold its ninth session in New Mexico in conjunction with this symposium. It was recommended that review reports should be obtained in 1956 on the formation and erosion of soils in arid zones as affected by climatic factors; these reports could then be published with the proceedings of a symposium on the same subject that is due to be held in the same year.

Travelling fellowships for senior scientists. Fellowships should be given to enable senior scientists to visit institutions outside their own country and, when these are given, the recipients should be allowed as much latitude as possible with regard to travel within the country visited.

Handbook and survey. At previous meetings it was decided to recommend the production of a handbook to guide in the collection of basic data that would be required when making plans for the development of an arid area, and preparations for writing this handbook are well under way. The Committee considered the advisability of instigating an integrated survey of one or more restricted areas on the lines proposed in such a handbook. It recommended that Dr. B. T. Dickson, who is editor of the handbook, should assemble information on such survey work that has been carried out in Australia and elsewhere, and that the Committee should consider the proposal at its next meeting.

Research projects. As a result of recommendations made by the Committee at previous meetings, Unesco has given grants for research on the following subjects: the geographical potentialities of coastal deserts; a survey of wind energy and of energy requirements in a typical arid area (Somaliland); the flow of underground water in calcareous mountains; the sulphate- and nitrate-rich soils of Algeria; changes in climate during the Quaternary Period in Israel, as evidenced by pollen analysis; the rolé of dew in plant growth in arid regions; plant ecological studies in French North Africa; the role of vertebrates in spreading desert conditions in India; and the physiology of the camel. At the meeting in Paris, reports on these investigations were received by the Committee, and grants were recommended for the development and testing of apparatus for the measurement of dew and for the study of plant distribution and ecology in the Rajistan desert in India.

Future meeting. The Committee will hold its next session in New Delhi during October this year in conjunction with the symposium on wind and solar energy that has been arranged at the invitation, and with the help, of the Government of India.

CHEMISTRY AND PHYSICS OF SYNTHETIC FIBRES

ALTHOUGH the subject of 'man-made' fibres is well to the fore in the world of polymer technology and names of new fibres such as 'Terylene' and 'Orlon' are beginning to compete in the housewife's mind with nylon, major discussions in Britain on chemical aspects of this topic have been few. The three-day symposium held during March 24–26 by the Plastics and Polymer Group of the Society of Chemical Industry on the subject of "The Chemistry and Physics of Synthetic Fibres", at the Institution of Electrical Engineers, Savoy Place, London, was therefore timely. More than three hundred participants, including a number from overseas, attended, and some interesting papers were read and discussed. During the first session, Mr. J. R. Whinfield (Terylene Council, Imperial Chemical Industries, Ltd.), chairman of the Group, presided.

Dr. R. Hill (Terylene Council, Imperial Chemical Industries, Ltd.), in an introductory paper on "Chemical Aspects of Fibres", discussed the structural features in polymers which have led to the mechanical behaviour characterizing rubbers, plastics and fibres; for the development of fibre properties a macromolecule needs to possess a regular, crystallizable structure and high interchain forces. In materials such as polyamides, polyurethanes and polyesters, these features are present, but fibre properties can be seriously affected if any branching or cross-linking occurs during condensation owing to the presence of impurities. In the vinyl polymer field, Dr. Hill referred to grafting, a new method by which the properties of a given polymer can be modified. It seems unlikely, partly for economic reasons, that any completely new fibre-forming polymers will be commercialized in the near future, but possible developments in such materials as polyvinylidene cyanide and polymers obtained by ring-opening of oxacyclobutane derivatives and N-carboxyamino-acid anhydrides were mentioned.

Among the new materials which have aroused interest in recent years are the polyaminotriazoles, which may be obtained by the reaction of dibasic acids with rather more than two moles of hydrazine; the recurring polar linkage in these polymers is a 4-amino-1 : 2 : 4-triazole ring. Mr. J. W. Fisher (British Celanese, Ltd.) gave an account of the chemistry and use of "Polyaminotriazoles as Fibre-forming Materials". A typical polyaminotriazole, that based on sebacic acid, has a melting point of 256° C. and can be melt-spun and cold-drawn to give yarns with mechanical properties generally similar to those of nylon or 'Terylene' and which can readily be dyed with dispersed acetate and wool colours. A structure of the polymer, as shown by X-ray examination, was proposed, involving a planar chain in which the octamethylene segments zig-zag at an angle of 20° on either side of the general fibre axis, and a resonant triazole ring; hydrogen-bonding between exocyclic amino-groups and nitrogen atoms in another ring is thought to be responsible for the high melting point of the polymer.

Turning to a subject related to the production of synthetic fibres from a natural material, Dr. W. E. F. Naismith (Nobel Division, Imperial Chemical Industries, Ltd.) discussed the "Chemical Denaturation of Groundnut Protein and Fibre-Formation". The globular proteins of groundnut must first be converted to an unfolded configuration (denaturation) before they can be spun: the denaturation by urea, guanidine salts and a series of organic bases has been investigated by measurement of the rise in viscosity increments of the solutions, and interpreted in terms of an increase in asymmetry of the protein molecules, using Simha's equation to calculate axial ratios. A definite relationship has been found between the ability of a base to cause rise in viscosity increment, and its ability to give spinnable solutions.

Few fundamental studies have been published of the industrially well-established processes for preparing polyamides from compounds containing carboxylic acid and amino-groups or by opening lactam rings. Dr. A. B. Meggy (University of Leeds) outlined a new thermodynamic method of attack in a paper on the "Free Energy of Formation of the Amide Bond in Polyamides". Equations were deduced in the case of the equilibrium between carboxyl, amino and amide groups and water molecules, relating the equilibrium constant k', the number-average chain length and the partial pressure of water. The effect of the presence of a cyclic monomer in amount determined by a second equilibrium constant k_1 was discussed, in cases where 5- to 8-membered rings might be formed. From somewhat limited data on the variation of k_1 with temperature T for ε-caprolactam, the heat of formation ΔH, entropy ΔS and free energy ΔF of the polyamide bond in polyaminocaproic acid have been calculated; the value of ΔH obtained agrees well with the experimental value. In the subsequent discussion, Dr. J. Saunders referred to other data on k_1 versus T which give a ΔH value according to Dr. Meggy's method which is considerably too high.

During the second session, Prof. J. B. Speakman (University of Leeds) assumed the chair. Dr. L. B. Morgan (Dyestuffs Division, Imperial Chemical Industries, Ltd.) discussed "Crystallization Phenomena in Fibre-Forming Polymers", his paper being illustrated by an excellent film showing the crystallization of polyethylene terephthalate from its melt, in spherulitic structures. Dr. Morgan's main thesis was that, after nucleation, preferential crystal growth takes place along the direction of the polymer chains rather than by sideways accretion, and that, during growth, coiling occurs with the formation of long helical polymer crystals. The ultimate result is the formation of coiled families of fibrillar crystals, which explains a good many of the physical characteristics of crystalline polymers, particularly the fact that in the spherulites the chains are known to be arranged tangentially. This paper provoked a great deal of controversy. Mr. C. W. Bunn was very doubtful if the physical evidence, particularly from electron microscopy, really justifies the theory of helical coiling, for which, in a perfectly symmetrical polymer, there is no apparent reason. Dr. L. R. G. Treloar also failed to see how helical structures of the size required by Dr. Morgan's theory could be formed.

Dr. G. Meacock (British Nylon Spinners, Ltd.) gave an account of the "Production of Fibres from 6,6-, 6,10- and 6-polyamides"; although the 6,6-polymer is somewhat less thermally stable than the other two, it has a higher melting point and greater strength at high temperatures. While all the polymers can be spun by similar methods to give similar fibres, the 6-polymer has the disadvantage of evolving its monomer during spinning, which complicates the process.

Dr. J. A. Chapman and Dr. J. W. Menter (University of Cambridge) then gave a brief account of some work they have been doing on the examination of fibre surfaces by reflexion electron microscopy. The micrographs exhibited show this to be a powerful method for observing the effect of frictional wear.

Cold-drawing and, in particular, 'necking' in fibres has until very recently been something of a mystery, which the authors of the next paper, "The Drawing of Terylene", by I. Marshall and A. B. Thompson (Terylene Council, Imperial Chemical Industries, Ltd.), have done much to clear up. Their paper was also illustrated by a fascinating film of the experimental drawing apparatus in action. By a consideration of load extension curves at various temperatures, the position of the draw point can be predicted; but complications arise owing to the crystallization of 'Terylene' during the process, and to necking. When necking takes place during the passage of the filament over a heated plate, the draw point only remains fixed relative to the plate over a fairly narrow range of draw ratios and temperatures; outside these limits, the draw point retreats to the feed roll or advances to the draw roll. The theoretical interpretation of these facts was given. During the discussion, Dr. H. T. Hookway commented on the relationship between second-order transition temperatures and temperatures at which necking could occur. Dr. D. V. N. Hardy mentioned a number of phenomena associated with the heat generated at the neck.

R. A. Horsley and J. Jack (B.X. Plastics, Ltd.) turned to the subject of vinylidene chloride copolymers, and gave details of the "Extrusion Properties of Saran Monofilaments". They described a commercial machine for extruding and stretching saran, and discussed various points of design. The effect on tensile strength, loop strength and elongation of variables such as distance between die and quench bath, stretch ratio, quench bath temperature and stretching temperature were given.

The symposium chairman on the third day was Mr. J. Wilson, director of the British Rayon Research Association. The first speaker was Dr. A. R. Urquhart (Shirley Institute, Manchester), who read a paper on "Cellulose Acetate as a Raw Material for Rayon Production". After giving a historical account of the development of 'secondary' acetate rayon, Dr. Urquhart went on to compare some of the properties of acetate with those of nylon, 'Orlon' and other synthetic fibres, with particular reference to subjective qualities such as drape and compliance; 'Terylene' and 'Orlon' staple fibres approach acetate and wool in these respects. The water absorption of acetate is lower than that of viscose, but higher than that of nylon, 'Terylene' or 'Orlon', which gives the latter fibres an advantage in rate of drying after washing; however, considerations of hygiene and comfort require that a fabric should be able to absorb a considerable amount of moisture, and rate of drying is really only a secondary consideration. A vigorous discussion was held on this paper, contributions being made by Dr. Corbiere, Dr. E. Kornreich, Mr. J. G. P. Baker and Dr. R. M. Lodge, and it was obvious that views on the comfort to the wearer of the various synthetic fabrics were somewhat divided; it was pointed out that the fabric construction is important, and that one outstanding property might for some purposes outweigh many other considerations.

Dr. T. H. Morton (Courtaulds, Ltd.), in his paper on "Textile Properties of Synthetic Fibres", also referred to the importance of those properties of a fabric which for assessment require a certain amount of subjective judgment, and in a detailed discussion graded various old and new fibres in a number of classes. All the established fibres have some good points and some properties which can be improved. It is not possible to say that one fibre is better than another, since they all have particular fields in which they are specially useful. Dr. Morton suggested that it will be a very long time before the 'perfect' fibre, having ideal properties in all respects, is produced. Nevertheless, the textiles obtainable using the present materials, alone or blended, cover a very wide range of properties. This paper also was followed by considerable discussion. In regard to dyeing hydrophobic fibres, the difference between what is possible and what is regarded as practical to the dyer was pointed out. The cohesion of cellulose fibres is dependent on secondary valency forces, some details of which were given by Dr. J. Mann and Dr. H. J. Marrinan (British Rayon Research Association) in their paper on "Hydrogen Bonding in the Crystalline Regions of Cellulose". The study of infra-red absorption changes on interaction of cellulose and heavy water enables stretching of the hydroxyl groups in the crystalline and amorphous regions to be observed independently. All the hydroxyl groups in the crystalline regions of regenerated and bacterial cellulose are found to be hydrogen-bonded, which rules out certain previously proposed crystal structures. Hydrogen bonds of types O—H . . . . O and also H . . . . O—H . . . . O are present in regenerated cellulose. Commenting on this paper, Dr. L. Valentine referred to regions in cellulose acetates and trimethyl cellulose found to be inaccessible to water vapour; such regions are presumably crystalline.

The static electrification of textile fibres is well known, and often troublesome. Prof. E. Darmois (Paris), in a résumé of work on this subject, pointed out that wool and silk become positively charged on rubbing, but polyvinyl chloride fibres ('Rhovyl') become negatively charged. A blend of 25 per cent polyvinyl chloride fibre and 75 per cent wool takes on no charge at all. Prof. Darmois outlined his theory of these effects.

The chairman, Mr. J. Wilson, summed up the symposium. He observed that a wide range of topics had been covered, some of which are individually worth a complete meeting for themselves, having regard to the large amount of work which is going on and to the vigorous discussions which were held, particularly on the subjects of crystallinity and the relationship between fibre and fabric properties.

THE WORKER IN INDUSTRY

INTRODUCING a joint paper presented to the annual conference of the British Institute of Management at Harrogate in 1953, K. H. F. Murrell, director of the ergonomics department of Tube Investments, Ltd., stated that the main contribution of the psychologist to industry would be in studying the effect of bad equipment design on the health and efficiency of workers on a long-term basis. This would include such factors as the posture, either seated or standing, which the equipment imposes on the worker, and which may follow either from the shape of the equipment or from the design of its controls; the actual methods by which work is done, such as the application of force in an unnatural position; and the conditions of heat or noise under which he has to work. Much of industry works below maximum efficiency because it has, through neglect of physiological principles, partly 'worn-out' its working force. The most important contribution of the psychologist might be summed up as attempting to answer various aspects of the question "What makes people behave as they do when confronted with a given situation and what can be done about it ?" Some of these aspects might be: What is a real incentive for people to work ? Why do people resist change ? Is there such a thing as fatigue in repetitive work or is it merely monotony or boredom ? What is the nature of skill in a particular task and how can it best be acquired ?

To be effective the research worker must be familiar with the worker on the job and, from his own experience, Murrell gave examples to show how good theoretical research had been ineffective because it had failed to take account of the actual work situation.

A. T. Welford, director of the Nuffield Unit for Research into Problems of Ageing in the University of Cambridge, described a closely connected series of studies on some problems of speed in human performance. Men of different ages from the twenties to the seventies were set to work at a task where they had to plot positions on a grid by moving a pointer. The older men were on average substantially slower than the younger, but the slowness was not due to slowness in moving the pointer; it was rather due to more careful and meticulous placing of it.

The same results appeared in several other tasks; an experiment was accordingly devised in which careful measurements were made of reaction times and movement times under conditions where they could be separated with certainty. A man doing a task sat in front of a panel of four lights. One of these came on and the operator had to move a lever in the corresponding direction as quickly as possible from a central point to an end stop and back again. As soon as he got back to the centre another light came on, and so on. When the results were examined it was found that the actual time moving did not increase but tended to fall with age. The time elapsing between a light appearing and the man beginning to move the lever did increase significantly. A further point with this was noticed, in that the oldest men, in their sixties, tended to fall slightly at the end stop. The older men appeared to be having difficulty in welding the out and back movements into a single whole. These experiments link with a number of other results to suggest an important general principle, namely, that it is the time taken over stationary portions of a manipulative task which are more deserving of attention. These tend to increase with certain types of fatigue.

Evidence would seem to be accumulating that it is not correct to think of a manipulative operation as consisting merely of a series of movements. It consists rather of a series of acts of perception either by the eyes or by touch or by sound which have to be translated into movement. It is the perception and translation by the central media of the brain which are the important components of the operation, and it is in terms of these that operators must be analysed for work study purposes if general results are to be obtained which apply more widely than to each individual operation studied.

Welford also said that, while relatively little interest has been shown by psychologists in training the industrial worker, there is great scope for further co-operation between experimenters and industry. One example of a study with important practical implications was the one carried out about four years ago by G. B. Gibbs, of the Medical Research Council. Gibbs studied the performances of men on a machine where the display-control relationships could be made easier or more difficult. He divided the men into two groups of equal ability and trained one, first on a relatively easy task, and then transferred them to one which was similar but in which the display-control relationships were more difficult. The other group were trained on the same two tasks but in the reverse order. The results showed clearly that the second group, after being trained on the difficult task, came to the easy one and performed it much better than they would have done if they had not had the previous difficult training. With the other group Gibbs found that the previous training on one easy task made no difference to their ability to perform the more difficult one.

Dr. H. D. Darcus, of the Climatic and Working Efficiency Unit of the Medical Research Council, stated that one of the possible approaches to the study of the activity of man at his work is to find out under what conditions the man may be allowed to work at his greatest physiological efficiency. Emphasis should be placed on the output of the man rather than the effort the man has to put in to achieve that output. This is probably acceptable in most work situations because the operator is only using a small proportion of his total capacity and he can be expected to do a little bit more without suffering physical harm. The load to which a man is subjected should be kept as low as possible to give him a reserve of effort, a reserve capacity. If that is done the problem of reduced capacity due to extremes of environmental conditions, hot climates, or due to disabilities or age, is not quite so acute because the load on the individuals working under those conditions or on the aged or disabled worker is still below their level of output.

What is the maximum capacity of the body for exercise? One approach has attempted to work out an endurance or tolerance limit, usually about 50 per cent of maximum capacity. When a person starts to work, physiological changes occur in the body, and these changes increase until a balance is struck between the energy he is putting out and his external work. He will go on using the same amount of energy for the same amount of external work, although not many people work at a steady rate. The endurance limit can be increased by training the individual to become physically fitter by acclimatization. One way to push the endurance limit up is to bring the load down, thereby reducing the effort to gain a given output. This endurance-level will fall with age, with certain disabilities and under extremes of temperature, and the safety level will become less and less.

This endurance limit is the maximum level at which a man can be expected to work over a period of time. During a long period of work, the energy output remains constant initially; but as time passes it is necessary to put out more energy because the efficiency of the muscles doing the job is becoming less and more muscles have to be used to produce the same result; more muscles demand more energy and the safety margin of effort becomes reduced. Provided this safety margin is not exceeded, the operator is paying as he goes; that is, he is getting sufficient oxygen to allow the energy for the muscles he is using. If this level of effort is exceeded, he no longer gets enough oxygen for his energy requirements. This condition can be maintained for a time; but the longer it goes on the bigger becomes the physiological debt. Another aspect of this is the use of rest pauses. In Great Britain it is usual to have a break in which the operators probably sit down. In Sweden, if work of a very cramped nature, such as sewing, tabulating or assembly, is being undertaken, they sometimes have Swedish drill, which is rather like organized ballet.

There is no one physiological method which will give an overall picture of man at work in all circumstances. If it is desired to use physiological methods for different measurements, the methods to be used for particular situations must be very carefully chosen, the results carefully integrated and finally interpreted with the utmost caution. The main difficulty at the present time is that these methods are mainly designed to investigate man working under extreme conditions, and these situations are very rare in industry.

The experimental approach is the one which will produce the best results, involving as it does formal scientific methods under controlled conditions. The first thing to do is to find out exactly what the problem is and then determine the main factors within that problem. One way of dealing with it is for research people to go out into industry with the industrialist to examine the problem and see if it really warrants research or if it can be dealt with by some other means. What is necessary is encouragement from industry itself, not so much on *ad hoc* problems, but for establishment of a long-term policy.

PROBLEMS OF AIRCRAFT NOISE

In reply to a question in the House of Commons on June 28, regarding progress in research by the Ministry of Supply into the silencing of aircraft engines, Mr. Duncan Sandys stated that work in this field is also being carried out by the Ministry of Transport and Civil Aviation and by universities and aircraft firms on their own initiative. In a detailed statement circulated in the Official Report, expenditure by the Ministry of Supply on this problem in the current year is given as £100,000 compared with £40,000 last year, and the Ministry of Transport and Civil Aviation is also expected to spend about £20,000.

The problem of reducing aircraft noise is being tackled from several angles. The main effort has been concentrated on jet engines. An extensive programme being carried out by a leading firm of engine makers, under contract by the Ministry of Supply, includes a detailed analysis of the noise of a jet engine operated with various alternative types of nozzle on an open-air test bed. The nozzles which are being tested include toothed, corrugated, convergent–divergent and fish-tail types. Promising results have been obtained from toothed and corrugated nozzles, and further studies are being made to decide the optimum shapes for these types. A special study of the by-pass engines in relation to the noise problem is being carried out, with the object of determining the relationship between noise, jet velocity and temperature. The effect on noise of injecting water into the jet stream is also being investigated.

Two other engine companies are working under Ministry of Supply contract on silencers for piston engines used in helicopters. The Ministry of Transport and Civil Aviation is experimenting with the construction of a brick baffle-wall at London Airport. This wall is shaped to accommodate the forward part of a large civil aircraft, with the object of reducing noise in certain directions when the engines are being run on the ground. Results are not yet entirely satisfactory, but the investigation is being continued. The Ministry of Supply has placed a contract for the design of two types of mobile ground mufflers, one suitable for single-engine aircraft and the other for multiple-engine aircraft. Experiments by a firm of aircraft manufacturers with portable screens, which are placed around the aircraft while the engine is being run up, showed some reduction of noise, and further screens are on order. A firm of consulting engineers is advising four other aircraft manufacturers on the use of specially designed pens for muffling the sound of aircraft the engines of which have to undergo running tests on the ground. Another firm, on its own initiative, is building a pair of mobile ground mufflers to its own design.

Tests being carried out by the College of Aeronautics, Cranfield, under Ministry of Supply contract, include the following: the measurement of thrust and noise-levels of engines with nozzles fitted with noise-reduction devices of various designs; the measurement of the sound field from small jets at supersonic speeds, combined with schlieren investigations; and the measurement of the turbulence structure in the mixing region at the jet exit, both at low and high speeds. Laboratory work being carried out at the University of Southampton, which is supported by the Ministry of Supply, includes the development of a shock tube for recording the interaction between an eddy and a shock wave; the development of an optical eddy-counting technique, including a focusing device; the measurement, by means of the hot-wire technique, of turbulence, velocity and temperature distribution along the jet; the examination of noise from jets of non-circular shape; and the study of noise emitted from special jet extensions, with annular corrugated orifices, designed to reduce low-frequency noise. Important fundamental research on the origin and nature of jet noise is also proceeding at the Universities of Manchester and Edinburgh.

The problem of aircraft noise was also debated in the House of Lords on July 7, when, for the most part, the question of legislation and responsibility for minimizing noise was discussed. Lord Hawke said that perhaps the most hopeful line of approach is in experiments with devices which act upon the gas when it leaves the jet and provide something in the nature of a gigantic exhaust box.

PHYSICAL SOCIETY

ANNUAL REPORT FOR 1953

At the annual general meeting of the Physical Society, held at the Royal Institution, London, on May 25, the reports of the council and of the honorary treasurer and the accounts and balance sheet for 1953 were presented and adopted. During the year the membership rose by 29 to 2,130, and the sale of publications continued to increase both at home and abroad. The new scheme of subscriptions which came into operation on January 1, 1953, by which subscriptions for publications are separated from the subscriptions for membership, has worked smoothly and appears to be serving better the needs of members. There has also been a steadily growing interest in the reprint service which was introduced at the same time. The treasurer's report shows that any loss of income resulting from the lowering of the Fellows' subscription from three to two guineas has been more than compensated for by the increased income from the sale of publications of the Society. The cost of the provision of *Science Abstracts*, now no longer provided to members, was reduced from approximately £2,500 to £500. The income accruing to the Society as a result of the publication of the "Handbook of Scientific Instruments and Apparatus", the catalogue of the Society's 1953 exhibition of scientific instruments and apparatus, was considerable, amounting to nearly £4,000, and the balance of income over expenditure for the year was £1,794.

In addition to five science meetings held in London during the year, two-day meetings were held at the University of Leeds during March 31–April 1, and at King's College (University of Durham), Newcastle upon Tyne, during July 13–14; a conference on ionization phenomena in discharges, sponsored jointly by the Electrical Research Association, the Institute of Physics and the Physical Society, was held at the Clarendon Laboratory, Oxford, during July 18–23. The thirty-seventh Guthrie Lecture was delivered by Prof. Max Born, who spoke on the conceptual situation in physics and its prospects of development. The eighth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society were presented to Mr. J. A. Ratcliffe in Paris in May, when Mr. Ratcliffe delivered the Holweck Discourse on the subject of diffraction of radio waves by the ionosphere. Prof. J. Bartels, of the University of Göttingen, received the seventh Charles Chree Medal and Prize on October 23, and for his address described Chree's influence on present-day geophysics. The thirtieth Duddell Medal was presented to Prof. W. Sucksmith, who gave a talk on "Some Magnetic Measurements—Techniques and Applications", and the ninth Charles Vernon Boys Prize to Prof. F. C. Williams, who spoke on "Cathode-Ray Tube Storage for Digital Computers".

Brief details of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustics Groups, together with a list of the numerous bodies on which the Society is represented, are given in the annual report. The activities of the Groups were not so varied as in former years, though the usual science meetings and summer meetings were held. The expenditure of the Groups fell markedly during the year, and, although the expense of the Groups to the Society was thus less than usual, it is emphasized that this is not a healthy sign since the activities of the Groups are vital to the welfare of the Society and any financial commitment entailed in their activities is more than offset by the contribution made by the Groups to the well-being of the Society.

At the annual general meeting the officers and council of the Society for 1954–55 were elected as follows: *President*, Prof. H. S. W. Massey; *Vice-Presidents in addition to ex-Presidents*, Mr. J. H. Awbery, Dr. R. C. Evans, Dr. A. B. Wood and Prof. S. Devons; *Honorary Secretaries*, Dr. C. G. Wynne, Dr. H. H. Hopkins; *Honorary Foreign Secretary*, Prof. E. N. da C. Andrade; *Honorary Treasurer*, Mr. A. J. Philpot; *Honorary Librarian*, Dr. R. W. B. Pearse; *New Ordinary Members of Council*, Dr. T. E. Allibone, Dr. A. H. Cooke, Prof. F. C. Frank and Prof. G. O. Jones.

ARTIFICIAL AND NATURAL COLORATION OF DIAMONDS

Most diamonds in their natural state are coloured; but the origin of the colour is still largely a mystery. There is little evidence that it is due to impurities, nor is it clear as to whether the colour is generally confined to the surface or distributed throughout the diamond, though in some cases, usually diamonds coloured yellow or yellow-green, the colour has been reduced or removed by polishing and grinding the surface. The colour has then been attributed to natural radioactivity. In 1923, S. C. Lind and D. C. Barwell established that diamonds were coloured green by bombardment with alpha-particles from radium, and there have been several reports during the past decade of the colouring of diamonds by proton and deuteron bombardment, though beta-, gamma- and X-rays seem to have little or no effect. The evidence suggests that diamonds are more readily coloured by energetic heavy particles. This supports the theory that the colour centres are connected with the vacant lattice sites and interstitial atoms formed when the bombarding particles collide with the carbon atoms of the diamond lattice.

A recent study by R. A. Dugdale of the effect of neutron bombardment of diamonds in the Harwell pile BEPO and of high-energy electron bombardment and of subsequent heat treatment confirms this view

(*Brit. J. App. Phys.*, 4, 334; 1953). The pile radiation induced a green colour which deepened as the irradiation proceeded until the diamond actually became opaque, usually after about one week of irradiation. The changes in the absorption and fluorescence spectra which occurred on subsequent heating of the irradiated diamonds to various temperatures up to 1,000° C. were studied visually, using a simple glass-prism spectrometer, and twenty-one specimens were examined in some detail. The effect of heating five natural green diamonds was also studied. Their general behaviour was similar to the irradiated specimens. Some twenty small blue-fluorescing colourless diamonds were coloured by bombarding them with electrons of ½, 1 and 3 MeV. energies, and the 3-MeV. bombarded specimens on subsequent heating behaved in much the same way as those coloured in the pile.

In the discussion of his observations, Dugdale refers to Seitz's statement that about 25 eV. recoil energy is needed for a carbon atom in diamond to be displaced, by bombardment, from its normal lattice site to an interstitial site, and estimates that 0·001 per cent of the atoms in diamond become Frenkel defects in a ten-hour irradiation in the pile. The plausible explanation advanced is that the green colour is associated with the lattice defects, and subsequent heating produces some mobility of the defects with some recombination and thus some reduction in the intensity of the colour.

ALLOY JUNCTION TYPE OF TRANSISTOR

A SPECIAL article entitled "New Advances in the Junction Transistor", by E. W. Herold, of the R.C.A. Laboratories Division, Princeton, N.J., which is printed in the April issue of the *British Journal of Applied Physics* (5, 115; 1954) will be of particular interest to solid-state physicists and to electronic engineers. The article is based on a lecture delivered by Mr. Herold in London on October 20, 1953, and in it a survey is given of recent research conducted in the United States into the alloy junction type of transistor which is now likely to supplant the older point-contact form. Taking as an example n-type, single-crystal germanium with indium as impurity, Mr. Herold describes first the various steps in the formation of a transistor junction where a technique involving alloying is utilized. A piece of indium is placed on the germanium, and the temperature is raised until the indium melts. On heating further the molten indium becomes saturated with germanium, and then, when the temperature is lowered, the germanium crystallizes out into indium-contaminated p-type form. The position and shape of the junction formed are, in principle, closely controllable by variation of the contact area between the p-type germanium and the n-type base, the volume of indium and the maximum firing temperature; but, in practice, surface wetting is a possible variant which must also be controlled.

The p–n–p alloy junction transistor made by using two junctions on opposite sides of a thin germanium wafer is considered next, and its performance is discussed in terms of the current amplification factor α. The effects of the geometry, surface combination and emitter current injection on α are separately analysed, and the high-frequency limitations and the equivalent circuit of the junction transistor are described in some detail. It is shown that the chief factors limiting frequency response can be reduced in magnitude in an improved p–n–p radio-frequency amplifier transistor, the details and dimensions of which are given, and which are compared with the earlier type *TA*153. Measured values show that the base-lead resistance is reduced by 5, the barrier capacitance by 3·5 and the diffusion capacitance by about 20 times, but the resistance between collector and base is less than that of the type *TA*153 transistor. Hence, α remains about the same with partial sacrifice of low-frequency gain but with great improvement in high-frequency performance. The improved form of transistor has an upper oscillation limit between 40 and 75 Mc./s.

Finally, an experimental all-transistor personal broadcast set using six of the new radio-frequency transistors and three other transistors is described. It is smaller in size than the battery-operated all-valve receiver sold in the United States under the designation 'personal portable', has about twice the audio-frequency output power and runs off a battery consisting of six ordinary flashlight cells lasting 500 hours.

MEASUREMENT OF ELECTRODE POTENTIALS IN LIVING AND DEAD TISSUES

By DR. D. B. CATER and DR. A. F. PHILLIPS

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IN the course of an investigation of the effect of oxygen on tumour tissue, a method has been developed for measuring platinum electrode potentials in tumours and normal tissues. Using rats bearing either Walker carcinoma 256 or Jensen sarcoma, definite potentials are obtained which respond in characteristic ways to various experimental procedures, such as the administration of oxygen, or the injection of 2-methyl 1:4-naphthohydroquinone diphosphate ('Synkavit')[1]. Different methods of killing the animal result in markedly different and characteristic changes in the electrode potentials.

The electrodes consist of fine platinum wires, insulated by a coating of 'Araldite 985E', supplied by Aero Research, Ltd., Duxford, Cambs. A bevel is ground at the end, and this is scraped clean with a glass knife to produce a bright platinum surface of small dimensions. Cemented alongside the wire, leaving 1 cm. projecting, is a short plastic guide tube, through which can be passed a modified hypodermic needle having a bevel 1 cm. long. The hypodermic needle is used to guide the wire into the tissues, after which the needle is withdrawn, leaving the electrode *in situ*. The electrodes can be sterilized by boiling, and are suitable for insertion into animal or human tissues with a minimum of trauma. Small silver – silver chloride electrodes are used to complete the circuit; it does not make any difference into what tissues these are inserted. Simultaneous measurement with a glass electrode records any changes of pH. Glass electrodes of capillary form have been used, both made by us using the method of Voegtlin *et al.*[2] as modified by Kahler and Robertson[3], and as supplied by the Cambridge Instrument Co., Ltd. The impedance of these ranges from 2 to 10 × 10^8 ohms.

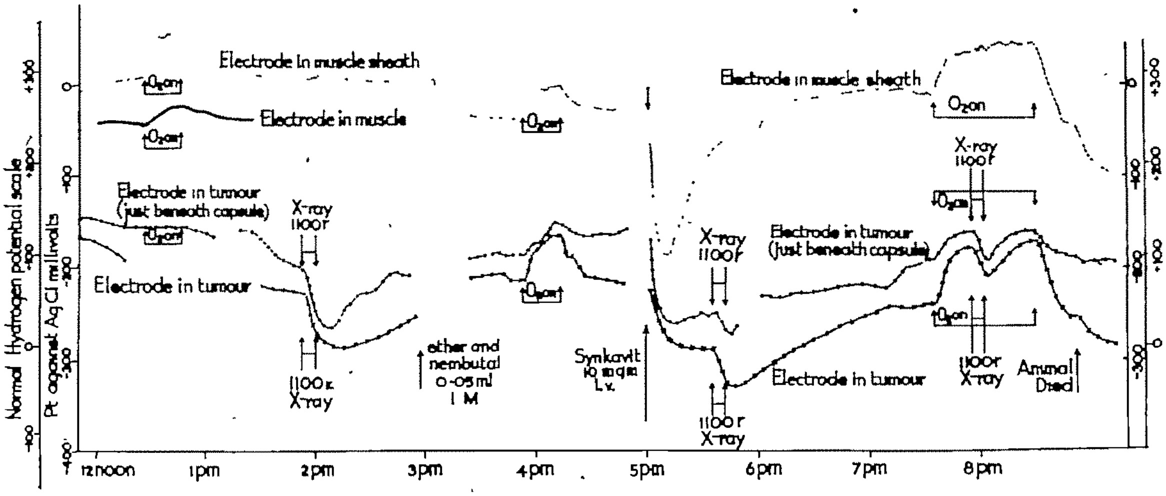

Fig. 1. Effect of oxygen, 'Synkavit' and X-rays, alone or in combination, on platinum electrode potentials in Walker carcinoma

The potentials are measured with an electrometer valve circuit, slightly modified from DuBridge and Brown[4]. The measurement is by a null method, in which the potential difference can be balanced to within 1 mV. in the four ranges 0 to ± 0·5 V. and 0 to ± 1 V. The input impedance is 5 × 10^{11} ohms, which is high enough to prevent polarization even when the potentiometer is temporarily out of balance. By attention to proper insulation and earthing it is possible to take readings with each type of electrode during experimental procedures, including irradiation by means of a 220-kV$_p$. X-ray generator. Complete electrostatic shielding of the animal has not been found essential.

In some experiments two platinum electrodes and a glass electrode are inserted into the tumour and one platinum electrode into muscle. Each electrode is connected to a separate co-axial cable. About four readings a minute can then be taken, which makes it possible to study the changes of potential at the four different electrodes. Fig. 1 shows a typical experiment. Note (1) the rise in electrode potential when the animal breathes oxygen, (2) the marked fall in potential, followed by slow recovery, after intravenous injection of 'Synkavit', (3) that X-rays (1,100 r. at 220 kV$_p$.) cause a fall in potential at the irradiated electrodes in the tumour, with no change at the non-irradiated electrode in muscle. A second dose of X-rays after 'Synkavit' still results in a potential drop, but oxygen administered during a third dose of radiation increases the speed of recovery.

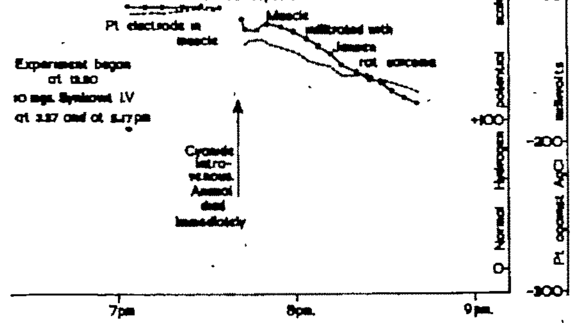

Fig. 2. Effect of death by cyanide on platinum electrode potentials

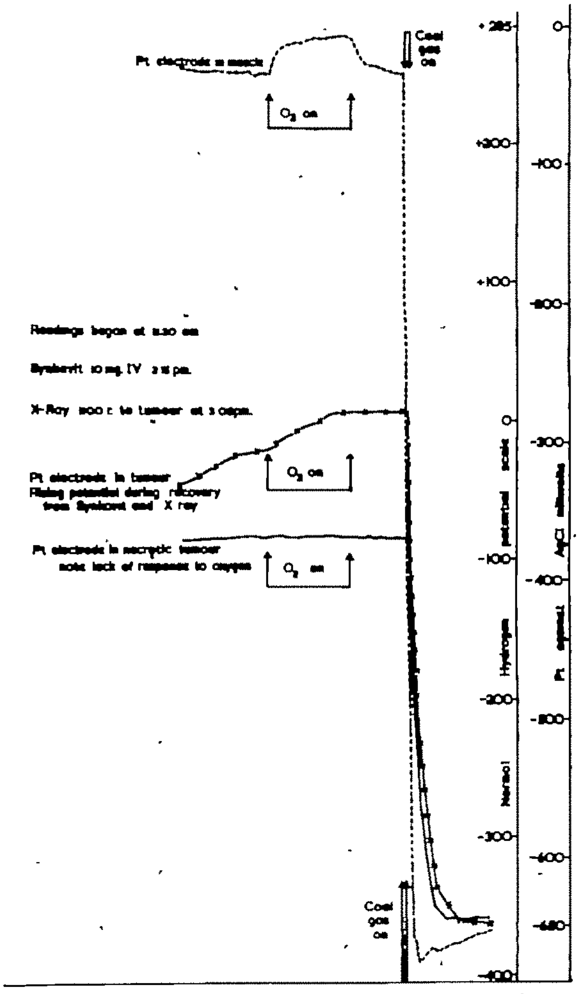

Fig. 3. Effect of death by carbon monoxide on platinum electrode potentials

Fig. 2 shows that when the animal is killed by intravenous injection of cyanide, the electrode potentials remain practically unchanged for 10 min. and then fall very slowly. Death from ether gives a similar slow fall. Compare this with the rapid fall of potential which occurs at all electrodes after death from coal gas as shown in Fig. 3.

The pH changes recorded by the glass electrode are small and cannot account for the large changes of potential at the platinum electrodes.

The exact meaning of the electrode potentials described here may be difficult to interpret. Preliminary experiments have been made to follow changes of oxygen tension by measuring the current flowing through one of the platinum electrodes when a suitable negative potential is applied[5]; these suggest that our measurements of electrode potentials are not merely dependent upon tissue oxygen tension. We are working upon the hypothesis that the potentials are closely related to the oxidation-reduction potentials of one or more of the respiratory enzymes of the tissue, and to the substrate potentials in the case of coal gas poisoning.

Our thanks are due to Prof. J. S. Mitchell for advice and encouragement, to Mr. R. Stearn for expert technical assistance, and to the Corning Glass Works for supplying us with Corning 015 glass. One of us (D. B. C.) acknowledges a British Empire Cancer Campaign research fellowship, and the other (A. F. P.) a Beit Memorial fellowship.

[March 22.

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A NEW METHOD FOR THE COLORIMETRIC ESTIMATION OF AMINO-ACIDS ON PAPER CHROMATOGRAMS

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A SHORT review of many of the earlier published methods for the estimation of amino-acids on paper chromatograms has been given in a paper by Thompson, Zacharius and Steward[1].

The present method was required, in the first instance, in connexion with experiments on the reaction between amino-acids and keto-acids in the presence of trans-aminase enzymes from wheat and barley. The amino-acids under consideration were glycine, alanine, phenylalanine, and aspartic and glutamic acids; because of this, investigation of the present method has been limited largely to these amino-acids, though it is clearly capable of a much wider application, especially in connexion with the science of food and nutrition.

The principle of the method is that the amino-acids are quantitatively converted on the paper into their yellow 2 : 4-dinitrophenyl (DNP) derivatives by treatment with 2 : 4-dinitro-fluorobenzene (DNFB), and these derivatives serve both to locate the position of the amino-acid and as a basis for the subsequent colorimetric estimation. The absorption spectra of the various dinitrophenyl amino-acids are very similar. However, treatment of the amino-acid on the paper with the large excess of dinitro-fluorobenzene necessary to ensure complete conversion to the corresponding dinitrophenyl derivatives results in the formation of a large excess of 2 : 4-dinitrophenol, which seriously interferes with any simple colorimetric estimation of the dinitrophenyl amino-acids. The present method, in fact, hinges on the discovery that the latter can be separated from dinitrophenol by dissolving the mixture in 91 per cent w/w sulphuric acid and extracting the dinitrophenol with benzene. In this strongly acid medium the dinitrophenyl amino-acids ionize as mono-acid bases and are insoluble in benzene. At lower concentrations of sulphuric acid the dinitrophenyl amino-acids are present in the normal un-ionized form and can be readily extracted with organic solvents. In practice, after the removal of the dinitrophenol, the solution of the dinitrophenyl amino-acid in 91 per cent sulphuric acid is diluted to 30 per cent and extracted with a mixture of *tert.* amyl alcohol and benzene. The dinitrophenyl amino-acid is finally transferred to an aqueous solution of sodium bicarbonate for colorimetric estimation.

The discovery of a method by which dinitrophenyl amino-acid can be separated from dinitrophenol is important even apart from the present study. The method has been used[2] to effect a clean separation of dinitrophenyl glycine from the hydrolysis products of casein which had been treated with dinitrofluorobenzene. Certain impurities which could not otherwise be removed were separated by dissolving the crude dinitrophenyl glycine obtained by the Sanger method[3] in 91 per cent w/w sulphuric acid and following the procedure described later.

Chromatographic separation of the amino-acids. These were separated on paper chromatograms, the apparatus and general conditions of development being substantially the same as those described for the phosphoric esters[4]. Two solvent systems were used. A single-phase mixture of *n*-propanol–water (80 : 20 vol.) was used for the mono-amino monocarboxylic amino-acids and a mixture of *n*-propionic acid – *tert.* butanol – water (60 : 30 : 10 vol.) for the separation of the two dicarboxylic amino-acids. The distances travelled by glutamic and aspartic acids and alanine on Whatman No. 1 paper in 15 hr. with these two solvents were 2·0, 1·3, 8·8 and 11·8, 8·0, 18·6 cm., respectively.

The solvent was removed from the chromatogram by hanging the paper in a current of air for 3–4 hr.; in the case of the second solvent, the last trace of *n*-propionic acid was removed by steaming the papers for a short time. Experience has shown that cellulose adsorbs a number of compounds such as *n*-propionic and acetic acids and phenol very tenaciously, and even long drying at 100° will not remove them. In the presence of water vapour, however, they are readily displaced from the paper.

The filter paper was chromatographically washed[4] to remove soluble impurities. Each paper was washed separately with 2 N acetic acid, water and 10 N ammonia. Tests have shown that this gives the most

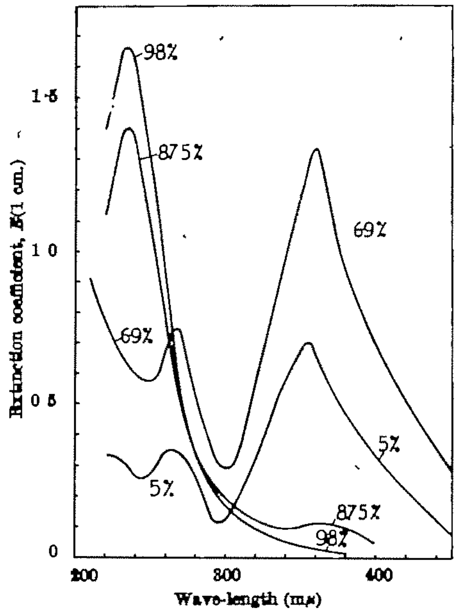

Fig. 1. Absorption spectra of dinitrophenyl glycine in various concentrations of sulphuric acid. Concentration of dinitrophenyl amino-acid, $M \times 10^{-4}$

satisfactory results. Washing filter papers[4,5] in the form of a pad does not seem so reliable, and it may be that the washing liquid tends to run through the capillary spaces between the papers rather than through the papers themselves.

Conversion of the amino-acids to their dinitrophenyl derivatives. The equivalent of 3–5 μl. of a 0·02–0·001 *M* solution of the amino-acid under investigation (in experiments on enzymes the total concentration of all amino-acids might be much larger) was present on the chromatogram. This was sprayed, as evenly as possible, at the rate of 5 ml. per 100 $cm.^2$ with a freshly prepared solution of dinitro-fluorobenzene in alcohol containing a borate buffer. An all-glass throat spray was used and the operation was carried out under a hood. The solution contained 0·06 gm. dinitro-fluorobenzene, 33 ml. of ethanol and 17 ml. of 0·2 *M* borate buffer *p*H 8·4 except in the case of the two dicarboxylic acids, when a 0·2-*M* borate buffer *p*H 10·0 was used. The amount of dinitro-fluorobenzene on the paper represented about 40 equivalents of amino-acid at the highest concentration at which they were applied to the paper (0·02 *M*). The reaction proceeded slowly in the cold but was very rapid at temperatures of 50–100° C. The recommended method is to heat the papers after spraying in a closed water-jacketed oven[4] at about 80° C. for 30 min., though successful results were obtained if the sprayed papers were left overnight in the dark at room temperature.

The detection of the amino-acid spots on the chromatogram was normally easy; but if the amount of amino-acid was very small, the paper was bleached by exposure to hydrogen chloride gas. The background colour, which was usually a pale yellow, was changed to white, and the dinitrophenyl amino-acids remained as orange-yellow spots. The limit of detection is about 0·0005 *M* calculated in terms of the concentration of the solution applied to the 'starting line' of the chromatogram.

Separation of dinitrophenol from dinitrophenyl amino-acids. This is effected by dissolving the mixture in strong sulphuric acid and extracting the dinitrophenol with benzene. The dinitrophenyl amino-acids are ionized in this medium and are not soluble in benzene.

The concentration of sulphuric acid which would cause the ionization of dinitrophenyl amino-acids but not of dinitrophenol was determined by a study of the absorption spectra of the dinitrophenyl amino-acids in various strengths of sulphuric acid. The simple fact that most organic acids and bases have absorption spectra which differ materially from those exhibited by the corresponding anions or cations means that the ionization can be followed by the change in absorption spectrum[6]. In Fig. 1 is shown the absorption spectra of dinitrophenyl glycine in 5, 69, 87·5 and 98·4 per cent (w/w) sulphuric acid, and in Fig. 2 that of dinitrophenyl phenylalanine in 69, 88 and 91 per cent (w/w) sulphuric acid. Inspection of the curves for dinitrophenyl glycine shows that the general appearance is the same in concentrations of sulphuric acid from 5 to 69 per cent, the change in the medium altering the extinction coefficient at all wave-lengths to much the same extent. In 98 per cent (w/w) sulphuric acid the dinitrophenyl glycine is almost certainly completely ionized, and it is significant that the absorption spectrum is very different from that in 69 per cent (w/w) sulphuric acid. In concentrations of acid between 69 and 98 per cent the absorption spectrum changes markedly, and this rapid change must be attributed to the presence in solution in varying amounts of two substances, one of which has an absorption curve like that in 69 per cent (w/w) acid and the other like that in 98 per cent (w/w) acid. Assuming the latter is due to the ionized form, a rough calculation based on the extinction coefficients at 350 mμ suggests that in 87·5 per cent acid at least 88 per cent of the dinitrophenyl glycine is ionized, and in 91 per cent acid at least 95 per cent: dinitrophenyl phenylalanine (Fig. 2) behaved similarly.

Examination of dinitrophenol under similar conditions showed that there was only slight ionization in 87·5 per cent w/w sulphuric acid, and even at

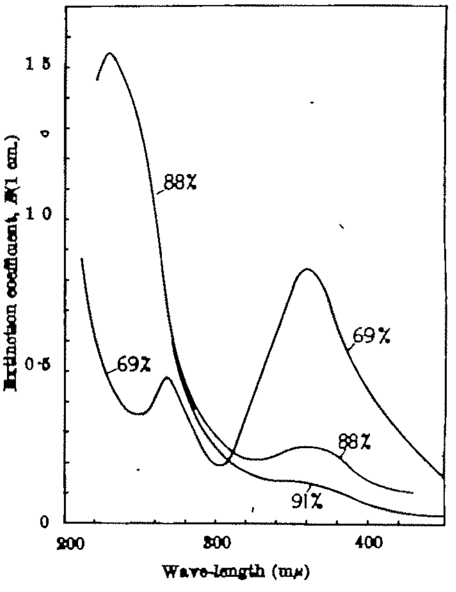

Fig. 2. Absorption spectra of dinitrophenyl phenylalanine in various concentrations of sulphuric acid. Concentration of dinitrophenyl amino-acid, $M \times 10^{-4}$

91 per cent it was not sufficient to interfere with the benzene extraction.

The theoretical treatment of the ionization is complicated by the fact that the dinitrophenyl amino-acids can ionize in two different ways. It is of interest that both benzoic and phenyl acetic acids are slightly stronger bases than dinitrophenyl glycine in sulphuric acid.

Recommended procedure. The analytical procedure based on the observations described above was as follows.

The piece of paper containing the dinitrophenyl amino-acid was cut from the chromatogram and then eluted with a solution containing 5 ml. of 0·2 *M* borate buffer (*p*H 8·4) and 10 ml. of alcohol. The extract (0·5 ml.) was collected in a standard test-tube (15 cm. × 1·5 cm.). Practically all the subsequent operations were carried out in this test-tube to avoid the losses which occur if solutions are transferred from one vessel to another. The alcoholic extract in the test-tube was evaporated to dryness by blowing a stream of cold air into the test-tube, and to the residue was added 1 ml. of 91 per cent (w/w) sulphuric acid. The test-tube was shaken for a few seconds until the dinitrophenyl amino-acid had dissolved. The solution was then shaken with 3 ml. of purified benzene for 3 min. A mechanical shaker (the 'Microid' shaker, by Baird and Tatlock, is suitable for this purpose) was used, and it was essential to obtain a thorough mixing of the two layers without the shaking becoming so violent that liquid was ejected from the tube. After standing for 5 min., the two phases completely separated and the benzene layer was sucked into a pipette with a fine tip, care being taken not to remove any of the sulphuric acid layer. The extraction was repeated five times. (The benzene used was purified by shaking it repeatedly with fresh 98 per cent (w/w) sulphuric acid until the acid layer was no longer coloured, washed with water and dried over sodium sulphate.) The solution of dinitrophenyl amino-acid in the 91 per cent (w/w) sulphuric acid was now free from dinitrophenol.

To recover the dinitrophenyl amino-acid, the acid layer was diluted to about 30 per cent by the addition of 2 gm. crushed ice and then extracted with an organic solvent. During the addition of the crushed ice, the test-tube was immersed in an ice–alcohol cooling-bath and shaken until the ice had dissolved. Tests showed that the temperature did not rise above − 6° at any time, and under such conditions no destruction of dinitrophenyl amino-acids took place. Without external cooling, the temperature may rise 40°–50° momentarily. When the ice had dissolved, the solution was removed from the cooling-bath. The dinitrophenyl amino-acid was then extracted by shaking with 3 ml. of 10 per cent (v/v) *tert.* amyl alcohol in benzene (the dinitrophenyl derivatives of most amino-acids are soluble but that of phenylalanine is best extracted with 5 per cent alcohol) and allowed to stand 5 min. The clear upper layer was carefully sucked up into a pipette and the extraction repeated twice. The combined extracts were then shaken with 1 ml. of a saturated aqueous solution of sodium bicarbonate and allowed to stand. 0·5 ml. of the clear aqueous layer was run into a 1-cm. glass micro cell and the extinction coefficient measured using a Hilger photoelectric colorimeter at either 3650 A. or 4047 A. Since the absorption spectra of the different dinitrophenyl amino-acids varied slightly, the reading was compared against that for a standard solution of the pure crystalline dinitrophenyl amino-acid dissolved in aqueous sodium bicarbonate. Blank readings were obtained by extracting an area of the paper close to those actually cut out for the estimation of the dinitrophenyl amino-acids. Such readings were never more than 2–4 per cent of those for the dinitrophenyl amino-acids and were probably due to impurities in the benzene and incomplete extraction of the dinitrophenol.

The above procedure has been applied successfully to the estimation of a number of mono-amino monocarboxylic acids and to aspartic acid. In the case of glutamic acid, the method was modified because dinitrophenyl glutamic acid is unstable in the presence of 91 per cent (w/w) sulphuric acid at room temperature. The modified method is as follows:

The dinitrophenyl glutamic acid was prepared and extracted from the paper chromatogram as described above. The dried alcoholic extract was then dissolved in 1 ml. of 91 per cent (w/w) sulphuric acid which had previously been cooled to − 12° C. in an ice–alcohol bath. The solution was extracted as described previously, with 3 ml. of a mixture of 30 per cent (v/v) purified toluene in purified benzene, the test-tube being immersed in an ice–alcohol cooling-bath throughout all the operations. The toluene was purified in the same way as the benzene. The mixture of toluene and benzene was used because, unlike benzene, it does not freeze at the temperature of extraction (− 12° C.). The extraction was repeated five times, working as quickly as possible and avoiding too vigorous shaking. To the acid layer was then added 2 gm. of crushed ice and the mixture shaken vigorously while still in the cooling-bath. As soon as the ice had dissolved, the test-tube was removed from the cooling-bath and the dinitrophenyl glutamic acid extracted with 10 per cent (v/v) *tert.* amyl alcohol–benzene as described previously.

Effect of light on the dinitrophenyl amino-acids. Light has been shown[7] to cause their destruction under certain conditions, and it was of interest to determine whether it had any effect in the present method. The result of experiments carried out in one case in direct sunlight and in the other in weak daylight are given in Table 1.

Table 1. EFFECT OF LIGHT ON THE ESTIMATION OF GLYCINE
Chromatograms developed with *n*-propanol–water (80 : 20 vol.) for 15 hr. Whatman No. 1 paper

Concentration of glycine applied to paper (3·03 μl.) (*M*)	Extinction coefficient (*E*, 4047, 1 cm.)		
	Solution of dinitrophenyl glycine equivalent to glycine added to paper	Solution from chromatogram in dim light	Solution from chromatogram in sunlight
0·04	1·32	1·027	0·963
0·02	0·66	0·64	0·481
0·01	0·33	0·32	0·210
0·005	0·165	0·165	0·111
0·0025	0·082	0·080	0·041
0·00125	0·042	0·041	0·012

It is clear from these figures that light has a harmful effect. The practice adopted for the final procedure was to shade the solvents and papers containing the dinitrophenyl amino-acids from strong light and, if convenient, to work in artificial light. The precautions need not be excessive, and by working in the absence of strong daylight no loss from this cause was detected.

Recovery of amino-acids. Quantities of the order of 6 μgm. (as 3 μl. of 0·02 *M*) of alanine can be estimated to within ± 5 per cent and the range of the method is from 0·5 µgm. to 20 µgm. The concentration of the amino-acid applied to the paper should not exceed 0·02 *M*, because at higher concentrations the reaction with the dinitro-fluorobenzene reagent does not give a quantitative yield of the dinitrophenyl amino-acid (cf. Table 1, concentration 0·04 *M*). Glycine, glutamic acid, aspartic acid, proline and phenylalanine give similar recovery figures to alanine.

Several workers have suggested that there is a loss of amino-acid depending on the distance travelled by the spot on the chromatogram[8,9]. Experience in the present study did not support this suggestion, though it must be emphasized that washed paper was used, and it may be that a compound is present in the unwashed paper which inhibits complex formation when using the copper method of assay. It is possible that the amino-acid can react with the dinitro-fluorobenzene reagent even in the presence of the inhibitor, whereas it may be less capable of forming a complex with copper. The shape of the spots on a paper chromatogram developed with *n*-propanol–water (80 : 20 vol.) was very much better if the paper had been washed. The outline of the spots was more nearly circular, and there was an absence of the forward-running shadow which is often present if ordinary Whatman No. 1 paper is used. It is significant that the recovery of phenylalanine, which has a high R_F value, and might be expected to show the maximum loss due to adsorption by the paper or combination with impurities, was of the order of 98 per cent.

So far as one of us is concerned (F. A. I.), the work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. The other (D. H. C.) is indebted to the University of Adelaide for a grant and to Prof. G. E. Briggs for the hospitality enjoyed while working in his department. [March 4.

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A PAPER CHROMATOGRAPHIC METHOD FOR THE QUANTITATIVE ESTIMATION OF AMINO-ACIDS

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A NEW method for the quantitative microanalysis of amino-acid mixtures has been developed, based upon the conversion of the amino-acids to their yellow N-2 : 4-dinitrophenyl (DNP) derivatives[1], followed by the separation of these compounds on a two-dimensional filter-paper chromatogram, and their subsequent quantitative elution from the paper and estimation at 360 mµ.

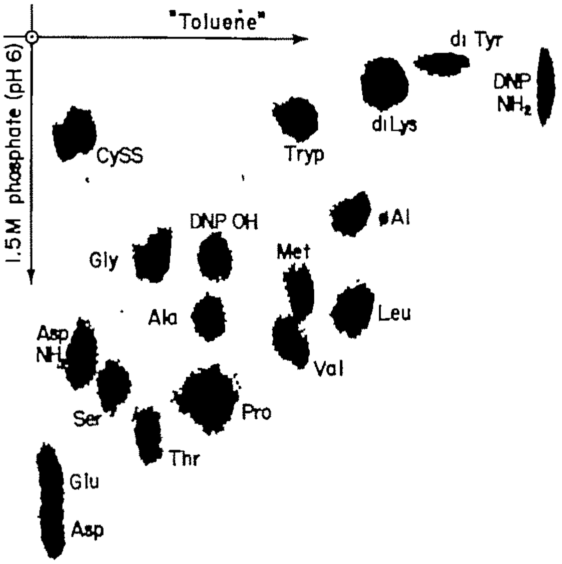

Fig. 1. 2-Dimensional chromatogram of a synthetic mixture of dinitrophenyl amino-acids (approx. 0·03 µ*M* of each)

Dinitrophenylation is effected quantitatively by stirring an aqueous solution of the amino-acid (20–30 µ*M* in 3 ml.) with a slight excess of 1-fluoro-2 : 4-dinitrobenzene (FDNB) for 30 min. at *p*H 9· and 40°, the *p*H being maintained at this valu throughout this period by intermittent additions o standard alkali; a Jacobsen–Léonis[2] autotitrator i particularly convenient for this purpose. Exces fluoro-dinitrobenzene is then extracted with ether the solution acidified, and the dinitrophenyl amino acids extracted into ether (5 × 5 ml.). The aqueou solution, which contains dinitrophenyl arginine an α-dinitrophenyl histidine, is diluted to 10 ml. A 2-ml. aliquot of the ether solution and a 1-ml aliquot of the water solution are next applied t adjacent corners of an 18¼ in. × 22¼ in. sheet o Whatman No. 1 filter paper, which is then irrigate by the ascending procedure with the toluene – chloro ethanol – pyridine – 0·8 *N* ammonia (modified t 5 : 3 : 1·5 : 3) mixture of Biserte and Osteux[3]. Th chromatogram is dried for 3–4 hr. at 40°, and th spots due to dinitrophenyl arginine and α-dinitro phenyl histidine excised at this point. The paper i then run in the second dimension by the descendin procedure with 1·5 *M* aqueous phosphate buffe (M NaH$_2$PO$_4$ + 0·5 M Na$_2$HPO$_4$) as irrigating flui to give the chromatographic pattern shown in Fig. 1 All the ether-soluble dinitrophenyl amino-acids ar thereby separated, except dinitrophenyl leucine an *iso*leucine. The positions of dinitrophenyl tryptopha and di-dinitrophenyl histidine coincide, but this doe not present a difficulty in practice since the forme amino-acid is not normally present in acid hydro lysates, and the latter is determined as its mono dinitrophenyl derivative.

The spots are cut out and dropped into a set o labelled test-tubes; three blanks are also cut fro each sheet. 4 ml. of water is pipetted into each o the tubes, which are then placed in a water-bath a 55–60° for 15 min. to allow complete elution of th colour. After an additional 15 min. to allow th solutions to cool to room temperature, they ar successively decanted into a 1-cm. quartz cuvett and the optical densities at 360 mµ (385 mµ in th case of dinitrophenyl proline) read in the Beckman model *DU* spectrophotometer against a water blank. The optical density reading of the tubes containing blank paper is 0·001–0·002 per sq. cm., and the appropriate corrections are made for each spot according to its estimated size.

The resulting ratios of the optical densities of the dinitrophenyl amino-acids are converted to molar ratios by multiplying by the following factors, which, within the accuracy of the method (± 4 per cent), are independent of the composition of the mixture analysed: Asp, 0·99; Glu, 0·94; CySS, 0·56; Ser, 0·97; Thr, 1·02; Gly, 1·03; Ala, 1·09; Pro, 0·93; Val, 0·99; Met, 1·21; Leu and *iso*Leu, 1·10; Phe, 1·03; Tyr, 1·54; Lys, 0·64; His, 1·62; Arg, 1·06. When the chromatograms are run in triplicate, the molar ratios are found to be reproducible to within 2–3 per cent. Tyrosine, however, is subject to rather wider variation, for reasons which are not at present understood.

For many purposes, a knowledge of the molar ratios is all that is required. However, when it is necessary to estimate the absolute amounts of the amino-acids present in a mixture, two independent methods of calculation are available. The less accurate one (2–5 per cent) involves a direct conversion of the optical density readings to micromoles by means of a set of effective millimolar extinction coefficients; they have the values 15·6/*F*, where *F* represents the above set of factors. The greater inaccuracy of this procedure arises from differences in the absolute recovery of colour from replicate chromatograms; however, these differences are not reflected in the molar ratios, since the variation seems to affect each amino-acid to a comparable extent. The preferable method, therefore, combines the more accurate (2–3 per cent) molar ratios with the total quantity of amino-acids present in the mixture; the latter figure, in turn, can readily be deduced from the alkali uptake which accompanies the reaction of the amino-acid mixture with 1-fluoro-2 : 4-dinitrobenzene. Thus, under the reaction conditions mentioned above, the alkali uptake is found to be 77 ± 1 per cent of the theoretical maximum (that is, 2 equiv. per NH_2 group, 1 equiv. for tyrosine OH and 0·25 equiv. for the iminazole ring of histidine), after due correction is made for the formation of dinitrophenol (0·044 μM of OH^-, $ml.^{-1}$ $min.^{-1}$). Incidentally, the latter by-product does not interfere with the chromatography when the condensation with fluoro-dinitrobenzene is carried out as described above in a solution approximately 0·01 *M* with respect to amino-acids; for more dilute solutions, however, it is necessary to reduce the dinitrophenol concentration by sublimation[4] before application to the paper.

The most obvious application of this method is to the analysis of protein hydrolysates, which requires about 0·2 mgm. of protein (equivalent to approximately 0·1 μM of each amino-acid) per chromatogram; although if paucity of material is not a decisive consideration, it is more convenient to weigh out 2–3 mgm. of protein, and take aliquots for chromatography as described above. The results of an analysis[5] made in this manner (in duplicate) of beef A insulin (kindly made available to us by Dr. Lyman C. Craig) are presented in Table 1, together with the results of an analysis[6] of the same material recently carried out by Dr. E. J. Harfenist using the classical ion-exchange column procedure of Moore and Stein[7], and, for comparison, the theoretical molar ratios for the structure proposed by Sanger[8]. Satisfactory analyses of α-corticotropin[9] (39 amino-acids), ribonuclease (123 amino-acids), growth hormone (361 amino-acids) and a variety of synthetic mixtures have also been made in this laboratory and will be reported separately.

Table 1. ANALYSES OF BEEF A INSULIN

24-hr. hydrolysates. Uncorrected for destruction or incomplete liberation from peptide linkages

	Residues per molecule		
	Levy and Chung (ref. 5)	Harfenist (ref. 6)	Sanger (theoret.) (ref. 8)
Asp	2·9	2·9	3
Glu	6·7	6·7	7
CySS	2·8	2·9	3
Ser	2·3	2·6	3
Thr	1·0	0·9	1
Gly	4·2	4·0	4
Ala	3·0	3·0	3
Pro	1·0	1·1	1
Val	4·6	4·7	5
Leus	7·1	6·5	7
Phe	3·0	3·0	3
Tyr	3·8	4·0	4
Lys	1·0	1·0	1
His	1·9	2·0	2
Arg	1·0	1·0	1
Totals	46·2	46·3	48

The method is, of course, ideally suited to the analysis of terminal amino-acids and peptides derived from proteins by Sanger's procedure[1], since they are already in the form of their dinitrophenyl derivatives. Further, by subjecting the hydrolysate to dinitrophenylation, an amino-acid analysis and end-group determination can be made on the same micro-sample of protein: examples of this application will be published elsewhere. Dr. J. I. Harris, in this laboratory, has successfully applied the method to the determination of very small quantities (0·05–0·2 μM) of amino-acids released by the action of carboxypeptidase on proteins. The method would also appear to be well adapted to the analysis of biological fluids, since it is unaffected by the presence of ammonia, salts or proteins.

The procedure described above has obvious affinities with the column-dinitrophenyl method of Mills[4], and with the many methods of quantitative paper chromatography of amino-acids using ninhydrin, copper, etc., as indicating reagents. Its particular feature is that it combines the convenience of the latter techniques with the accuracy of the former.

Full details of this method will be published shortly.

I wish to express my thanks to Mr. David Chung for his expert technical assistance, and to Prof. C. H. Li for his interest and encouragement in connexion with this work. The investigation was supported in part by research grants from the National Institutes of Health, United States Public Health Service (grant No. G 2907) and the Rockefeller Foundation. [Feb. 24.

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LETTERS TO THE EDITORS

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Ribonucleotide Analysis of Individual Nerve Cells

CHEMICAL analyses of individual body cells are valuable in view of the importance of exact localization of substances; but reliable analyses can, however, be performed only to a limited extent. This is due to the difficulties of applying biochemical procedures in dimensions of the order of magnitude in question. It has therefore been necessary to rely almost entirely on histophotometric methods. In most cases there are only restricted possibilities of obtaining chemical data on the cell by such means. An account is given in the following of a procedure for the extraction, isolation and hydrolysis of the ribonucleic acid in individual nerve cells, with subsequent separation and identification of the mononucleotides formed.

The chromophil substance in the nerve cells has earlier been shown to contain a substance with many properties similar to those of ribonucleic acid[1]. It was, however, not known whether it also contains the four mononucleotides which characterize this acid. Analyses of the ribonucleic acid in nerve cells cannot be carried out with current macro- and microchemical methods. This is because of the structure of the nervous tissue, in which the cell bodies constitute only a small percentage of the volume. Consequently, it is necessary to analyse individual cells. Large cells with a volume of (10–100) × 10^3 μ^3 contain 100–1,000 pgm. of ribonucleic acid (1 pgm. = 10^{-12} gm.)[2]. Since the usual microchemical methods[3,4] require quantities a million times greater for analyses, we were obliged to use a special technique. By means of ionophoresis on a cellulose fibre, nucleotide analyses on individual motor anterior horn cells from the rabbit were performed.

Using a de Fonbrune micromanipulator[5], individual cells are dissected out of Carnoy-fixed nervous tissue, cut into sections 70 µ thick and mounted on cover-glasses. A section is saturated with dilute acetic acid and surrounded by liquid paraffin in an oil chamber[5]. A micro-needle is used for dissection, separate cells being placed on a free part of the cover-glass and crushed against it with the needle. Each cell is incubated with a volume of extraction fluid four to five times greater than that of the cell. The cells are extracted three times for a total period of 1 hr. at 20° C. The extraction medium consists of 0·4 mgm./ml. of ribonuclease in a 0·2-*M* ammonium carbonate, ammonium acetate buffer of *p*H 7·7. The buffering substances are volatile. The procedure so far is essentially the same as that used for quantitative determinations of ribonucleic acid from single cells[6].

The extracts are evaporated on another cover-glass, which forms the roof of a part of the oil chamber free from paraffin. The cell extracts are conveyed to this cover-glass with a micropipette. The extracted, enzymatically degraded nucleic acid is freed from buffer electrolytes by this evaporation. When each cell has been completely extracted and the extracts from one and the same cell have been evaporated on to the same point of the cover-glass, each cell extract is incubated with a volume of 1 *M* hydrochloric acid of the same order of magnitude as the extraction volumes. Evaporation is prevented with liquid paraffin. Hydrolysis is allowed to proceed for 18 hr. at 26° C. The hydrolysate is then evaporated on to a dry cover-glass, in the same way as in the extraction procedure. The hydrochloric acid is removed by this means from the mononucleotides formed during hydrolysis. When the extract is to be analysed, it is dissolved in a small volume of 0·02 *M* sodium hydroxide in the paraffin-filled chamber.

The mononucleotides formed are separated by ionophoresis on a cellulose fibre, using in principle the same technique as that described by Edström[7]. Artificial silk produced by the copper–ammonia method from cellulose is treated with alkali and saturated with a highly viscous, non-volatile citrate buffer of *p*H 3·6. A fibre is taken out of a thread and freed from excess moisture. It is then stretched on a quartz slide. Two dabs of a paste consisting of the citrate buffer stirred into silica gel are smeared on to the fibre at a distance of about 1 mm. from each other. The inverted quartz slide is then made to form the roof of a part of the oil chamber, free from liquid paraffin. A cover-glass with a dissolved hydrolysate forms an oil-filled part in the same chamber. Hydrolysate is taken from the cover-glass with a micropipette and, with the tip of the pipette applied to the fibre, it is evaporated at some point between the two dabs of paste. This part of the chamber is then also filled with liquid paraffin.

Metal wire electrodes are insdrted into the dabs of paste by means of the micromanipulator. When the buffer has a viscosity of 500 poises, a direct current voltage of 500 V./mm. is applied for 90 min. The mononucleotides move towards the anode and separate from each other to a total distance of about 0·5 mm. When adequate separation has been achieved, the quartz slide is removed from the chamber and taken to the Köhler ultra-violet microscope. The fibre is photographed in monochromatic light of 257 and 275 mµ. The migration velocities and the ratio of the absorption values for each band at 257 and 275 mµ have been found to be equal to those of the bands resulting from ionophoretic runs of pure preparations of the four ribomononucleotides. The bands, counting from the cathode to the anode, are: cytidylic acid, adenylic acid, two bands of guanylic acid and uridylic acid. Cytidylic acid and guanylic acid are found in the largest amounts. An ionophoretic analysis of a motor anterior horn cell from the rabbit is shown in Fig. 1.

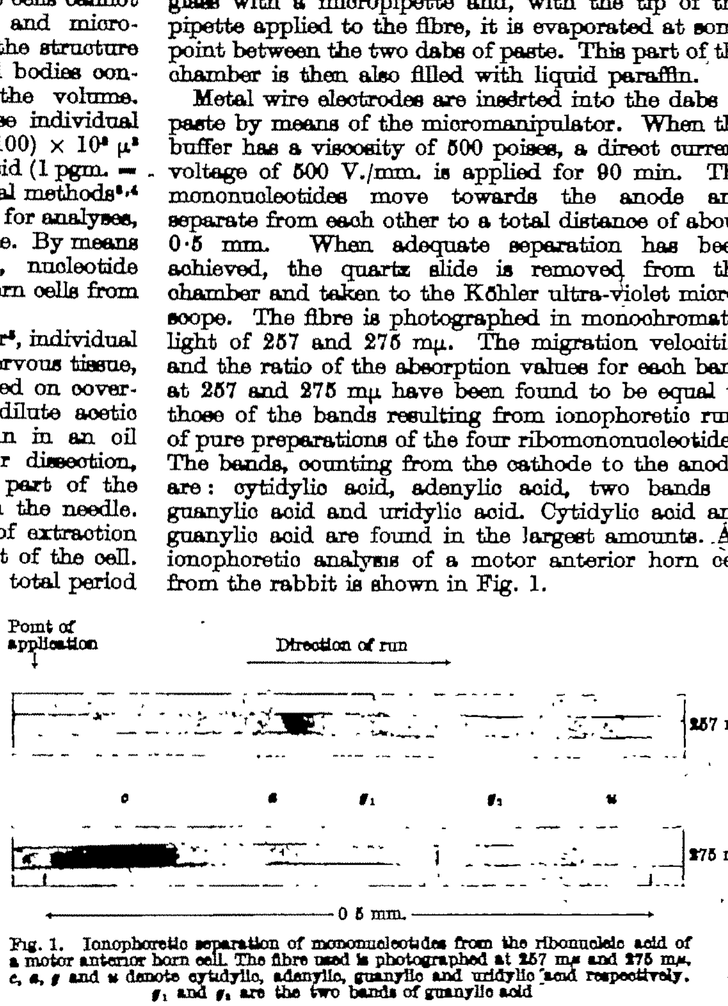

Fig. 1. Ionophoretic separation of mononucleotides from the ribonucleic acid of a motor anterior horn cell. The fibre used is photographed at 257 mµ and 275 mµ. *c*, *a*, *g* and *u* denote cytidylic, adenylic, guanylic and uridylic acid respectively. g_1 and g_2 are the two bands of guanylic acid

It is evident that the nerve cells contain a ribonucleic acid which, with respect to nucleotide composition, is similar to that obtained from other organs of the body.

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A Possible Function of Intracellular Ribonucleases

MANY theories have been put forward concerning the mechanism of protein synthesis, and most of them have suggested that ribonucleic acid acts as a template upon, or alongside which, peptide chains are synthesized. The arrangement of the amino-acids in the peptide chain is supposedly regulated by the highly specific arrangement of the nucleotides which, it has been suggested[1,2], may contain high-energy phosphate at the proper intervals to effect peptide bond synthesis. A recent detailed account of this theory and some evidence for the phosphorylation of ribonucleic acid has been offered by Dounce[1,3].

It is not clear how the peptide chains, once formed, would be separated from the nucleic acid, since there would be strong electrovalent forces holding them together, particularly between highly positive basic amino-acids and strongly negative nucleotide residues, as well as secondary hydrogen bonding and van der Waals's forces. It is possible that the release of the protein may be accomplished by partial or complete degradation of the polynucleotide chain by intracellular ribonucleases. It should not be difficult to devise experimental procedures to determine whether these enzymes are able to break down the ribonucleic acid portion of ribonucleoprotein complexes, thereby releasing active enzymes. If a system could be obtained in which complexes of enzymes with ribonucleic acid tended to accumulate, then the addition of a ribonuclease to such a system should result in an increase in enzyme activity.

Attempts were made to demonstrate this using relatively old (7–10 days) cultures of *Tetrahymena pyriformis* S. The methods of preparation of the cultures, isolation of the organisms and preparation of the homogenates, as well as the enzyme assays have been previously described[4,5]. Assays were carried out for deoxyribonuclease and the oxidation of succinate. The results of a typical experiment with deoxyribonuclease are shown in Fig. 1. The addition of 2·5 mgm. of protease-free ribonuclease (Worthington Biochemical Sales Co.) approximately doubled the deoxyribonuclease activity, so that the hydrolysis of the substrate was essentially complete after 30 min., whereas in the control this required [illegible]0 min. Similar results were obtained with 8–10 day old cultures of the *W* strain.

In the assays for the oxidation of succinate the results were more variable. Increase in activity on addition of ribonuclease (0·1–0·5 mgm. per Warburg flask) ranged from 0 to 35 per cent. The succinate oxidizing system does not appear to be well suited to these experiments, as in older cultures the activity was quite low and small changes were thus likely to be magnified.

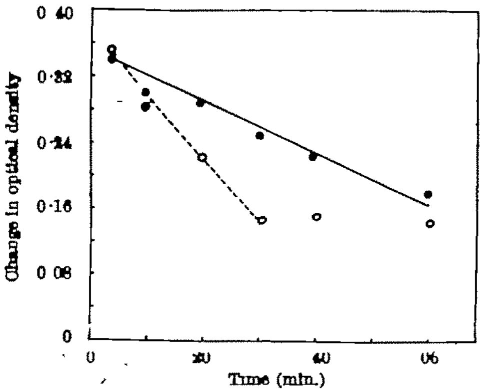

Fig 1. The deoxyribonuclease activity of a homogenate of an eight-day old culture of ***Tetrahymena pyriformis*** S. with and without added crystalline pancreatic ribonuclease. Closed circles, control, open circles, control plus 2·5 mgm. ribonuclease. The system contained 10·0 ml. of 0·1 *M* veronal-acetate buffer, *p*H 5·2, 10·0 ml. of 0·2 per cent NaDNA and 5·0 ml. of homogenate. The activity is expressed in terms of the decrease in optical density with time of aliquots precipitated with an equal volume of 1·0 *N* HCl. The values above have been corrected for the action of crystalline pancreatic ribonuclease on the RNA in the homogenate. The sample of pancreatic ribonuclease used had no action on NaDNA under identical conditions

The above results are admittedly only suggestive, but it may be possible to obtain a better demonstration of the release of protein enzymes by ribonuclease in some other biological system, possibly one that has been inhibited by ribonuclease inhibitors. Recently, Lundblad and Hultin[6] demonstrated the liberation of proteolytic enzymes of the sea urchin egg by ribonuclease. A clearer proof would be to show an increase in enzyme activity or the liberation of enzyme activity on treatment of purified isolated ribonucleoprotein with ribonuclease.

The rather rapid turnover of ribonucleic acid in both the cytoplasm and nucleus might be due to the action of intracellular ribonucleases, and the occurrence of these enzymes in the nucleus, as well as the cytoplasm, in certain tissues seems probable[7].

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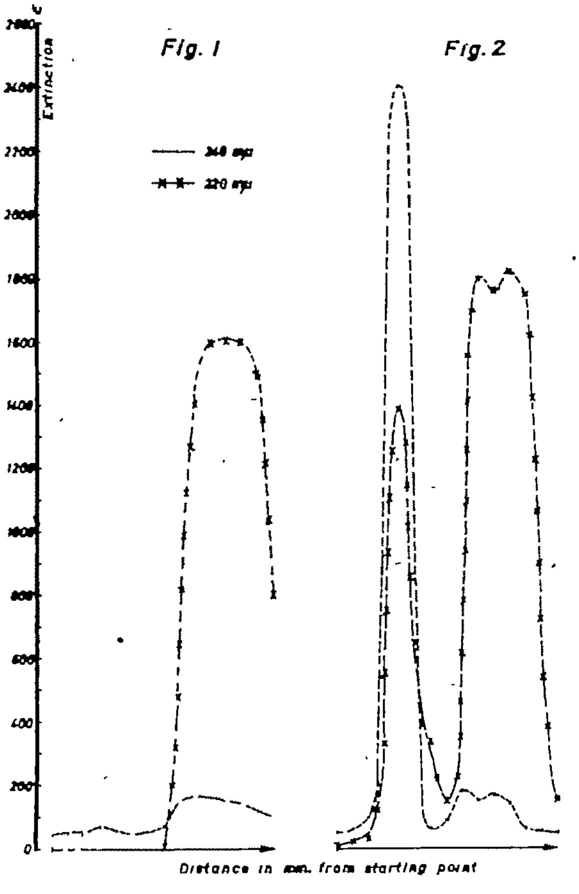
Solubility and Electrophoretic Behaviour of Steroid-Detergent Mixtures in Aqueous Buffers

WE have tried to overcome the well-known difficulty of preparing aqueous solutions of steroids by the use of detergents. We have been interested further in the study of the behaviour of the detergents themselves and of steroid-detergent mixtures in the electric field and in the practicability of separating steroids by this means. One of us[1] has described the application of paper electrophoresis for separating steroids after esterifying with anhydrous succinic acid and forming the sodium salt. There are very full accounts of protein-detergent complexes and their behaviour in the electric field[2,3]. Polonovski[4] has recorded his studies of the dissolving power of invert soaps in cholesterol, lecithin, cerebrosides and glycerides; but we were unable to find any similar observations on steroids and detergents.

A special procedure permits the emulsification or dissolution of crystalline steroids (deoxycorticosterone, androsterone, cortisone, testosterone (Schering A.G., Berlin)) and of the neutral ketonic fraction of urine in aqueous buffers by anionic, cationic or non-ionic detergents. There are seemingly analogous stoichiometric relations as in protein detergent complexes. In general, the ratio deoxycorticosterone: detergent was 1 : 4; but it was necessary to double the concentration for androsterone. The dissolving power increases from cationic through anionic to non-ionic detergent; but anionic detergents were most effective in our electrophoretic tests.

Paper electrophoresis was performed according to the method of v. Holt, Voigt and Gaede[5], using phosphate buffers of pH 7·2 and an ionic strength of 0·045. The paper strips after electrophoresis were examined by fluorescence and the required parts cut out and eluted; alternatively, lengths of 5 mm. were cut off and eluted.

Electrophoresis of detergents alone had various results according to the brand and purity of detergent. Up to seven distinct isolated bands could be determined by fluorescence and ultra-violet absorption.



Detergent W 6763 (Chemische Fabrik Stockhausen und Cie., Krefeld), the sodium salt of a sulphonated alkyl-benzene, was the most useful for the paper electrophoresis of steroids, its dissolving power being effective and having only one strong and a second weak band.

Fig. 1 shows the electrophoretic behaviour of W 6763; Fig. 2 shows that of the W 6763 cortisone complex. The abscissæ give the distances from starting point in mm. intervals, the ordinate the extinction at 240 and 220 mμ. The migration of the detergent-cortisone complex is evident. We were able to show the migration of deoxycorticosterone and androsterone in the same manner.

Investigations by this method are being carried out, especially in separating steroids of urine. Details of this work and the possible biological use of such steroid-detergent solutions will be described elsewhere.

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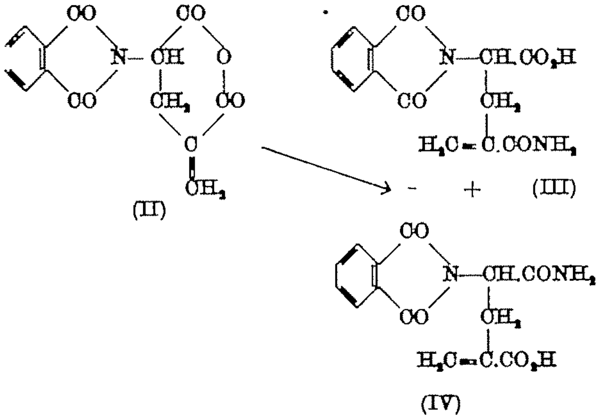
Synthesis of γ-Methyleneglutamic Acid and γ-Methyleneglutamine

The isolation of two unsaturated amino-acids (I, X = OH and NH$_2$) was recently reported[1]. They were first obtained from groundnut plants, but have since been detected in two quite unrelated species, namely, tulips[2] and hops[3]. In groundnut plants they have been shown[4] to be of considerable biochemical importance, playing a major part in nitrogen transport.

$$HO_2C.CH(NH_2).CH_2.C(=CH_2).CO.X \qquad (I)$$

We have now confirmed these structures by rational synthesis. 1-Formamidobut-3-yne-1 : 1-dicarboxylic ester[5] was treated with nickel carbonyl in aqueous-ethanolic acetic acid[6], when the expected Reppe carboxylation took place, giving the corresponding α-substituted acrylic acid in 45 per cent yield. Vigorous alkaline hydrolysis then removed ester groups and effected decarboxylation and extensive deformylation, giving (I, X = OH) directly, admixed with the corresponding formyl derivative, which was readily separated.

Treatment of (I, X = OH) with phthalic anhydride in pyridine and afterwards with acetic anhydride yielded (II), which was treated with ammonia under anhydrous conditions. In contrast to the corresponding derivative of glutamic acid itself[7,8], this anhydride gave a mixture of half-amides (III and IV) inseparable by crystallization, but counter-current partition between n-butanol and M-phosphate buffer (pH 6·2) separated the two isomers, which had almost identical melting-points (205°) but significantly different dissociation constants (pK values 5·18 and 5·99 in 60 per cent ethanol; cf. values of 4·93 and 6·38 for phthalimidoacetic and methacrylic acids, respectively, under these conditions). The more abundant and more acidic isomer, evidently (III), gave a complex



mixture of products on treatment with hydrazine in boiling alcohol[7b], but in cold, neutral aqueous solution[7a] gave a 25 per cent yield of an easily isolated amino-acid (I, $X = NH_2$). From (IV) no homogeneous dephthaloylation product could be obtained.

The identity of (I, $X = OH$) and natural γ-methyleneglutamic acid was established by racemizing the latter in acid solution and examining infra-red spectra of 'Nujol' suspensions[8a] and X-ray powder diffraction lines[8b]. In each case detailed and identical patterns were obtained. The two racemic acids were shown to be inseparable from the natural L-acid (configuration assumed) when co-chromatographed on Whatman No. 4 filter-paper, using water-saturated phenol, n-butanol–acetic acid[9], collidine–lutidine[10], or 70 per cent n-propanol as solvents. Identical and characteristic yellowish-brown spots were obtained when the dried chromatograms were treated with ninhydrin; in aqueous solution with an excess of the reagent normal blue-purple colours resulted. Finally, the synthetic and racemized natural acids were decarboxylated by *Clostridium welchii S.R.*12 (N.C.T.C. 6784), when under comparable conditions in a typical experiment the initial rates of carbon dioxide evolution were 149 and 154 $mm.^3$/hr., respectively. The natural L-form was decarboxylated at about double the rate of the DL-forms; in all cases complete decarboxylation of the L-isomer eventually occurred, with the liberation of the theoretical amount of carbon dioxide.

The identity of synthetic (I, $X = NH_2$) and the natural L-amide—which has not as yet been racemized without simultaneous hydrolysis—could not be confirmed by infra-red[8a] or X-ray diffraction data[8b]. These showed appreciable differences, due, no doubt, to the former being a true racemate; infra-red spectra of optically active amino-acids and the corresponding racemates are known[11] to show unusually large differences, probably because of the importance of hydrogen bonding in their crystal lattices. The two amides were, however, inseparable on paper chromatograms developed with the solvents listed above, and gave identical reddish-brown spots when the dried chromatograms were treated with ninhydrin. Both amides were enzymically deamidated to γ-methyleneglutamic acid by dialysed extracts of groundnut leaves at pH 7; using solutions equimolar with respect to the L-isomer the deamidation appeared to proceed at similar rates for the two substances. The natural acid was completely converted to γ-methyleneglutamic acid in less than 3 hr., while approximately 50 per cent of the synthetic amide (that is, the D-isomer) remained at the end of the same period. Since the other known deamidases are fairly specific as to substrates, these observations indicate, independently of other evidence, that the two amides are identical in structure.

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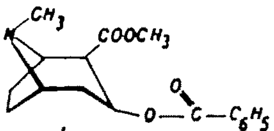
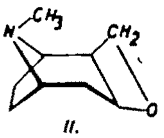
Stereochemistry of Cocaine

Two years ago, positive evidence was presented for the configurations of tropin and ψ-tropin[1], ψ-ecgonin[2], scopolamine and valeroidine[3] using the acyl migration reaction[4,5] and other methods. Regarding the steric structure of cocaine (I), the *cis* relationship of the COOH and OH groups has been demonstrated[2], while in ψ-cocaine these groups appear to be *trans* placed. The failure of N-acetyl-*nor*-ecgonin ethyl ester to undergo acyl migration was considered[3] as evidence for the *anti* position of both functional groups of (I) with respect to the ring nitrogen atom. However, we tried to get more conclusive experimental proofs; more so since our attention was directed by G. Stork (private communication, October 15, 1952) to the possibility of dehydration during acyl migration in the case of N-acetyl-*nor*-ecgonine ester. Furthermore, Prof. W. Hückel postulated (January 24, 1953) the hindering effect of the carbethoxyl group to be responsible for the failure of the acyl shift.



I.



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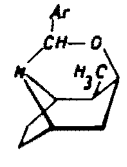

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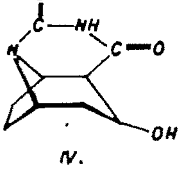

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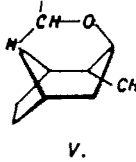

V.

Ecgoninol was converted into 2-chloromethyl-3-tropanol (hydrochloride m.p. 217° $[\alpha]^{20}_{D} = -60\cdot2$ (H_2O)), and this, in turn, forms by hydrogenolysis 2-methyl-3-tropanol (m.p. 56°, $[\alpha]^{20}_{D} = -58\cdot2$ (C_2H_5OH)).

On the other hand, the chloromethyl derivative furnished a compound on the action of sodium bicarbonate—a compound showing correct analytical data for the structure of an internal ether (II) (hydrochloride, m.p. 222°; $[\alpha]^{20}_{D} = -78\cdot3°$ (H_2O). Found: C, 57·08; H, 8·28; N, 7·28; Cl (ionic), 18·63. $C_9H_{15}ON.HCl$ requires: C, 56·97; H, 8·50; N, 7·39; Cl (ionic), 18·70 per cent). This did not show olefinic character, but can be reconverted by hydrochloric acid under pressure into the chloromethyl derivative and gave on the action of sodium methoxide 2-methoxymethyl-3-tropanol.

The formation of (II) from ecgoninol gives definitive evidence for the *cis* position of the CH_2OH and OH groups (already proved by the formation of a cyclic benzylidene acetal with a six-membered ring[3]) and consequently for that of the functional groups in cocaine, since a four-membered ring fused to a six-membered ring in the 1.2-position is too highly strained to exist in a *trans* modification[6].

2-Methyl-3-tropanol (from I, m.p. 56°) was converted into the *nor* compound ($[\alpha]^{20}_{D} = -57°$, H_2O) and this, in turn, furnished reversibly an oxazine derivative (III) ($[\alpha]^{20}_{D} = +3\cdot5°$), when treated with *p*-nitrobenzaldehyde. (The conversion of *nor-syn*-tropine into an oxazine was realized first by Hardegger *et al.*[8]. This method furnished obviously in the case of its homologues non-equimolecular mixtures of the two possible epimers on the μ-C-atom. Consequently, the analytical figures correspond to the calculated values, but the melting points are not sharp.) Thus the correlation of cocaine to ψ-tropine is established. Meanwhile, in agreement with our findings, Findlay recorded recently[7] another piece of evidence for the *syn* position of C_3—OH and ring N in (I) and consequently for the C_2-epimerism of cocaine and ψ-cocaine. This was based upon the method of acyl migration O → N, in the case of O-benzoyl-*nor*-ecgonin.

Direct evidence supporting the *syn* position of COOH and N in cocaine is now presented by us as follows.

N-cyano-*nor*-cocaine gave on hydration N-carbamyl-*nor*-cocaine (m.p. 180°; $[\alpha]^{20}_{D} = -34°$, CH_3OH), and this, in turn, furnished on the action of sodium methoxide at − 15° (to avoid epimerization at C_2) N-carbamyl-*nor*-ecgonin methyl ester (m.p. 212°; $[\alpha]^{20}_{D} = -93°$; in 70 per cent CH_3OH (H_2O)), together with the neutral cyclic ureid of N-carbamyl-*nor*-ecgonin (IV) (m.p. 198°. Found: C, 55·45; H, 6·30; N, 14·09; OCH_3 φ; active H, 1·03 per cent. Calc. for $C_9H_{12}O_3N_2$: C, 55·00; H, 6·16; N, 14·29; OCH_3 φ; active H, 1·01 per cent).

Furthermore, considering the formation of (II) and (III), the structure of (−) 2β-carbomethoxy-3β-benzoyloxy-tropane (for the stereochemical notation of tropane derivatives the α,β conventions proposed in our first paper[1b] were used) (I) for cocaine is confirmed.

These facts may also be regarded as additional evidence for the steric structure of ψ-cocaine, suggested previously by one of us[4]. A further direct proof for the *syn* position of C_3—OH and N was furnished by converting it via ψ-ecgoninol into 2-methyl-*nor*-3-tropanol ($[\alpha]^{20}_{D} = +50\cdot5°$), which afforded a cyclic oxazine derivative (V) ($[\alpha]^{20}_{D} = +70\cdot5°$) when condensed with *p*-nitrobenzaldehyde.

Since the stereochemistry of cocaine and ψ-cocaine seems to be settled, further investigations will be directed towards the synthesis and configuration of the two remaining epimers.

Experimental details will be published soon in *Helvetica Chimica Acta*[9].

This work was supported by the Hungarian Academy of Science.

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Transition Temperatures of Polymers at Ultrasonic Frequencies

THE variation of ultrasonic velocities with temperature in methyl methacrylate polymers was determined by Protzman[1] and by Melchor and Petrauskas[2]. Using the optical diffraction method, Protzman found a transition temperature at which there is an abrupt increase in slope in the linear variation of the velocity with temperature and also found that this transition temperature decreases linearly with frequency, in the range covered by his experiments. Working in the same range of frequencies and using the pulse method, Melchor and Petrauskas reported a slightly different transition temperature which, however, was found not to vary with frequency.

Using the ultrasonic pulse method involving the principle of total internal reflexion described in detail

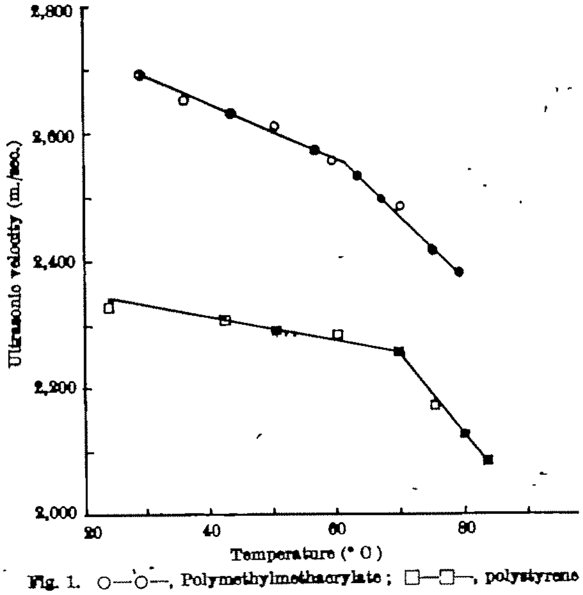

Fig. 1. ○—○—, Polymethylmethacrylate; □—□—, polystyrene

in a paper by Krishnamurthi and Balakrishna[3], we have determined the variation of longitudinal velocities with temperature in methyl methacrylate and styrene polymers. We have found that there is a transition temperature for sound velocity in polystyrene. The velocities are measured with an error of less than 1 per cent.

The velocities are determined at four different frequencies in each case, namely, 1·15, 2·30, 3·45 and 5·75 Mc./s. For the first two frequencies, the thickness of the samples used is not sufficient to give correct values of velocity, whereas for the two higher frequencies identical values of velocities are obtained at each temperature. However, at all frequencies, the transition temperature is found to be the same. In Fig. 1 the results obtained at the higher frequencies are plotted. The graphs show transition temperatures at 61° C. for polymethyl methacrylate and at 70° C. for polystyrene. Thus, in the frequency-range 1–6 Mc./s. used in this experiment, the transition temperature remains the same at all frequencies. This is in agreement with the earlier observation by Melchor and Petrauskas in polymethyl methacrylate.

We thank Prof. S. Bhagavantam for his guidance and interest throughout this work.

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Chlorine Isotope Effect

DURING the past few years, there has been a growing interest in the differences in reaction-rates which arise from isotopic substitution. Attention has been largely focused on the isotopes of carbon, nitrogen and oxygen[1], but recently the effect has been demonstrated for heavier atoms, in particular for the isotopes of sulphur[2].

We have been able to demonstrate such an isotope effect for the natural isotopes chlorine-35 and chlorine-37. We allowed *tert.*-butyl chloride to react with silver nitrate in 98 per cent alcohol at room temperature and found that the chlorine-35 compound reacted faster than the chlorine-37 compound. Three experiments were carried out as follows.

(1) The silver chloride formed by reaction of the first 30 per cent of the *tert.*-butyl chloride was isolated, the silver chloride formed from the remaining 70 per cent being rejected. (2) The silver chloride formed by total reaction of the *tert.*-butyl chloride was isolated. (3) The silver chloride formed by the reaction of the first 95 per cent of the *tert.*-butyl chloride was rejected and that from the last 5 per cent was isolated. Each of the three silver chloride samples was converted to chlorine gas by a procedure designed to avoid isotopic fractionation, and the isotopic composition of the samples was determined by mass spectrometry. The ratios of chlorine-35 to chlorine-37 found were: (1) 3·104 ± 0·003, (2) 3·087 ± 0·003 and (3) 3·019 ± 0·005. (The natural abundance ratio as measured by Nier[3] is 3·07 ± 0·03.) The relative rates of reaction for the two isotopically distinguishable *tert.*-butyl chlorides, $^{35}k/^{37}k$, were calculated first from the results of experiments (1) and (2) and secondly from the results of experiments (2) and (3). The values thus obtained were 1·007 ± 0·003 and 1·008 ± 0·001.

We hope to present a more detailed account of this work at a later date.

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Paper Electrophoresis of *Strychnos* Alkaloids

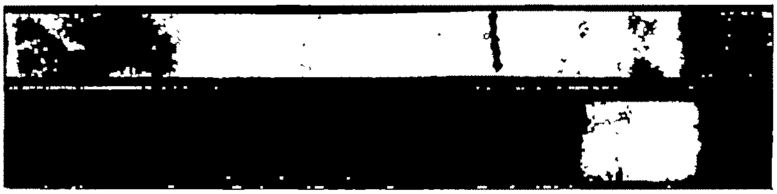
IN several recent publications, separation of the alkaloids of the South American *Strychnos* into a great number of constituents by paper chromatography has been recorded[1,2]. The most successful solvents for two-dimensional analysis yield, however, almost the same sequence of spots. Thus it was considered desirable to find methods of separation which gave sequences different from those obtained by partition chromatography.

Several authors have already used paper electrophoresis for the separation of organic bases, the acridine compounds[3] as well as some pairs of alkaloids[4,5]. Also some alkyl ammonium quaternaries, the functional group of which is common to all the *Strychnos* alkaloids, have been recently separated by one of us by paper electrophoresis[6].

Separation of the alkaloid chlorides of *Strychnos trinervis* prepared from soluble reineckates were effected: (i) with *M*/5 borax as electrolyte using Whatman No. 31 (extra thick) paper and a potential of 300 V. for one hour; for this separation the paper was sandwiched between two glass plates as previously described by one of us[7]; (ii) with 25 per cent acetic acid as electrolyte, also on Whatman No. 31 extra thick paper with 300 V. for one hour, but employing the technique of Durrum[8].

Both electrolytes produce fractionation into several bands. The fluorescent bands visible under ultraviolet light are shown in Figs. 1 and 2. Other bands may be revealed by using specific reagents for *Strychnos* alkaloids such as ceric sulphate solution[9], cinnamic aldehyde and hydrochloric acid[10], ferric chloride, etc.

The sequence of the bands is different in the two cases. Comparing the bands of the two electropherograms on the basis of the colorations with reagents and under ultra-violet light, it is possible to establish the presence and the position of some alkaloids such as C-calebassin, C-fluorocurin and C-alkaloid *K*, already detected in the same product by paper chromatography.



Since as many as eight to twelve bands can be detected by the various methods on a single electropherogram, a complete resolution of all the constituents may be feasible by carrying out a continuous electrophoresis with one of the two electrolytes followed by electrophoresis and/or paper chromatography of the fractions obtained.

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A New Spray Reagent for Paper Chromatography of Polyols and Cetoses

VARIOUS reagents for indicating polyols in paper chromatography have been proposed by Hough, Buchanan *et al.* and Hockenhull[1]. These reagents all have the disadvantage of reacting also with the sugars, not distinguishing them from the polyols.

We have found a reagent which enables us to distinguish the polyols from the cetoses but does not reveal the aldoses. Just before use, one volume of 1 per cent vanillin solution in ethanol is mixed with one volume of 3 per cent perchloric acid in water. This is sprayed on the previously dried chromatogram, which is put in an oven at 85° C. for 3–4 min. Glycerol, erythritol, xylitol, arabitol, adonitol, mannitol and sorbitol give, on a pale sandy background, spots going from pale blue to lilac pink, then all swiftly turning to pale grey-blue. Inositol, dihydroxyacetone, the aldopentoses and the aldohexoses do not react, except rhamnose, which gives a brick red spot. Sorbose and fructose give a very deep grey-green spot, easily distinguished from that of the polyols.

The limiting amounts of these substances which can be identified are: 0·005 mgm. for the cetohexoses, 0·015 mgm. for the hexitols, 0·020 mgm. for rhamnose and the pentitols, 0·025 mgm. for erythritol and 0·03 mgm. for glycerol.

The phenols and some indolic compounds react also with this reagent, which explains why it cannot be employed when using phenol or cresol as chromatography solvent. Similarly, it cannot be used for some acids, especially malonic and gluconic acids, which give the same tint as the polyols. Acid and basic substances must be removed by suitable ionic resins before polyols can be identified by this reagent.

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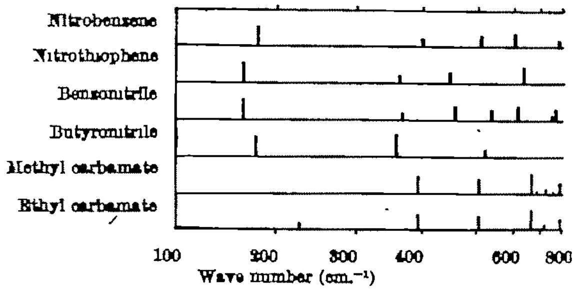
Odour and Molecular Vibrations

DYSON'S[1] hypothesis correlating odour specificity with molecular vibration has recently been extended by Wright[2] to frequencies below about 700 cm.$^{-1}$. In this region he claims to have found a statistically significant correlation for sixteen compounds with an almond-like odour, all but one (nitrothiophene) being benzene derivatives.



Our recent infra-red studies have included the aliphatic urethanes, the first member of which methyl carbamate, possesses a distinct almond odour Its Raman[3] and infra-red frequencies are shown above together with those of ethyl carbamate and the four spectra depicted by Wright. The spectrum of methyl carbamate bears a closer similarity to the spectra of the 'almond-like group' than the spectrum of butyronitrile does, in spite of the fact that the seemingly characteristic frequency at 170 cm.$^{-1}$ is absent. Due to the lack of a suitable prism, we were unable to extend our investigations to this region it also appears that the Raman studies were not extended as low as this, so that it is quite possible that methyl carbamate possesses this vibration and a search for such a frequency would be worth while

On the other hand, the spectrum of ethyl carbamate also shows a similar resemblance to the 'almond-like group' yet has no trace of such an odour, being in fact almost odourless.

These observations emphasize the necessity for a much more detailed survey, covering several groups of compounds of different odour, as suggested by Dyson[4]. Due to the sparse data in the region below 700 cm.$^{-1}$ it would seem that some long time must elapse before such a comprehensive survey can be attempted and a reasonable foundation for a molecular vibration theory of odour obtained.

This work was carried out at the Edward Davies Chemical Laboratories, University College, Aberystwyth, by kind permission of Prof. C. W. Davies.

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Indirect Effect of Ultra-Violet Light on Skin Blood Vessels

IT is known that the ultra-violet wave-lengths responsible for producing vasodilatation or erythema penetrate only a short way into human skin[1,2]. These studies, however, do not by themselves exclude a direct action of ultra-violet light on the blood vessels as the cause of the characteristic erythema, for they have shown that a small fraction (up to 20 per cent) of these wave-lengths is able to penetrate through the avascular epidermis to the vascular corium. Further evidence that the effect of ultra-violet light on the skin blood-vessels is an indirect one would therefore seem of interest.

The following experiment was carried out. In each of six normal female subjects aged nineteen to twenty-three, three skin sites were marked out close together on the lower part of the back. Histamine was introduced into two of these three areas by iontophoresis; the anode (7·25 sq. cm.) of a d.c. circuit was applied to four layers of filter-paper soaked in a 10^{-4} gm./ml. solution of histamine, the cathode being a large pad of lint soaked in water and applied to the thigh. A current of 0·5 m.amp. was passed for 10 min. At the end of this time the skin was whealed and flared. Into one of the wheals a 2·5 per cent solution of tripelennamine hydrochloride ('Pyribenzamine', Ciba) was injected. All three sites were then exposed to ultra-violet light from a Kromayer lamp at contact range for 30 sec. The sites were inspected 24 hr. later. It was found that in each subject all three areas—control, whealed, whealed and injected with tripelennamine—showed a similar and normal sunburn response.

It is known that wheal fluid has a protein content similar to that of serum[3]. It is also known that serum[4], serum albumen[5] and tripelennamine hydrochloride[6] all strongly absorb the ultra-violet wave-lengths responsible for producing erythema. In the present experiment histamine was introduced into the skin by iontophoresis in order to involve the superficial blood vessels in a wheal and so provide them with a surrounding screen of serum-like fluid. An attempt was made to reinforce this screen in one of the two whealed areas by injecting tripelennamine hydrochloride into the wheal fluid. In spite of these screens, the development and appearance of vasodilatation following irradiation with ultra-violet light was quite normal. These observations supply further evidence that the ultra-violet wave-lengths responsible for vasodilatation act primarily on the epidermis and not directly on the blood vessels.

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Structures of Native and Mercerized Celluloses

In *Nature* of February 13, p. 298, Sen and Roy report new equatorial reflexions in the X-ray diagrams of native and mercerized celluloses; the corresponding mean spacings are 13·6 A. for native, and 14·4 A. for mercerized, cellulose. Similar extra reflexions have been reported from time to time, but they have always been found to be spurious, in the sense that they were not due to diffraction of the characteristic radiation that was employed. They may even appear when supposedly monochromatic radiation, obtained by reflexion from a crystal, is used, if precautions are not taken to eliminate radiation with a wave-length half that of the selected radiation[1,2]. However, a commoner cause of spurious reflexions is the diffraction of certain components of the 'white' radiation present in the X-ray beam when unfiltered or filtered radiation is used[3-6].

The most complete study of this phenomenon is that of Sisson, Clark and Parker[6], who showed that the effective components of the 'white' radiation have wave-lengths coinciding with those of the silver and bromine absorption edges. These workers had previously observed spots in the X-ray diagrams of native and mercerized celluloses that corresponded to apparent spacings of 13·4 A. and 14·2 A. respectively, and they were able to demonstrate that these spots were, in fact, silver absorption edges. Their observations and conclusions have been confirmed in these laboratories, and silver absorption edges that could be mistaken for $K\alpha$ reflexions have also been observed in X-ray photographs of nylon, 'Orlon' and silk.

Sen and Roy state that their X-ray photographs were taken "under various conditions of prevailing humidity, intensity and purity of radiation (including monochromatic radiation)"; they thus imply that the new reflexions were obtained even when monochromatic radiation was employed; but they give no details about the method used to obtain such radiation. There is nothing in their communication to suggest that they gave special consideration to the possibility that these reflexions might be spurious, and until this possibility has been fully tested it would be premature to conclude that the accepted structures of native and mercerized celluloses require revision.

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The article by M. K. Sen and S. C. Roy in *Nature* of February 13, p. 298, invites the following comments:

(1) A reflexion at $2\theta \simeq 6°$ which, if it resulted from copper $K\alpha$ radiation, would correspond to a Bragg spacing of ~ 14 A. is sometimes observed in X-ray photographs of cellulose (I, II, III or IV) when nickel-filtered radiation is used; but it is never observed with strictly monochromatic radiation (assuming that the cellulose is free from foreign matter having a spacing of this value).

(2) The intensity of this reflexion relative to (002) copper $K\alpha$ does not apparently depend upon whether the specimen is wet or dry, but is very sensitive to the particular copper anode in use at the time (demountable X-ray tube), being normally zero.

(3) The position of this reflexion is slightly different for each of the cellulose structures I, II, III and IV, and in every case is such that it would result from the reflexion of radiation of wave-length $\simeq 0·47$ A.

from the strongest plane(s). The two strong planes (002), (101) of cellulose II are not resolved at $2\theta \simeq 6°$ in the X-ray cameras generally employed for fibre work (excepting low-angle cameras), so that in all cases the extra reflexion appears single.

(4) With the tube conditions which produce a reflexion from cellulose at $2\theta \simeq 6°$, a reflexion is obtained from other substances, for example, from graphite at $2\theta \simeq 8°$, again corresponding to a wavelength of $\sim 0{\cdot}47$ A.

It can only be concluded that the reflexion at $2\theta \simeq 6°$ provides no justification whatsoever for revision of the unit cells of any or all cellulose structures.

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THE occurrence of an equatorial reflexion of spacing about 15 A. in the X-ray photograph of jute has been observed consistently in this Laboratory over a period of more than six years. The following observations indicate that this reflexion is not spurious in the sense claimed by Warwicker and Wellard.

(1) It appears on photographs taken with radiation monochromatized by reflexion in calcite, using a line slit.

(2) It appears in photographs taken with nickel-filtered copper radiation from an X-ray tube run at 22 kVp., which is below the excitation voltage of 0·47 A. radiation.

(3) In photographs taken with filtered radiation (30 kVp.) and with a sheet of aluminium 0·3 mm. thick interposed between two photographic films, it appears on the first film but not on the second, on which the white radiation alone is recorded (transmission at 0·5 A. about 86 per cent for 0·3 mm. aluminium).

(4) We have observed the reflexion using an experimental Geiger–Müller spectrometer (filtered radiation).

(5) We have observed consistently that the intensity of the reflexion in jute depends on the humidity in the way described by Sen and Roy. The changes of intensity are, by visual estimation, much greater than can be ascribed to the effect reported by Legrand, who found (002) to be rather stronger for wet than for dry specimens.

(6) In our experience (and here we differ from Sen and Roy), the reflexion does not occur in ramie photographs taken under the same conditions as the jute photographs referred to above, although the (002) reflexion in ramie is at least as intense as, and is certainly sharper than, that of jute. We have evidence, at present inconclusive, that degradation of ramie fibres may, in certain circumstances, lead to the appearance of this reflexion or one of similar spacing.

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Conductivity Induced in Polytetrafluoroethylene by X-rays

IN the course of further measurements of conductivity induced in insulating materials by X-rays[1,2], we have investigated polytetrafluoroethylene, and find a relatively large induced current with a very long time constant. A small cylindrical condenser 2·5 cm. long with polytetrafluoroethylene as the dielectric medium was used in a vacuum chamber for the measurements during irradiation. The current (down to 10^{-12} amp.) was measured with a Baldwin 'Ionex' Mk3 d.c. amplifier. The X-rays were generated at 220 kVp., with a half-value layer of 1·7 mm. of copper.

Dose-rate dependence. The equilibrium induced current i is related to the dose-rate R by the general relationship:

$$i \propto R^{\Delta},$$

where Δ is a characteristic of the material. For polytetrafluoroethylene over the range $R = 2$ to 65 r./min., and between 20° and 110° C., we find $\Delta = 0{\cdot}63 \pm 0{\cdot}08$, with the higher values at the lower temperatures. This is in contrast to 'Perspex'[2] and some specimens of amber, for which $\Delta = 1{\cdot}0$, but compares with polythene[2,3], for which $\Delta = 0{\cdot}8$.

Such a value of Δ leads us to postulate an exponential distribution of traps below the conduction band for polytetrafluoroethylene, using Rose's model of electron trapping[4]. Quantitative predictions can also be made of the temperature-dependence of induced current.

Temperature dependence. Fig. 1 shows the curves of log conductivity of polytetrafluoroethylene plotted against $1/T$°K. The relationship is of the usual form[1]:

$$\sigma = \sigma_0 \exp(-W/kT),$$

giving a straight line the slope of which is a measure of W.

Curve *a* in Fig. 1 is for the 'static conductivity' (that is, with no incident radiation; the specimen had, however, received a total dose of 10^4–10^6 r. some months previous to these experiments). This slope gives $W = 1{\cdot}1$ eV.

Curve *b* is for the equilibrium induced conductivity under X-irradiation, at $R = 7$ r./min. The slope in this case corresponds to $W = 0{\cdot}5$ eV.

From this slope, it can be seen that the induced current increases by a factor of 50 between 300° and 400° K. The corresponding increase predicted using Rose's model of an exponential distribution of traps, with $\Delta = 0{\cdot}63$, is by a factor of 30. The agreement is fair, and would be improved by taking a slightly higher value for the number of available energy-states in the lowest levels of the conduction band.

A further demonstration of the applicability of this model is provided by the variation of Δ with temperature. If $\Delta = 0{\cdot}63$ at 65° C., then calculation predicts $\Delta = 0{\cdot}60$ at 110° C. and $\Delta = 0{\cdot}66$ at 20° C. A systematic variation of Δ was in fact observed, with $\Delta = 0{\cdot}55$ at 110° C. and $\Delta = 0{\cdot}71$ at 20° C. The measured variation is somewhat greater than the predicted variation; but this is probably because the experimental accuracy is rather low with such a small specimen.

Decay of induced current. The time-constant of decay varies slowly with temperature, showing the

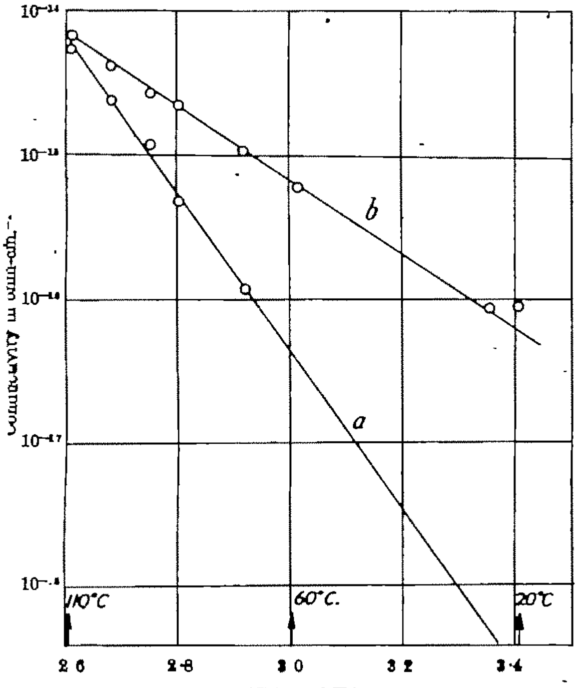

Fig. 1 (a). Without incident X-rays; (b) during irradiation

same general features as for polythene; at temperatures below 50° C., the current falls at first more rapidly, but after a few minutes more slowly, than at higher temperatures, so that complete decay takes longer at the lower temperatures. The time-constant decreases with increasing dose-rate. After a few minutes, the remaining current is inversely proportional to time, as for polythene. The magnitude of the time-constant is large. For example, the current induced in polythene at 80° C. falls to a enth of its initial value in 5 min., and to a hundredth n 25 min., whereas for polytetrafluoroethylene the fall to a tenth takes 6 hr. at the same temperature and dose-rate.

Comparison with other materials. The conductivity induced in polytetrafluoroethylene by X-rays is less han that induced in polythene under the same conditions by a factor of ten. Nevertheless, the fact hat the time-constant of recovery is much longer in polytetrafluoroethylene means that, so far as materials for ionization chambers are concerned, polythene and polytetrafluoroethylene are about equally undesirable. The induced conductivities in 'Perspex' (both red and colourless) and in some specimens of amber (for which we found Δ = 1) are less than that in polyetrafluoroethylene by a factor of ten, and in addition he time constants of recovery are very much shorter. This contrasting behaviour is likely to be a result of he different trap distributions.

Warner pointed out in 1949[5], from the expected complexity of molecular branching in polytetrafluoroethylene, that large induced conductivities would probably be observed under X- and γ-irradiation. Our results confirm this.

Liversage[6] has investigated the behaviour of polytetrafluoroethylene ionization chambers under X-rays. His information is too incomplete to corelate with the present results; but his general onclusions concerning this compound were the same: he insulating properties are seriously impaired by radiation in doses (and, we would add, at dose-rates) which leave amber relatively unaffected.

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Photographic Recording of Cathode Ray Tube Traces

WHEN recording oscillograms by means of a camera, it is desirable to photograph at the same time the scale markings engraved on the oscilloscope graticule; if the graticule includes scales of distance along the two axes, direct measurements may then be made on a subsequent enlargement. It is also necessary to have some positive means of identification for each oscillogram, and the best method is one which allows the relevant data to be photographed at the same time as the cathode-ray tube trace.

A popular method of illuminating a 'Perspex' graticule is by means of edge-on lighting, but this does not provide any means for photographing, say, a written note, about the phenomenon to be recorded. To do so usually involves the use of ambient lighting, causing a loss of contrast which may not be permissible if the intensity of the trace is low.

A simple method by which it has been found possible to secure satisfactory illumination both of a graticule and a small slide of relevant data is by mounting two indicator bulbs behind the plane of the cathode-ray tube face, and over the gap between the internal graphite shield and fluorescent coating. This allows light to shine into the tube itself and upon the inside surface of the screen. The phosphor causes diffusion of the light, and possibly some fluorescence, resulting in an even illumination of the screen, graticule and small glass slide. This slide, which is ground on one side, is supported close to the tube face. Details of the oscillogram written on the slide in pencil can be clearly seen in the photo-

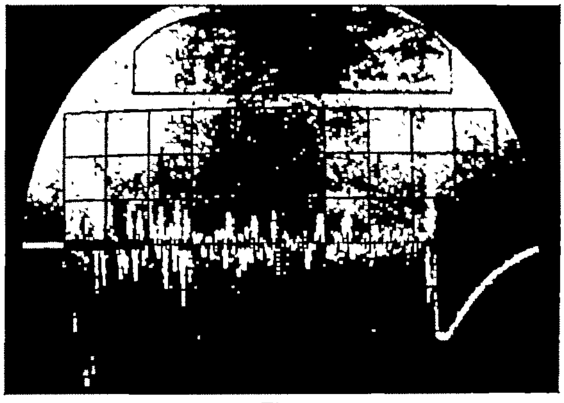

Fig. 1

graph (Fig. 1), and the visibility of even a faint trace is little affected by the illumination.

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Unusual Doubling of Spectral Lines

When we were taking spectra of a high-frequency operated interrupted a.c. arc with the Zeiss autocollimation camera (Försterling set of 3 prisms, $f = 1{,}300$ mm.), a doubling of spectral lines was observed. The distances of the components increase with increasing refractive indices n and decreasing λ. It was ascertained that the trouble was due to oscillations of the prisms, which were in perfect synchronization as to period and phase with the cycles of the light source. These oscillations were caused by the vibrations of the housing of the arc source, which was placed too near the support of the spectrograph.

Such an explanation, however, seemed at first inconceivable, as differential deviations caused by oscillating prisms at minimum deviation should be zero for the region of the minimum rays and very inconspicuous in the other parts of the spectrum. But since there is also a Pellin–Broca prism of constant deviation in the prism set, things turned out rather differently. The reason for the difference is that the variation of the deviation ϑ with the variation of the incident angle α_1 is different for ordinary prisms and for Pellin–Broca types, namely,

$$\frac{d\theta}{d\alpha_1} = 1 \pm \frac{d\alpha_2}{d\alpha_1},$$

where the plus sign holds for ordinary prisms and the minus for the Pellin–Broca type (α_2 being the angle of the outgoing ray). The differential quotient $d\alpha_2/d\alpha_1$ is found to be

$$\frac{d\alpha_2}{d\alpha_1} = -\frac{\cos\alpha_1 \cos\beta_2}{\cos\beta_1 \cos\alpha_2},$$

β_1 and β_2 being the refracted angles within the prism. This quotient is equal to -1 for the ray of minimum deviation, and equal to a quantity $A_1 = f(\gamma, n_0, \Delta n)$ for rays the index of refraction of which differs from that of the minimum deviation (n_0) by Δn. We found, approximately,

$$\frac{d\alpha_2}{d\alpha_1} \doteq -\frac{1}{1 + C_0\Delta n} = A_1,$$

where

$$C_0 = \frac{2\sin^2\gamma/2\,(1 - n_0^2)}{n_0\cos^2\gamma/2\,(1 - n_0^2\sin^2\gamma/2)},$$

γ being the refracting angle of the prism, and n_0 the refractive index of the ray which is at minimum deviation. For 60° prisms C_0 reduces to

$$C_0 = \frac{8(1 - n_0^2)}{3\,n_0(4 - n_0^2)}.$$

A_1 holds only for a single prism. If there are several prisms of the same refracting angle and the same material, then for the prism k

$$A_k = \frac{1}{1 + (2k - 1)\,C_0\Delta n}.$$

For calculating the amplitude of the prism oscillation from the displacements of the spectral lines onl the region of the λ_0 of the minimum deviation ha to be considered. In addition, only prisms of constant deviation give a contribution to the effect i the sense that

$$d\vartheta = 2d\alpha_1.$$

In the present case these amplitudes range betwee 3·5′ for the original position of the arc source whe the effect was first observed, to about 8·5′ for position where the housing of the generator wa purposely pressed against the support of the spectrograph.

A fuller account will be published in *Ricerch Spettroscopiche*.

J. Junkes
E. W. Salpeter

Astrophysical Laboratory,
Vatican Observatory,
Castel Gandolfo.
March 7.

A Graphical Method of analysing Creep Curves

The retarded elastic extension of a high polyme under load can be represented by a series of Voig elements, each consisting of a spring and dashpot i parallel. With each element is associated a retardatio time, and a series of Voigt elements therefore give rise to a spectrum of retardation times. This spectru can be obtained from a creep curve by a method du to Alfrey[1]. In his method the extension is plotte against log-time, and the slope of this curve whe plotted against log-time gives a close approximatio to the spectrum.

When applying Alfrey's method to some cree curves of polyester, it was found that the spectr obtained were similar in outline to a Gaussian curv confirming a suggestion by Weichert[2] that such distribution of retardation times explained satis factorily the creep curves of some rubbers. Th graphical method of analysis described below sti uses the assumption of a Gaussian log-normal di tribution, but eliminates the need for tediou graphical differentiation and numerical calculation It provides a simple way of evaluating the thre constants involved and has been used to analyse th creep curves of polyesters, poly*iso*butylene, polythen and other high polymers. In all cases the experiment curves lie very close to those that can be calculate using the values of the three constants.

Applying Alfrey's method to a creep curve an assuming the resulting distribution to be Gaussia when plotted on a log-time scale, then it can b shown that

$$\frac{t\,d\gamma}{dt} = \frac{ch}{\sqrt{\pi}} \exp -\left(h \log \frac{t}{\tau_m}\right)^2,$$

where γ is strain, t is time, τ_m is maximum of th Gaussian curve, h is $1/\sqrt{2}\,\sigma$, σ is standard deviatio of the Gaussian curve and c is a constant.

When integrated from $t = 0$ to $t = t$ this gives

$$\gamma = c/2\,(1 \pm \operatorname{erf} h \log t/\tau_m),$$

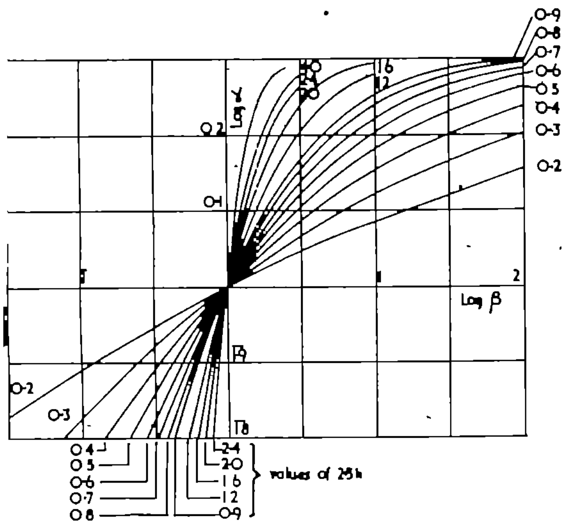

Fig. 1. Master curves

he positive sign referring to $t > \tau_m$, the negative ign to $t < \tau_m$.

It will be observed that when t is infinite then ' = c, and hence c is termed the equilibrium strain. A creep curve with no instantaneous extension and o viscous flow is therefore analysed in terms of three onstants, namely, the equilibrium strain (c) for a iven stress, the modulus of precision (h) of the etardation time spectra and the most common etardation time present (τ_m) in the deformation.

It has been found possible to develop a simple raphical method for the evaluation of the three onstants. If t is expressed in terms of τ_m, then a hange in τ_m results in a change in the time-scale of he experimental curve and moves a plot of γ against og t along the time axis with no change in shape. imilarly, if γ be expressed in units of $c/2$ and log γ s plotted against log t, then a change in c will move he curve along the extension axis with no change of hape. The shape of the curves of log γ against log t, herefore, will be independent of both τ_m and c and ill be determined entirely by h. It is therefore ossible to produce a set of master curves (Fig. 1) aving the general equation:

$$\log \alpha = \log(1 \pm \operatorname{erf} h \log \beta),$$

here $\alpha = 2\gamma/c$ and $\beta = t/\tau_m$.

The experimental curves when plotted as log-train against log-time will have a close fit in one and ne only of the curves, provided the distribution of etardation times can be satisfactorily described as Gaussian log-normal'. This has been found to be the ase with many types of polymers.

The general procedure for analysing experimental urves is as follows. The extensions are taken from he experimental curve at twenty to thirty points ogarithmically distributed along the time axis. A lot is then made on tracing paper of log-strain gainst log-time, using the same scale axes as for the aster curves. The unique position of this curve on he master set is then determined and the position f the point (log $\alpha = 0$, log $\beta = 0$) is noted as well s the value of h. When log $\alpha = 0$, $\alpha = 1$, and herefore the strain is $c/2$, and also log $\beta = 0$ and ence the time is τ_m. Both these values are read off rom the experimental axes.

With an experimental curve extending over three decades of time, $2{\cdot}3h$ is determined correct to at least 5 per cent, which causes τ_m to change by a factor of about 2 while the equilibrium modulus changes by ± 7½ per cent.

A. J. ELLEMAN

Imperial Chemical Industries, Ltd.
(Paints Division),
Wexham Road,
Slough, Bucks.
Feb. 25.

---

[1] Alfrey, T., "Mechanical Behaviour of High Polymers", 556 (Interscience Pub., 1948).

[2] Weichert, H., *Ann. phys. Chem.*, 50, 335 (1893).

A Statistical Method of estimating the Periods of Incubation and Infection of an Infectious Disease

CERTAIN infectious diseases are supposed to have relatively constant incubation periods with short intervals of high infectivity. Greenwood[1] studied an idealized model, having a fixed incubation period and point-infectivity. He showed that a single primary case in a small family group of susceptibles would lead to a chain of binomial distributions of new cases. With measles, the observed distribution of the total size of family epidemics agreed closely with that predicted by the theory. Later, Wilson *et al.*[2], analysing new data with respect to the actual links of each chain, obtained only poor fitting of theory to observation. Following a hint of Greenwood's[3], Bailey[4] showed that satisfactory agreement could be restored by introducing a suitable distribution for the chance of infection in different families.

There has, however, always been difficulty in the 'chaining' of data, partly because the intervals between successive cases are liable to show appreciable variation, and partly because of the occurrence of multiple primaries. Some data had to be rejected before neat chains could be exhibited. An attempt has therefore been made to find a more realistic model of the process of infection, particularly one which would take account of the time-intervals between successive cases and which would not ignore parts of the data.

Attention was first turned to families with only two susceptibles, one of which was the index case. In some families this would be the only case; in others there would be a second case. Excellent detailed records of the right kind have been collected by Dr. R. E. Hope Simpson, of the Cirencester Public Health Laboratory Service[5]. Thus, in 264 families with two susceptible children under the age of fifteen, and at least one case of measles, 45 families had a single case, while for the remaining 219 the time-interval distribution between the two cases is shown in Fig. 1.

The distribution in Fig. 1 falls into two distinct parts: that marked A, which is presumably due to two primary cases, both infected from a single outside source; and B representing infection within the family. Consider the hypothesis of a variable incubation period, at the end of which there is a very short period of infection followed by the appearance of symptoms. The variance, v, of the curve B measures the variation of the incubation period. Curve A is the distribution of the difference, without regard for sign, between two incubation periods commencing at the same instant. The second

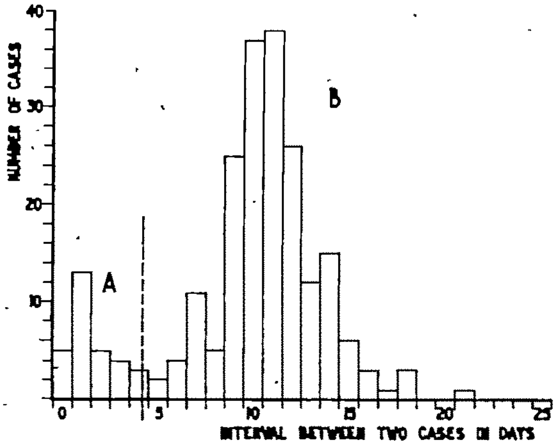

Fig. 1.- Distribution of time-interval between two cases of measles in 219 families with two susceptibles

moment, V, of this distribution about the origin should therefore be $2v$. It is a striking fact that in Fig. 1 V is only about $\frac{1}{2}v$. A new hypothesis is necessary.

Suppose now that after infection there is a latent period which is normally distributed with mean m and variance σ^2, and that it is followed by an extended period of infection of constant length a, after which symptoms appear. Following Hope Simpson[6], the incubation period is then constituted by the latent period plus the period of infection. When there is a single primary case, let the chance of the second susceptible being infected in time dt, during the period of infectivity of the first case, be $\lambda\, dt$. Let there be a total of N families. A of these have double primaries, and lead to curve A, for which we may put

$$V = 2\sigma^2. \tag{1}$$

B families have two cases, a primary and a secondary. The infection of the second case by the first occurs as a Poisson process operating over the limited time a, and this adds a variable time to the latent period to give the time-interval distribution of curve B. It can be shown that equating the mean $\bar{x}$, and the variance, v, of B, to their population values, gives the equations:

$$\bar{x} = m + \lambda^{-1} - a/\{\exp(\lambda a) - 1\}, \tag{2}$$

and

$$v = \sigma^2 + \lambda^{-2} - a^2 \exp(\lambda a)/\{\exp(\lambda a) - 1\}^2. \tag{3}$$

Finally, let there be C families with only one case. Setting this number equal to its expectation in the $(B + C)$ families without a double primary yields:

$$C/(B + C) = \exp(-\lambda a). \tag{4}$$

We can most easily solve successively for λ, a, m and σ from the following equations, which are derived from (1)–(4),

$$\lambda = \sqrt{\left\{1 - \frac{C(B + C)}{[B \log(1 + B/C)]^2}\right\}/(v - \tfrac{1}{2}V)}, \tag{5}$$

$$a = \lambda^{-1} \log(1 + B/C), \tag{6}$$

$$m = \bar{x} - \lambda^{-1} + aC/B, \tag{7}$$

$$\sigma = \sqrt{\tfrac{1}{2}V}. \tag{8}$$

Expressions for the standard errors are availab but are tedious to write down here. Arbitrari separating the distributions A and B by the vertic dotted line shown in Fig. 1, we find that for the data the mean and standard deviation of the di tribution of the latent period are 9·52 and 1·32 day while the period of infectiousness, a, is 3·84 days a λ is 0·43. Thus the incubation period has mean a standard deviation 13·36 and 1·32 days.

A more sophisticated treatment is by using t method of maximum likelihood, which provid efficient estimates, together with their standa errors, and a measure of the goodness-of-fit. It al enables us to dispense with an arbitrary assignme of border-line observations to curves A or B. is intended to describe this work more fully els where, and to include extensions to families wi more than two susceptibles.

NORMAN T. J. BAILEY

Nuffield Lodge,
Regent's Park,
London, N.W.1.
April 1.

[1] Greenwood, M., *J. Hyg. Camb.*, 31, 336 (1931).

[2] Wilson, E. B., Bennett, C., Allen, M., and Worcester, J., *Proc. Am. Phil. Soc.*, 80, 357 (1939).

[3] Greenwood, M., *Biometrika*, 36, 1 (1949).

[4] Bailey, N. T. J., *Biometrika*, 40, 279 (1953).

[5] Hope Simpson, R. E., *Lancet*, ii, 549 (1952), and private co munication.

[6] Hope Simpson, R. E., *Lancet*, ii, 755 (1948).

Determination of Sour Orange Rootstock by Paper Chromatography

'QUICK decline', a devastating virus infection orange trees, was first found to be present in southe California in 1939, and by 1952 it had spread to s of the fourteen counties in which oranges are grow in California. Inoculation tests[1] demonstrated th tolerance to the virus varies with the variety of t rootstock on which the sweet orange is growing, an that the disease is likely to be fatal only if the roo stock is that of the sour orange (*Citrus aurantium* L. Because of this scion-rootstock relationship to t seriousness of the disease, which in one form or anoth is widely spread throughout the citrus-growing are of the world, a method for the detection of the so orange rootstock in established orchards is of co siderable significance.

In this study more than 2,400 ascending a descending chromatograms were made of ten varieti of citrus seedlings, and nine varieties of rootstoc budded with valencias and the same nine budded navel oranges. The ten varieties of seedlings we the Palestine sour, Wolf sour, bittersweet, Robbi grapefruit, Robbins sweet, Wieland rough lemo Cleopatra mandarin, tangelo (variety ?), Troy Citrange and Rubidoux trifoliate orange. T varieties of rootstocks budded to valencias and nave which were planted in 1927 included the Brazili sour, Rubidoux sour, Duncan grapefruit, Koetha sweet, rough lemon, Cleopatra mandarin, Sampso tangelo, Troyer citrange and trifoliate orange.

Fresh pieces of the entire thickness of the bar approximately one-eighth of an inch square, are c from the roots that are to be tested. The piec are placed cambium side down on Whatman No. filter paper and are mashed or struck with a hamm

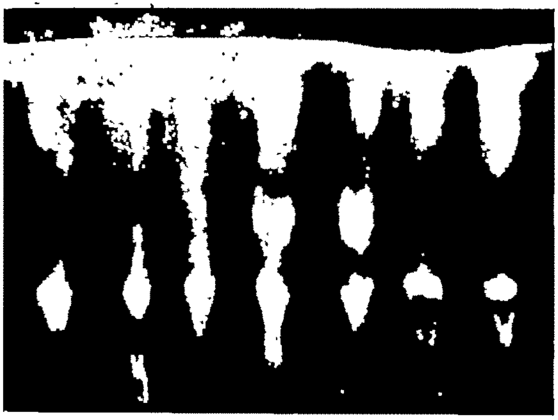

Fig. 1. Chromatograms of seven varieties of seedling citrus rootstocks, from left to right: Troyer citrange, Trifoliate orange (Rubidoux), Cleopatra mandarin, Sour (Palestine), Sour (Wolf), Sweet (Robbins), Grapefruit (Robbins). The solvent was *n*-butanol – acetic – water mixture. The chromatograms were sprayed with ninhydrin, photographed with long-wave ultra-violet light on Plus *X* film and Wratten *K2* filter

order to squeeze out the juices of the bark; or an ation of the bark may be made in the butanol ixture described later and drops of it placed on the ter paper. This is of particular value when working ith the small roots of seedlings[2].

Of the twenty-six different solvents that were sted, the most satisfactory one is the organic phase a mixture of 4 parts of normal butanol, 1 part acial acetic acid, and 5 parts of water. After the lvent has ascended six or seven inches, the paper dried and sprayed with a 0·2 per cent solution of nhydrin in 95 per cent ethanol. The colour is lowed to develop for 24 hr.

Under a long-wave ultra-violet lamp (3600 A.) the nhydrin-sprayed chromatograms of the sour orange otstocks show a yellowish fluorescent, 'flame-like' ot with an R_F value of approximately 0·50. Fig. 1 ows the chromatograms of seven seedling rootstocks. he fourth and fifth ones from the left are those of o varieties of sour orange. Commercial rootstocks of citrus trees that are not 'sour' do not give the 'flame reaction'.

Table 1

	Solvent	Quality of 'flames' on Whatman No. 1 filter paper when sprayed with ninhydrin
1	*n*-Propyl (2): 5 per cent ammonium hydroxide (1)	None
2	*n*-Propyl (70): glacial acetic (15): water (10)	Hazy
3	*iso*-Propyl (2): 5 per cent ammonium hydroxide (1)	None
4	*iso*-Propyl (70): glacial acetic (15): water (10)	Hazy
*5	*n*-Butyl (4): glacial acetic (1): water (5)	Very good
*6	*n*-Butyl (4): propionic acid (1): water (5)	Very good—equal or better than 5
7	*n*-Butyl (80): 25 of (10 con. formic + 1,500 water)	Good
8	*n*-Butyl (80): 25 of (10 con. hydrochloric + 3,000 water)	Fair
*9	*sec.*-Butyl (4): glacial acetic (1): water (5)	Fair
*10	*iso*-Butyl (4): glacial acetic (1): water (5)	Good
11	*tert.*-Butyl (70): con. formic (15): water (10)	All rootstocks appear similar
12	*tert.*-Butyl (70): glacial acetic (15): water (10)	Hazy
*13	Amyl (4): glacial acetic (1): water (5)	Poor; small R_F values
*14	Octyl (4): glacial acetic (1): water (5)	Nothing
*15	Butyl acetate (4): glacial acetic (1): water (5)	Nothing

* Mixture separates; only the top phase is used

Table 1 shows that the three four-carbon, water-insoluble butyl alcohols (namely, *n*-butyl, *sec.*-butyl and *iso*-butyl) give the 'flame reaction' with sour orange rootstocks. *Tert.*-butyl, which is water-soluble, produces a haziness in the 'flame' area with acetic acid, and when formic acid is used all rootstocks have similar and indistinctive chromatograms.

'Sour' rootstocks form 'flames' with the organic phase of *n*-butyl alcohol – water mixtures when the *p*H is adjusted between 2·4 and 3·0 with a number of acids including acetic, propionic, formic and hydrochloric.

This method makes it possible to determine which, if any, of the trees in a citrus orchard are growing on sour orange rootstock, and therefore susceptible to the virus of quick decline.

I wish to thank Dr. Carl Wolf, of the La Cienega Nursery, Fillmore, California, and Dr. W. P. Bitters, of the University of California Citrus Experiment Station, Riverside, California, for supplying rootstocks of known pedigrees. I also acknowledge valuable discussions with my colleague Dr. Frank L. Lambert.

RAYMOND M. SELLS

Department of Biology,
Occidental College,
Los Angeles,
California.
March 4.

---

[1] Bitters, W. P., and Parker, E. R., Agric. Exp. Stat., Univ. Calif., Berkeley, 6, (4), 10 (1952).

[2] Sells, R. M., *Citrus Leaves*, 34, 6 (1954).

Frequency Distribution of the Concentrations of Elements in Rocks

IN a recent communication[1], Ahrens reported some data on the frequency distribution of some of the elements in igneous rocks, and enunciated a geochemical law to the effect that the concentration of an element in a specific igneous rock is lognormally distributed. Observations have been made at the Fuel Research Station of the Department of Scientific and Industrial Research on the trace elements in coals and coal ashes. Our data, although applying to this special type of sedimentary material, have suggested certain considerations which appear to be relevant to the subject of Ahrens's communication.

In dealing with the concentrations of a minor constituent expressed as a proportion of the whole, it is clear that there are far greater possibilities for the data to vary to higher values than to lower values. It would be expected, therefore, that such data would have a positive skew distribution which might, to some extent, simulate the lognormal. The position is different when considering the concentrations of a major constituent of a material. In a system with only two main components, it is clear that if the distribution of concentration of one of these has a positive skewness then that of the other will have a negative skewness, which will be a mirror image of the distribution of the first constituent. The position is less well defined when the number of major constituents is increased; but here again the distribution of the data for at least one of the constituents will tend towards a negative skewness. This may be illustrated by data for the three most abund-

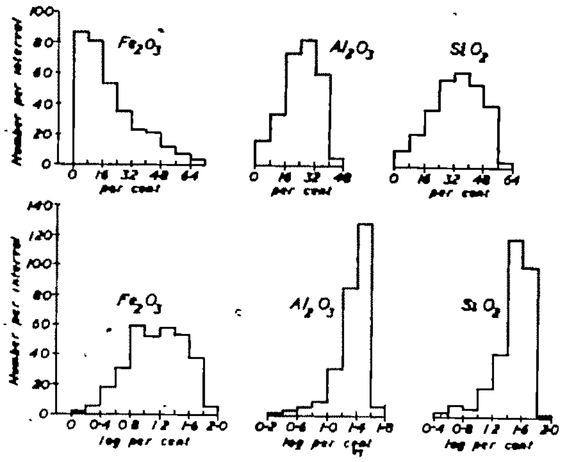

Fig. 1. Frequency distributions of the major constituents of coal ash. Crown copyright reserved

ant radicals in coal ash, namely, SiO_2, Al_2O_3 and Fe_2O_3 (Fig. 1): the figures for Fe_2O_3 follow very approximately a lognormal distribution, but those for SiO_2 and Al_2O_3 exhibit a slight negative skewness for the untransformed variable and a marked negative skewness for the logarithmic derivative. It is assumed that the law suggested by Ahrens was meant to apply only to minor constituents, but the above considerations raise the interesting point as to the level of concentration at which the distribution of the data for an element might begin to lose its positive skewness.

The same considerations also indicate the possibility that even a trace constituent of a rock might fail to follow a lognormal, or even an approximately lognormal distribution. This could arise if the trace element were closely bound to one particular ma constituent which itself failed to exhibit a positi skew distribution. Ahrens has shown that the co centrations of many trace elements in igneous roc follow an approximately logarithmic distributior but if a law, rather than a working rule, is to enunciated, it would be desirable to show that departure from a strictly lognormal distribution h been observed or might be expected. In this co nexion it appears that the data quoted for rubidiu (*loc. cit.*) show some evidence of a slight negati skewness when in the logarithmic form.

The data obtained at the Fuel Research Station the occurrence of about twenty trace elements more than two hundred British coals have provid many examples of an approximation to a lognorm distribution. This is exemplified by the diagran for the distribution of concentration of copper coal, on a linear and logarithmic basis (Fig. 2 Other elements, such as vanadium (Fig. 2), exhib a certain amount of negative skewness in t distribution of the logarithmic derivative, althou it is clear that the distribution is nearer to the lo normal than to the normal. It has been possible some cases to relate these differences to the differe parent materials responsible for introducing t elements into coal. This and other aspects of su data for coal will be discussed in greater det elsewhere.

This work forms part of the programme of t Fuel Research Board of the Department of Scienti and Industrial Research and is published by pe mission of the Director of Fuel Research.

K. V. AUBREY

Fuel Research Station
(Department of Scientific and Industrial Research),
Greenwich,
London, S.E.10.
March 17.

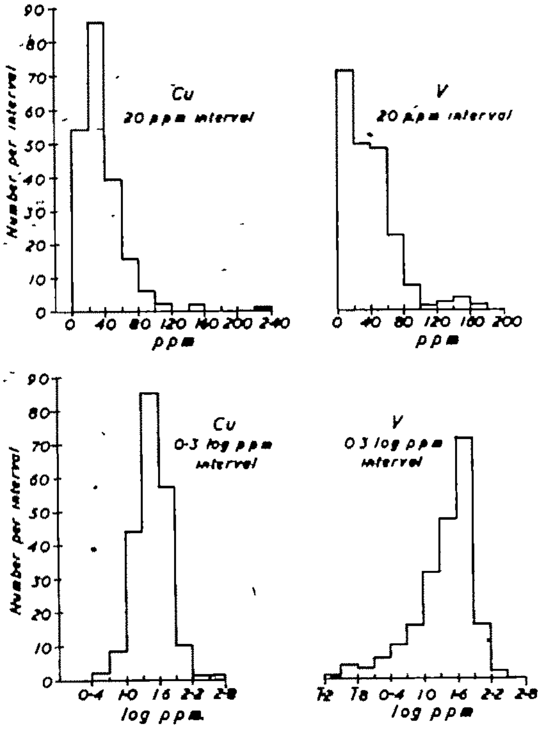

Fig. 2. Frequency distributions of the concentrations of two minor constituents of coal. Crown copyright reserved

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[1] Ahrens, L. H., *Nature*, 172, 1148 (1953).

Light Cages for Birds

THE principle of bird-cages using a screen bright light, but no glass, wire or other mechanic means of preventing escape, was arrived at approxin ately simultaneously and independently in the zo at Antwerp and Basle.

I do not wish to claim priority for the discover of this principle of display.

H. HEDIGER

Copenhagen.
June 25.

[Dr. Hediger, who is director of the Zurich Zo logical Gardens, in his book "Wild Animals Captivity" (London, 1950) wrote on p. 58: "Follo ing the conference of zoo directors in Rotterdam 1946, the author had a conversation with the ne director of the Antwerp Zoo about this improve type of cage. That same year he constructed similar experimental cage in the Basle Gardens. Th was officially visited in 1947 when the conference zoo directors met in Basle. In 1948 cages of th sort were opened to the public for the fir time in the modernized aviary in the zoologic gardens at Antwerp and claimed as an Antwe discovery".]

FORTHCOMING EVENTS

Monday, July 19

St. Bartholomew's Hospital Medical College (in the Physiology cture Theatre, Charterhouse Square, London, E.C.1), at 5.30 p.m.—of. Seymour S. Kety (U.S.A.): "The Theory and Applications of art Gas Exchange".

Monday, July 19—Tuesday, July 20

University of Birmingham, Department of Metallurgy (at e University)—Conference on "Mechanical Effects of Dislocations Crystals".

Monday, July 19—Friday, July 23

Department of Atomic Energy (at Oxford)—Radioisotope nference.

Wednesday, July 21

Society for Analytical Chemistry (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Special Meeting on "The Use of Perchloric Acid in Analytical Chemistry".

Thursday, July 22—Friday, July 23

Society for the Study of Fertility (at the Meeting House of e Zoological Society of London, Regent's Park, London, N.W.1)—nference.

Friday, July 23—Saturday, July 24

Nutrition Society (in the Dobbie Lecture Theatre, University llege of North Wales, Memorial Buildings, Deiniol Road, Bangor, aernarvonshire)—Symposium on "The Efficiency of Food Conversion Farm Animals".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or fore the dates mentioned:

Assistant Lecturer (with special qualifications in petrology) in he Department of Geology—The Registrar, University College Wales, Aberystwyth (July 20).

Head (with a good honours degree and/or an appropriate professional alification, and senior experience in a technical college or university) the Engineering Department, and Head of the Science epartment, Royal Technical College of East Africa, Nairobi—The cretary, Advisory Committee on Colonial Colleges of Arts, Science d Technology, 1 Gordon Square London, W.C.1 (July 20).

Research Fellow (with previous research experience) in Geology -The Registrar, The University, Edgbaston, Birmingham 15 (July 21).

Assistants (2) (with a degree in agriculture, botany or agri- ltural botany, and a special interest in grasses), for recording getation changes resulting from the death of rabbits through the read of myxomatosis—The Establishment Officer, The Nature nservancy, 19 Belgrave Square, London, S.W.1 (July 22).

Senior Scientific Officer (with a degree of high standard in athematics or one of the physical sciences) in the Department of pply, Research and Development Branch, Central Staff, Mel- urne, for research activities with the Australian Army Operational search Group, involving the scientific study and analysis of a wide nge of operational problems including the assessment of new eapons—The Senior Representative (A.P.19), Commonwealth of ustralia, Department of Supply, Australia House, Strand, London, .C.2 (July 23).

Physicist or Fuel Technologist (preferably with a university gree or equivalent qualifications) to undertake miscellaneous in- stigations on the physical properties of fuels and refractories—The ivisional Chief Scientist, National Coal Board, Roundwood Colliery fices, Parkgate, Rotherham (July 23).

Assistant Lecturer (preferably with qualifications in physical d inorganic chemistry) in the Department of Chemistry—The gistrar, The University, Hull (July 24).

Research Fellow (preferably with experience in use of mass ectrometer or molecular stills) in the Department of Chemistry, r the investigation of evaporation processes, with special reference the break-up of complex molecules—The Registrar, The University, dgbaston, Birmingham 15 (July 24).

Lecturer (with a university degree, or equivalent and considerable aching experience) in Mathematics—The Principal, Royal Aircraft tablishment Technical College, Farnborough, Hants (July 26).

Research Fellow in Theoretical Nuclear and Elementary rticle Physics—The Professor of Natural Philosophy, The Univer- y, Glasgow (July 26).

Lecturer (with special interests in animal husbandry) in Agri- lture—The Registrar, The University, Nottingham (July 28).

Demonstrator in the Department of Animal Pathology—e Secretary, Appointments Committee of the Faculty of Biology B", Department of Pathology, Tennis Court Road, Cambridge uly 31).

Lecturer or Assistant Lecturer (with a special interest in the nnective tissues) in Pathology—The Registrar, The University, anchester 13 (July 31).

Lecturer (with experience in hydraulics and public health gineering (water supply, sewage treatment, etc.), and able to lecture d organize laboratory and research courses on these subjects) in vil Engineering—The Registrar, King's College, Newcastle-upon- ne (July 31).

Research Assistant (with an honours degree in metallurgy or ysical chemistry) to the Joseph Lucas Research Fellow in Electrometallurgy, to undertake research on the growth and properties of electrodeposits; and a University Research Fellow (graduate in metallurgy, engineering or a related science), to engage in research in the field of metal working—The Registrar, The University, Edgbaston, Birmingham 15 (July 31).

Research Officer (Geomorphologist) (with a university honours degree in science, with geology as a major subject, or equivalent qualifications, and preferably with experience in field surveys and the interpretation of aerial photographs) in the Land Research and Regional Survey Section of the Commonwealth Scientific and Industrial Research Organization, to be a member of a scientific survey team which is conducting potentiality surveys in the Papua–New Guinea region—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 570/31 (August 7).

Scientist, Grade III (with a good honours degree or equivalent in a science subject, and preferably with a sound background in geology and chemistry), in the National Coal Board Survey Laboratory, Birmingham, for work which will include the preparation of detailed reports on the structure and physical and chemical properties of the coal seams covered by the laboratory—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/804 (August 7).

Lecturer in Plant Physiology at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 10).

Lecturer in Classical Archæology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, August 14).

Lecturer in Dressing of Minerals and Coal Preparation, to undertake and promote research, lecture on coal preparation and mineral dressing, and assist in the supervision of laboratory work—The Registrar, The University, Leeds 2 (August 14).

Lecturer (with special qualifications in physical or inorganic chemistry) in Chemistry—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (August 27).

Lecturer (preferably with qualifications in the fields of human and regional geography) in Geography, at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

Senior Lecturer in Chemical Engineering, and a Lecturer in Geography, at the University, Cape Town—The Secretary, Association of the Universities of the British Commonwealth, 5 Gordon Square, London, W.C 1 (August 31).

Reader in Pure Mathematics at the University of Oxford—Prof. E. C. Titchmarsh, Mathematical Institute, 10 Parks Road, Oxford (September 15).

Senior Research Officer (with a doctor's degree in physics), and Research Officers (with an honours degree in physics or equivalent, or a degree in light current engineering) in the Nuclear Physics Division of the National Physical Laboratory, Pretoria, South Africa—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, September 15).

Assistant Experimental Officer (with a pass degree or H.N.C. or equivalent in chemistry, and preferably with experience of analysis), in the Department of Scientific and Industrial Research, Fire Research Station, Boreham Wood, Herts, for duties which will involve chemical analysis, assistance in research on fire extinction, and the investigation of industrial fire hazards—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S W 1, quoting F.355/54A.

Assistant Lecturer, Grade B, in the Department of Chemistry, and an Assistant Lecturer, Grade B, in the Department of Mathematics, at the College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

Assistant Lecturer, Grade B (with a good degree in botany and zoology) in the Department of Biology, and an Assistant Lecturer, Grade B (with an honours degree in chemistry, and able to teach one branch of chemistry, preferably physical or inorganic, up to B.Sc. Special Chemistry standard) in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Biochemist (Senior Scientific Officer or Scientific Officer grade), for research on the composition and metabolism of leaves—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Electronics Engineers and Physicists, Scientific Officer grade (with first- or second-class honours degree or equivalent) or Assistant Experimental Officer grade (with H.S.C. (science) or equivalent), at Ministry of Supply Experimental Establishments at Farnborough, Hants, Malvern, Worcs, Sevenoaks, Kent, and elsewhere, mainly in Southern England, for duties which include research, development or design of telecommunications and radar equipment; guidance and control systems; instrumentation for a variety of research problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.296/54A.

Laboratory Assistant (female) (with a degree in pure botany, agricultural botany, or equivalent) in the Plant Pathology Section of the Department of Agriculture, Scott Agricultural Laboratories, Kenya—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/7/09.

Lasdon Research Fellow (with an honours degree in one of the biological sciences, and some research experience) to work on the chemotherapy of tuberculosis, under the direction of Dr. V. C. Barry, in the Laboratories of the Medical Research Council of Ireland—The President, University College, Dublin, Ireland.

Lecturer in Pharmaceutics at the Technical College, Bradford—The Director of Education, Town Hall, Bradford 1.

Lecturer (with a degree or equivalent qualification, and some industrial experience, preferably in the field of electrical measurements) in the Department of Electrical Engineering—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

Lecturer (with special qualifications in pure mathematics) in Mathematics—Head of the Mathematics Department, Imperial College, London, S.W.7.

Metallurgist (with a first- or second-class honours degree in metallurgy, or A.I.M., or equivalent, with at least three years industrial experience), to advise on selection of materials for use on specialized plant; to deal with day-to-day metallurgical problems arising on design work; and to maintain liaison between development laboratories and design offices—Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 693.

Metallurgists to study industrial problems on the melting, casting and fabrication of non-ferrous metals—The Secretary, British Non-Ferrous Metals Research Association, 81 Euston Street, London, N.W.1.

Physical Chemist (with post-doctorate or equivalent research experience, and preferably with experience in vacuum techniques and a knowledge of electronics), to study evaporation from solid surfaces—The Laboratory Superintendent, Department of Chemistry, The University, Edgbaston, Birmingham 15.

Protozoologist (with a medical or veterinary degree or diploma registrable in the United Kingdom, and with two years postgraduate research experience, and a sound knowledge of protozoology), with the East Africa Tsetse and Trypanosomiasis Research and Reclamation Organization, to undertake research in the human and animal trypanosomes—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.195/188/01.

Reader or Senior Lecturer in Agricultural Genetics and Plant Breeding; Lecturer in Agricultural Genetics and Plant Breeding, and a John Mortlock Research Fellow, in the Department of Agronomy, Waite Agricultural Research Institute, University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

Research Assistant (graduate (honours or pass degree), with qualifications in botany or biochemistry) **in the Department of Botany**, to work on the physiology of plant growth hormones and inhibitors—George Harrison Professor of Botany, The University, Manchester 13.

Scientific Officers (with a first- or second-class honours degree in physics or equivalent qualifications) for (*a*) to undertake studies of the mechanical effects of stresses applied to atomic weapons (Ref. 109/WGH/34); (*b*) to work in close conjunction with a group of chemists engaged in research on radioactive materials (Ref. 161/WGH/34), and (*c*) for work of a qualitative and quantitative spectrographic analysis of inorganic substances—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

Senior Entomologist or Entomologist (with a university qualification with entomology as a special subject, and for the senior post, some years experience) **in the Veterinary Department**, Kaduna, Nigeria, for work on the eradication of tsetse fly in relation to trypanosomiasis of cattle—The Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.67/14/07.

Teachers (with high qualifications and able to teach to advanced level and university scholarship standard) **of Mathematics and Chemistry**—The Headmaster, Dartington Hall School, Totnes.

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SCIENTIFIC ADVANCES AND INDUSTRIAL DEVELOPMENT

IN an address on science and our industrial future to the Parliamentary and Scientific Committee on May 11, Sir Ben Lockspeiser reviewed some of the ways in which scientific advance has modified profoundly the pattern and character of manufactured goods in international trade. The decline in importance of the older industries in favour of the metal-using industries and those yielding engineering products of a much higher capital value in relation to raw materials used is, he believes, to the advantage of Great Britain. We have the scientific power, the mechanical skill, ingenuity and design ability required; but we can only adapt ourselves to changing conditions by deliberate forethought and concentration of purpose. Sir Ben instanced some of the new opportunities presented to the gas scientists and engineers and in the manufacture of chemicals from oil, as well as in industrial microbiology; but his main stress was laid on the far-reaching consequences which might flow from the applications of the electronic computor in its fully automatic general purpose form. Such machines make considerable demands for the use of scarce and expensive materials such as germanium. A new atomic battery which uses a silicon transistor might be no more than a scientific curiosity; but it could equally prove the first step in the direct conversion of atomic radiation to electrical power.

The full exploitation of transistors, special circuits and electronic innovations generally would no doubt promote the coming of the fully automatic factory. It would also have a profound effect on the development and conservation of natural resources and on human relations in industry. We are, Sir Ben said, within sight of being able to remove the boredom of repetitive routine work, and in the future people may be called upon more and more for creative activity which machines cannot give. This would undoubtedly involve social strains. It could, for example, call for a larger number of highly skilled technicians associated with a comparatively small number of unskilled workers. Already the diminishing differential in pay between skilled and unskilled workers tends to discourage the young worker from serving the years of apprenticeship or training necessary to acquire skill or technique, and the situation envisaged by Sir Ben may well require considerable readjustment of such differentials in pay.

We would require also a much clearer understanding of human behaviour. The Department of Scientific and Industrial Research, said Sir Ben, is already studying the effect of automatic control on human relations in industry, on the skills required and on the problems of management, organization and control, and he referred to an exploratory research project which the Human Relations Committee, established last year jointly by the Department and the Medical Research Council, is sponsoring at the University of Cambridge. This project will cover such matters as the skills required to operate automatic control techniques, problems of adaptation and re-learning by operators, the attitudes of workers to the changes and the implications for management structure and communication.

Many old conceptions on both sides of industry are still current in Great Britain, although completely out of step with modern technology; a considerable revolution in thought by employers' federations, trade unions, and the nation as a whole must be faced if we are to keep our place as an industrial nation. Scientists may need to broaden their outlook; but we may well advance more quickly in the field of human relations if, to the classical tradition in education, is added a working knowledge of the scientific method, thus enabling more people to bring the rich background of the humanities to the systematic study of human relations. The problem must be tackled realistically, making use of knowledge from the social as well as from the physical sciences.

As Sir Ben pointed out, we cannot expect anybody to invest the large capital required for these new developments without some assurance that they will be operated fully and properly. It is this that gives such importance to the study of the human factors facilitating and restricting the introduction of new production techniques and methods. At the University of Liverpool, for example, the Human Relations Committee is sponsoring an investigation designed to throw light on the factors which tend to facilitate or impede change, the kinds of relationship which tend to promote the absorption of change, and the methods by which change can be absorbed with the minimum disturbance of human relations and welfare. Another study, at the Tavistock Institute of Human Relations, seeks to clarify particularly the way in which technological factors and social or works organizations are related to each other, while a fourth project sponsored by the same Committee at the University of Edinburgh is on the adaptation of the management structure in several Scottish firms to their new activities in the development of electronic equipment, and the adjustment of individuals and groups to new requirements and routines.

The rate of technological innovation is likely to be the most significant factor determining industrial productivity in the future, but the study of human relations is only one of the ways in which technological innovation makes great demands on management. Some of the wider implications have been discussed by Dr. Alexander King, chief scientific officer, Intelligence Division, Department of Scientific and Industrial Research, in a recent article in *The Manager*. Dr. King was concerned with the personal qualities which are needed for wider application of science in industry and the rapid adaptability of industrial design to need and to changing conditions. He recognizes that technological development depends on other factors also, including investment policy and the availability of capital, which are in turn related to the level of taxation and general economic conditions, apart from the psychological conditions under study by the Human Relations Committee and that since established by the Royal Society of Arts, the British Association and the Nuffield Foundation. He insisted, nevertheless, that, at the least, the management of a firm must possess a general background understanding of science and sufficient knowledge of its own expanding technology to enable a balance to be struck between the scientific and economic factors. All major technological development depends on striking such a balance—also, as we are now realizing, on striking it with the social or psychological factors also. There must be, Dr. King says rightly, some point in the councils and management of industry where scientific and technical ideas can be considered with full understanding in making decisions on policy.

Hitherto, admittedly, failure to build a bridge between manager and scientist has been due as frequently to the narrowly specialized attitude of the scientist as to the lack of appreciation of scientific needs by the manager. It is a problem of communication which has been considered at more than one conference organized by the Federation of British Industries in recent years. As yet we know little about the best training for the scientific administrator. The ability to find or select new knowledge, to recognize its significance and the need for change is only one aspect. The manager must also possess sufficient will and initiative to effect the change required, including the persuasion of others, from directors to work-people, to accept the innovation and to co-operate.

As yet we do not really know to what extent the smooth flow of science to industry is blocked by traditional attitudes, bordering upon prejudice, at different levels, or among the workers, nor how far such resistance to change arises from the structure and psychology of the firm or the general thinking of the industry. There are variations in the climate of opinion here, ranging from that current in the family firm, through the large private enterprise to the executive board of a nationalized industry, which may repay study, equally with those rational or irrational factors noted by Dr. King on which managements customarily base their decision to adopt an innovation.

The way in which existing methods of finance stimulate some kinds of innovations and inhibit others, or the extent to which monopoly and free competition, respectively, force or retard the adoption of new methods to the interest of the consumer and the economy, may well involve much more research before decisions are based on knowledge rather than prejudice. The influence of labour costs as an incentive, and the effect of technological change on the general level and distribution of employment are commonly matters of opinion rather than factual inquiry, and there are also such general differences of opinion as that noted by Dr. King in regard to the advantage of being the first in the field with an innovation. In the United States, this is almost axiomatic. In the United Kingdom, on the other hand, it is often held that the first firm to introduce a major innovation bears an undue share of development costs which are escaped by competitors who ome in later when the change is made and a new market created. Each of these beliefs may or may not be valid in the different circumstances prevailing in the two countries. Clearly it would be of great value to British industry to determine that validity, as would more accurate knowledge of effects of echnological innovation on the general level and distribution of unemployment assist in overcoming he opposition of work-people to development, and in reconciling their interests with the increase of productivity and the interest of the community. Nor does the small firm escape such problems. As Dr. King showed, the small firm has advantages as well as disadvantages, compared with the large firm, in applying new knowledge. The one essential need of he small firm is at least one reasonably well-trained echnologist to keep in touch with the advances of echnology and the best general practice of the industry, and to help put these to productive ffect.

Dr. King's paper provides the perspective against which a sounder judgment may be made of some of he projects now being sponsored by the Human Relations Committee with Conditional Aid Funds, particularly those which at first sight might appear o be of dubious value, like the study of the flow of information in industrial organizations. The special eference to the making of decisions relating to production made in this project is liable to give an impression which may well be entirely unjustified.

Both Sir Ben Lockspeiser's address and Dr. King's paper, like the recent inquiry sponsored by the Manchester Joint Research Council, point to he importance of getting more men into the management of British industry competent to meet the scientist and technologist on equal terms, and to assess the scientific and technological factors along with the economic, financial and social factors in development; such men would also be able to see hat full use is made both of the results of scientific research and of the opportunities which new scientific techniques, such as operational research, afford in management. Nevertheless, training for management, or the training of the technologist, is only one spect of the problem. There are personal qualities involved, and perhaps the scientist or technologist will seldom prove to possess administrative gifts of high order. The more talented he is as an investiator, the more likely his gifts are to find their fullest xpression in research and its immediate direction. There are limits also to the use which can be made f such techniques as operational research and improvements in communication.

What needs to be remembered is that there have been changes in the way in which technical innovation works in the British economy, of which the establishment of the National Research Development Corporation in 1949 is one sign. Sir Henry Tizard ommented on this in his Messel Memorial Lecture at Aberdeen in 1952, and its implications were disussed in a recent supplement, "Research for ndustry", in *The Economist*. Sir Henry judged that Government appropriations supply more money for engineering development than all the engineering industries put together, and the main stimulus to British engineering of the highest quality in recent years has come, he said, from defence research and development rather than from private enterprise. Even then the question could be asked whether the taxpayer would in future have to undertake the risks which formerly were taken by private enterprise. Sir Henry said frankly that he was not happy at the principle behind the National Research Development Corporation, and he did not like to think that the leaders of British industry were becoming less adventurous.

Something more than research on the factors affecting the speed at which technological innovation proceeds is required to answer the questions which the growing dependence of research upon government support raises. Those questions are a matter of concern in the United States quite as much as in the United Kingdom; nor should it be assumed that the balance between public and independent or private support should be the same in both countries, still less that the balance between applied and fundamental research should be the same. It may well be true that, as *The Economist* suggests, Britain should be devoting a much greater proportional effort to research than the United States. It may also be true that the proportion devoted here to applied research and development requires to be increased relative to that devoted to fundamental research. The major issue to be raised first, however, is whether the direction of our research effort, as well as its distribution, is likely to be wise if it continues to be financed so preponderantly from government sources.

Admittedly, in such new fields as atomic energy the main research effort for some time to come is likely to remain entirely under State control; but with the Ministries most concerned with research and development almost trebling their expenditure in the past four years, there is, in the first place, some risk that the continuance of such dependence on State support may warp the direction of research effort away from the lines that ordinary economic demand would indicate. It is no answer to point out that defence research may and does assist in the commercial development of some valuable technical innovations. The price which has to be paid in the retardation of technical progress elsewhere for the civil developments which defence research brings in its train should be remembered. Often it cannot be estimated, particularly if we think in terms not of money or materials, but of the even scarcer factor—outstanding scientists.

The second factor which Sir Henry Tizard had chiefly in mind is even more important. Can we rely on a government department to select the right targets and to take the risks inherent in technological development as wisely and as boldly as the individual entrepreneur? Arguments advanced in the debates on the Atomic Energy Authority Bill should give pause to any such thinking. The weakness, if not fallacy, of any such assumption was demonstrated in a pamphlet, "The Chemical Industry and Challenge to Britain", issued by Imperial Chemical Industries, Ltd., last February for the information of stockholders and employees. If British industry is defective in initiative, in enterprise or in judgment, its weaknesses are unlikely to be rectified from without the industry by any public body.

This is not to say that the National Research Development Corporation will not perform useful functions, or that self-financing and institutional investment will not promote as many risks as saving by the individual investor. But they may not, and if Britain is to devote the maximum share of her industrial resources to research, and if her present industrial economy is to be as effective in promoting technical advances as those out of which it has emerged, it would be prudent to see that individual initiative and originality have their opportunity to contribute to the scientific industries of the future. Moreover if, as the investigators of the Manchester Joint Research Council found, the personalities of directors and managers at the highest level in a firm and the attitudes to the scientific approach to production are the dominating factor determining the use of new knowledge or the adoption of new ideas, the decisive factor will be the industrial and social climate of opinion which the late Dr. K. T. Compton stressed in his address to the Parliamentary and Scientific Committee last February.

In forming such a climate of opinion in which technological progress and productivity thrive, education, and especially higher technological education, as Dr. Compton pointed out, is of far-reaching importance. More light on the factors which assist or retard the adoption of technological innovation in industry will be welcome, and it is possible that some of the investigations already in progress in this field may yield results which will enable measures for the encouragement of enterprise and originality, or the removal of hindrances to change, to be based on factual knowledge rather than on political theory or prejudice. The essential task, however, is that of education, and education at all levels affecting the climate of opinion within which the scientist and technologist work. If by the expansion of higher technological education and the broadening of the content of education, not only of the scientist and technologist but equally of the administrator, the industrialist, the manager and the trade unionist, we encourage the development of such a climate of opinion that the implications of technological change for Britain's industrial and economic future are clearly understood, it will become relatively less important whence the main support for research is derived. The direction of research and the application of its results are likely to lie, in that event, in the hands of those competent to appreciate the significance of new discoveries, to evaluate the complex scientific, technical, economic and social factors involved and to secure the co-operation of all concerned in and affected by the technological changes they initiate.

LYSENKO IN PERSPECTIVE

Agrobiology

Essays on Problems of Genetics, Plant Breeding an
Seed Growing. By T. D. Lysenko. (Translated from
the Fourth Russian edition.) Pp. 636+12 plate
(Moscow: Foreign Languages Publishing House
London: Collet's Holdings, Ltd., 1954.) 15*s*.

BRITISH research workers regard polemical pape with suspicion, not to say distaste. This circumstance has engendered among us a delicate ar of scientific (as distinct from literary) criticism. A critic is permitted to demonstrate that his colleague' facts are incorrect. He can go further and demonstrate that his colleague's hypotheses are inconsisten with the facts. But he cannot with propriety g further still and impute motives or reasons for hi colleague's inaccuracies: as that his technique wa sloppy, or that his ambition drove him to publis prematurely, or that his political views coloured hi writing, or simply that he is a liar. Therefore w would not expect to read in the *Annals of Botany* passage like the following: "Why has . . . one o our outstanding biologists fallen into error in hi work on mutation of species? . . . Because he ha departed from the principles of Darwinism . . . [an because his] statements have not been subjected t the appropriate comradely criticism without which as our teacher Stalin points out, science canno advance".

This quotation is from the *Botanicheski Zhurna* (Botanical Journal) for December 1952. The write is a *bona fide* botanist and the outstanding biologis he refers to is T. D. Lysenko. British scientifi journals would not be likely to accept such a passag as this, even if it were about Lysenko, and it i important to remember this difference in intellectua climate when we discuss Soviet science. Of cours the Russians publish scores of papers which are a objective and impersonal as the papers in Britis journals. But when they do descend to scandal the do so unambiguously and in public.

This much understanding of the Russian temperament is a prerequisite for reading the recentl translated volume of Lysenko's collected essays o agrobiology. If the British reader approaches it a he would (for example) a volume of essays from Rothamsted he will be nauseated. If he approache it to gain an understanding not of agrobiology bu of Lysenko's career he will be deeply interested. Fo this book contains some of the data necessary for a understanding of the recent history of biology i the U.S.S.R.

It begins with two essays on phasic developmen in plants, published nineteen years ago. Lysenk had stumbled upon the discovery made by Gassne in 1918 that certain plants ripen earlier if subjecte to a cold period, and he spent some years unsuccessfully trying to apply Gassner's technique on a commercial scale. These early essays, though tediou and unconvincing, do make some pretence of recording and interpreting observations. Their obviou intention is not to advance science but to appl science to agriculture. It has to be remembered tha while Lysenko was working on phasic developmen Russia was passing through a terrible crisis. Compulsory collectivization of farms had brought abou a collapse of food production, and millions wer dying of starvation. It is therefore not surprisin that Lysenko's work was tendentious.

There follow in "Agrobiology" half a dozen essays which are little more than harangues to collective farmers. For Lysenko had discovered his flair. He had an uncanny power of persuading peasants to adopt better methods of husbandry and to take a pride in increasing yields; and that was what Russia needed twenty years ago: not so much more science in farming, but simply more common sense in farming. In fulfilling this need Lysenko was notably successful.

His success brought him into conflict with the genuine biologists of Russia for two reasons. First, he sincerely imagined that his successes as a propagandist for better farming were due to his ideas about biology, for he was not content with a pragmatic approach to crop yields: he had to rationalize his methods with the pseudo-philosophical theories of men like Michurin. This he tried to do in a series of violently polemical papers (1937–48), many of which are reproduced in this book. His train of thought was transparently tendentious. "If," he says (p. 230), "I have made a trenchant assault on Mendel's law . . . it is primarily because this law greatly hinders me in my work." Secondly, he sincerely imagined that the failure of other Russian biologists to improve the efficiency of agriculture was due to their preoccupation with fruitless scientific problems and fundamentally unsound theories. The natural reaction of Russian biologists was to ignore Lysenko and his colleagues as troublesome cranks; and this they did successfully until 1948. In that year the State made the decision to give Lysenko official support, and his powerful adversaries were driven into obscurity. It is a mistake to suppose that any reputable Russian scientist was under the impression that Lysenko had made any major discovery. It was a temporary triumph of expediency over truth. As Zhukovsky said at the time, it is important "at this juncture to cherish the prestige" of Lysenko.

"Agrobiology" reproduces in full Lysenko's speech to the Academy of Agricultural Sciences on this melancholy occasion in 1948. There follow a series of essays in which Lysenko's ideas, now free from public criticism, undergo an unrestrained proliferation. He claims to have produced, by manipulating the environment, soft wheats from hard wheats and rye from wheat. He writes less agricultural propaganda and more woolly theory. Apart from advocating the sowing of forest belts on hills, he has little to say which is likely to catch the imagination of the peasant. His articles, notably one (p. 582) published in 1952 for the "Soviet Encyclopedia", become more speculative and more fantastic. Meanwhile, Russian agriculture has again entered upon a crisis, and N. S. Khrushchev, first secretary of the Central Committee of the Party, initiated in 1953 a new set of reforms on collective farms. He heavily criticized the previous policy of the Ministry of Agriculture, and it seems as though he is now willing to charge Lysenko with the very sort of inefficacy with which Lysenko charged his critics in 1948. For on March 29, 1954, the official journal of the Communist Party published the following statement: "The monopolisation of science leads . . . to the cutting off of people who do not think on orthodox lines, and living scientific thought is stifled. This has been shown, for instance, in the All Union Academy of Agricultural Sciences".

Lysenko is still director of this Academy. For a time, and probably due to the critical condition of Soviet agriculture, the Russian Government backed a man who would otherwise have sunk into the scientific obscurity he deserves. His book of essays is a warning against confusing science with practice; and it now seems that it may mark the end of a deplorable incident in the history of scientific thought.

E. ASHBY

THE RISE OF EVOLUTIONARY CONCEPTS

Evolution

Die Geschichte ihrer Probleme und Erkenntnisse. Von Dr. Walter Zimmermann. Pp. ix + 624 + 8 plates. (Freiburg–München: Verlag Karl Alber, 1953.) 32 D. marks.

THE author of this book, Dr. W. Zimmermann, aims at providing a detailed historical survey of the gradual emergence of the concept of evolution in plants and animals and of the progressive realization of the problems it presents. It is divided into three parts. The first, entitled "Doctrines of Descent, without a Scientific Foundation" (Abstammungslehren ohne Abstammungswissenschaften), embraces the ancient period up to the Middle Ages and is largely concerned with a consideration of the attitude of the Greek and Roman philosophers. The second part, "Evolutionary Science without Evolutionary Doctrines" (Abstammungswissenschaften ohne Abstammungslehren), covering the period from the Renaissance to the eighteenth century, is mainly devoted to the role of such pioneers of classification as Caesalpinius, Ray, Linnaeus, etc., but also includes sections on the development of the scientific method (Bacon, Descartes, Spinoza, Leibniz and others) and on the commencing realization of the meaning of fossils. The third part, covering recent times, the "Period of Conscious Evolutionary Science" (Zeit der bewussten Abstammungswissenschaften), deals successively with the pre-Darwinian period (Lamarck, St. Hilaire, Oken, A. Braun), Charles Darwin, and the post-Darwinian period; under the latter heading are included sections dealing with the return to the idealistic point of view (Troll), the rate and causes of evolution (viruses), the biogenetic law, speciation, etc. Such an outline gives but a bare indication of the many aspects of biological science taken into consideration and of the innumerable authorities whose attitude and contribution are evaluated.

The method of treatment is peculiar, since much of the book is occupied by frequently lengthy quotations from various sources, for the most part citations (in German) from the particular authority momentarily under discussion. These are interspersed with often quite brief passages (printed in smaller type) in the author's own words, which serve as commentaries and to link together the matter in successive quotations. This, combined with the division of the subject-matter into numerous sections and subsections, gives a somewhat disjointed character to the whole presentation, and one is inclined to wonder whether a less fully authenticated account would not have resulted in an equally valuable and shorter, but more readable, version. The disadvantage of this dissection makes itself specially felt when the author is tracing the progressive steps in interpretation arrived at by such pioneers as Goethe and A. P. de Candolle, the protagonists of comparative morphology, or, in other domains, of such men as Linnæus and Darwin. There is no doubt that Dr. Zimmermann brings out successfully the gradual development in Darwin's mind of the theory of descent and of the struggle for existence; but could it not have been done more smoothly and just as convincingly in a more connected narrative and in less than twenty-three pages?

On the whole, that dealing with the post-Darwinian period is the least impressive part of the book. Referring, as it must, to almost every aspect of biological science, it is too much crowded with detail to give that broad conception of the forward march during this modern era that would have been specially valuable.

F. E. Fritsch

PROGRESS IN NUCLEAR PHYSICS

Progress in Nuclear Physics

Vol. 2. Editor: O. R. Frisch. (Progress Series.) Pp. viii+295. (London: Pergamon Press, Ltd., 1952.) 63s. net.

The second volume of "Progress in Nuclear Physics" contains an authoritative series of articles on the electron optical properties of magnetic beta-ray spectrometers, by N. F. Verster; nuclear paramagnetic resonance, by R. V. Pound; luminescent materials for scintillation counters, by G. F. J. Garlick; the neutron–proton interaction, by G. L. Squires; nuclear fission, by W. J. Whitehouse; the low-lying excited states of light nuclei, by W. E. Burcham; the nuclear shell model, by B. H. Flowers; and ionization by fast particles, by T. E. Cranshaw. These articles are well written by leading workers in their respective fields.

The review by R. V. Pound describes the magnetic resonance experimental methods for measuring nuclear magnetic moments, the interaction of nuclear moments with the surrounding media and the *g*-values describing the relation between magnetic moments and cylinder momentum. An account is given of the theory of these phenomena.

The scintillation counter has now become one of the most widely used tools of nuclear physics, and Mr. Garlick's review gives an account of their construction and application to the detection of neutrons, cosmic-ray particles, fission fragments, gamma-ray energies and X-rays.

The interaction of the neutron and proton is determined by the all-important nuclear forces. Mr. Squires gives a good account of the contribution of experiments on the scattering of neutrons by protons, protons by protons and the photo-disintegration of the deuteron to the study of this interaction. The experimental data are not yet good enough to come to any firm conclusion about the potentials describing the interaction, and this subject is still being pursued energetically by most laboratories equipped with large cyclotrons.

A vast amount of data has been published since the Second World War on the important subject of nuclear fission, and Mr. Whitehouse's review is very useful and timely in bringing all this together. A brief account of the theory of fission and the experimental techniques is followed by experimental data on fission cross-sections and thresholds; fission yields for particles of different energies; and studies of the energy distribution and properties of fission fragments. An account is also given of the phenomenon of delayed neutron emission, which is a important to reactor design and spontaneous fission rates.

Prof. Burcham gives a brief theoretical description of nuclear spectra in the light elements in terms o the characteristic of nuclear forces. A brief account of the experimental methods used in low-energy nuclear physics is followed by an account of important experimental phenomena such as the energy-levels o mirror nuclei and their interpretation in terms o spin and parity.

Mr. Flowers gives an account of the evidence fo the shell model in terms of spin-orbit forces. Mr Cranshaw describes the theory of loss of energy by ionization of high-energy particles and compares thi with experiments with cosmic-ray particles.

J. D. Cockcroft

SUGAR TECHNOLOGY

Principles of Sugar Technology

Edited by Pieter Honig. Pp. xxii+767. (Amsterdam and New York: Elsevier Publishing Company, Inc. London: Cleaver-Hume Press, Ltd., 1953.) 95s.

Many up-to-date handbooks on sugar technology already exist which might be supposed to cove the needs of the sugar industry, but the one now under review fills a new niche. The editor, Dr. Pieter Honig at present research director to the West Indies Suga Corporation of New York, is rather better known fo his earlier work at the renowned Proefstation voo de Java Suikerindustrie (Java Sugar Experimenta Station), Pasuruan. He has enlisted the assistance o some former colleagues and a number of other leading authorities to write the eighteen chapters of thi volume. The endeavour has been made to link physical and chemical properties of sucrose, reducing sugars and non-sugars with the processes involved in suga manufacture and to assess the degree to which theory underlies actual practice. A second volume is proposed which will be concerned with evaporation crystallization, heat transfer, drying and cooling. The volume is divided into Part 1, which deals more with chemistry and physics, and Part 2, which is concerned with purification of sugar solutions.

Taking these in reverse order, for the latter part i of direct practical importance, it can be said that the three chapters on clarification (chemical technology fundamental reactions and process technology) are uniformly of high standard, and the references in the bibliography at the end of the chapters, as is the case throughout the volume, are extensive and well up to date. Some overlapping occurs, as is usual with a number of authors. The succeeding chapters deal with sulphitation, carbonatation (by Dr. Honig), middle juice carbonatation and ion exchange, and are also to be commended.

Part 1 is open to some criticism; it includes matter which could well have been omitted. For example, in Chapter 2 the tables of physical constants occupy about 42 out of 52 pages and are already available in standard text-books—Spencer-Meade, Brown and Zerban, Circular *C*.440 of the National Bureau of Standards. The physical properties of sucrose are given in bare detail without much discussion of their significance, and the subject of optical rotation is discussed in one page. No reference is made to the recent work on solubility of sucrose by

L. Taylor. Activity coefficients are not defined; those uoted of Downes and Perman (1928) have been otally superseded by the far more accurate work of catchard (1938). The value quoted for the thermal onductivity of packed granulated sugar is undoubtedly too low and approximates more nearly to hat given for raw sugar. The chapter generally lacks o-ordination, being just a compilation of isolated ots and figures. It does serve, however, to emphasize he lack of existence of much correlated data on the hysical properties of sucrose and the need for more oncerted effort in this field. The physical and hemical properties of reducing sugars comprise a ell-written chapter that is marred by inclusion f methods of analysis already mainly found in ell-known works of reference. Other chapters of eal merit have some shortcomings. Some subjects re not discussed at a length commensurate with a olume of this size: for example, kestose, bone harcoal and sugar salt complexes in relation to olasses formation. The described preparation of ure sucrose is out-dated, and later, more suitable ethods are ignored. It is doubtful whether, in fact, ure sucrose can be prepared by recrystallization f beet sugar without some contamination with ffinose.

Chapter 11, with its curious title, is nevertheless a ear and enlightening account of a difficult subject. might have given greater stress to the necessity for lass electrode systems in process control and should ave mentioned the more accurate pH of buffer lutions at elevated temperatures, published by the ational Bureau of Standards, Washington, D.C.; also, more recent book than Dole's is that of L. Kratz, amely, "The Glass Electrode and its Applications".

Chapters on non-nitrogenous acids as well as amino-cids are a useful inclusion, there being no other mprehensive up-to-date collection of data. Chromatographic analysis for the latter has been well covered, ut one is puzzled at the absence of chromatographic amination of sugars and derivatives. One must, wever, be grateful for small mercies, and there is no oubt that Honig's information is by no means small. much useful material has been collected, screened d discussed, together with multitudinous references, at no progressive sugar company can afford to glect this volume; and even the sugar beet industry, hich has not had special attention by Dr. Honig and s colleagues, will find much of interest and importance in its pages.

H. C. S. DE WHALLEY

BRITISH MEDUSAE

he Medusae of the British Isles

nthomedusae, Leptomedusae, Limnomedusae, achymedusae and Narcomedusae. By Frederick ratten Russell. (E. T. Browne Monograph of the arine Biological Association of the United Kingdom.) p. xiii + 530 + 35 plates. (Cambridge: At the niversity Press, 1953.) £6 10*s*. net.

THIS very fine book is not only an outstanding monograph on an animal group and a monument the skill and energy of Mr. F. S. Russell, but is also beautiful thing to have and possess; apart from its rious scientific merits, it has a good deal of entertainment value. This will not have been lost on the thor himself. It is the persons (not to say personalities) of the medusae and polyps which lend themselves to this effect: not only are their figures often elegant, but their postures are frequently lively, comic or grotesque, their tentacles and other parts are waved or brandished with decorative or dramatic insistence, and sometimes assume the semblance of the arms and legs of humanity (see, for example, Figs. 255–6). Thus the volume is full of Russian ballet *décor* and has also its moments of comic relief, as in the clog-dancer of Fig. 211, who is misleadingly described as a "portion of umbrella margin". Here and there the text achieves the same result, where Mr. Russell quotes from an earlier author (as on p. 88, from Forbes, 1848) who uses a descriptive language more vivid than is customary in scientific works of the present day. To return to Mr. Russell's skill and industry, he has illustrated the volume by 319 text figures and 35 plates, the drawings for which were made by himself except where otherwise stated. Among the figures he has included not only many showing the elegancies of living polyps and medusae, but also others giving the appearance of preserved material—very different in its crumpled aspect from that of the live animals, but the more useful for identification in that many collections of planktonic species have to be named from preserved specimens. An interesting and ingenious feature is the introduction of a very effective pictorial key to the British species. A small diagrammatic figure of each is given, and the figures are so arranged as to make preliminary identification practicable not only more quickly but also with less possibility of error than would be the case with a verbal key. The thirty-five plates are reproduced, in the main, from exquisitely delicate coloured drawings by the author. These have been excellently reproduced on pleasing paper, but it is unfortunate that the caption for each plate has been printed in black on the back of its predecessor, so that it shows through the paper slightly and mars the perfection of the preceding plate.

The text begins with an introduction, which is followed by a clear account of the structural features of medusae, including a section on their nematocysts. The next sections deal with life-histories and distribution, the rearing of hydroids and medusae, collection and preservation, with a subject index to the literature. There follow a note on the identification of medusae, and the pictorial key already mentioned. After this begins the main part of the book, which is occupied by descriptions of the British species. These attain the high level to be expected of Mr. Russell, and include notes on distribution, developmental stages, nematocysts, seasonal occurrence and habits, as well as the customary details of structure and history. Finally, there are appendixes and a thirty-page bibliography.

The publication of this book, which has naturally been very expensive to produce, was made possible in the first place by a bequest to the Marine Biological Association from that well-known student of the medusae, Mr. E. T. Browne, who first stimulated Mr. Russell's interest in the group. This initial bequest was supplemented by grants from the Browne Fund of the Royal Society and from the Syndics of the Cambridge University Press. As it is now more than a hundred years since Edward Forbes's "Monograph of the British Naked-eyed Medusae" appeared (in 1848), the publication of a new and much fuller account has been greatly needed. Its achievement in this majestic form redounds greatly to the credit of Mr. Russell, Mr. Browne and the Cambridge University Press.

T. A. STEPHENSON

Onoranze a Leonardo Da Vinci nel Quinto Centenario della Nascita—Comitato Nazionale

Nr. 1: Leonardo Da Vinci: la Vita. Da Titina Strano. Pp. 84+9 plates. Nr. 2: l'Ingegneria Militare di Leonardo. Da Ignazio Calvi. Pp. 40+24 plates. Nr. 3: la Visione Scientifica di Leonardo Da Vinci. Da Carlo Zammattio. Pp. 46. Nr. 4: le Armi di Leonardo Da Vinci. Da Luigi Tursini. Pp. 14+13 plates. Nr. 5: la Botanica nel Pensiero di Leonardo. Da Alessandro Bazardi. Pp. 40+17 plates. Nr. 6: Geografia e Geologia negli Scritti di Leonardo Da Vinci. Da Agostino Gianotti. Pp. 48+7 plates. Nr. 7: Leonardo Da Vinci e la Meccanica Tessile. Da Giovanni Strobino. Pp. 100. Nr. 8: l'Anatomia e la Fisiologia di Leonardo Da Vinci. Da Mario Senaldi. Pp. 64 (24 plates). Nr. 9: Programma e Idealità del Museo Nazionale della Scienza e della Tecnica "Leonardo Da Vinci". Da Guido Ucelli. Pp. 102 (45 plates). Nr. 10: Vinci Leonardo e la sua Famiglia. Da Renzo Cianchi. Pp. 106 (22 plates). Nr. 11: Leonardo Architetto e Urbanista. Da G. U. Arata. Pp. 182+6 plates. Nr. 12: il Pensiero Estetico di Leonardo Da Vinci. Pp. 30. (Milano: Museo Nazionale della Scienza e della Tecnica.)

TO readers of *Nature* the value of eleven monographs on the life and achievements of Leonardo da Vinci is limited by their being written in Italian and the fact that only Nos. 5, 7, 8 and 11 contain bibliographies. All but Nos. 3 and 12 are profusely illustrated, many of the pictures being of the lavishly produced models sponsored by the Italian Government before the Second World War and now re-built to furnish the Italian National Science Museum in Milan (see *Nature*, **172**, 377; 1953). Others among the illustrations will be familiar to those who visited the Royal Academy exhibition in London last year, and it is particularly interesting to note the way in which Leonardo's scientific methods of observation illumine his artistic work on physiology, botany, geology and geography. The range of his interests is astonishing, but there is still doubt as to how far his recordings were of his own original devices and, if so, how far they actually influenced future developments. Pamphlet No. 7 on textile machinery traces devices similar to Leonardo's right down to those in modern machines. Less than justice is done to his work on aeronautics in this series, although it is probably true to say that no evidence exists to show that he had the slightest influence on the future, and some of his ideas were fundamentally unsound. Pamphlet No. 9 is largely an illustrated account of science museums in other countries designed to stimulate Italian interest in the Museum newly raised to Leonardo's honour in Milan.

Physics

By Prof. Noel C. Little. Pp. viii+648. (Boston: D. C. Heath and Company; London: George G. Harrap and Co., Ltd., 1953.) 35*s*.

THIS course represents a decided break from the traditional approach to physics, for it is organized around five fundamental concepts and five types of phenomena. Thus the watertight compartments of heat, light and so on have been broken down, and the subject is presented as a unified whole. Now all will agree that this method has undoubted merits; but the real test of its efficacy is whether it will be more beneficial to students than the more orthodox teaching. Apparently the author and his colleagues have used the course for many years and are satisfied with the results; so far as British schools are co
cerned, one feels that it would probably take a lon
time to establish such a departure from the orthodo
method, whether desirable or not.

For an elementary text tradition has again bee
broken by the use of the M.K.S. system (probably th
most useful) rather than the C.G.S. system of unit
while the British units are confined to the gravitation
system; it will come as a shock to the uninitiate
student that the unit of force is the 'newton', not th
'dyne'.

The course is evidently well planned and excellentl
presented; the mathematics involved is quit
simple, and many typical questions are worked out i
the text. It is sad, however, to find that the ter
'electromotance' supersedes our old friend 'electr
motive force'; in spite of this, though, one suspect
that students and engineers will continue to speak
'e.m.f.'.

Geometrical Optics

By Dr. C. Curry. Pp. viii+173. (London: Edwar
Arnold and Co., 1953.) 21*s*. net.

ALTHOUGH the reviewer is not wholly satisfie
that it is necessary or desirable to devote a separat
book to geometrical optics at this stage of the worl
yet the author, Dr. C. Curry, as a result of his e
perience, is undoubtedly convinced that such a boo
is necessary. His aim is to give a balanced account
the subject suitable for students in the two yea
before a degree examination, at the same time keepi
in view the underlying physical principles and t
ultimate application to optical instruments and the
design.

It must be said at once that Dr. Curry has achiev
his aim very satisfactorily, and he has studiousl
avoided the temptation to lengthen the book
developing certain sections to a more advanced lev
The explanations are very clear and easily followe
and if any section can be singled out it is that on t
aberration of optical systems, which is particular
well done.

Certain departures from the usual nomenclatu
have been made. For example, μ is used exclusive
for relative refractive index, while the time-honour
u and *v* for object and image distances have d
appeared. The so-called new Cartesian sign co
vention is used as being most in line with advanc
optical practice, and in this connexion dare we ho
that one day just one convention will be adopted f
universal use?

River Purification

A Legal and Scientific Review of the Last 100 Yea
By F. T. K. Pentelow. (Being the Buckland Lectur
for 1952.) Pp. viii+63. (London: Edward Arno
and Co., Ltd., 1953.) 5*s*. net.

THIS small volume contains the text of the thr
Buckland Lectures for 1952, which were deliver
by F. T. K. Pentelow, chief inspector of salmon a
freshwater fisheries in the Fisheries Department
the Ministry of Agriculture and Fisheries. The fi
lecture—on the development of the law affecti
pollution of rivers—is an admirable summary, w
a useful bibliography of Acts of Parliament. T
remaining two lectures deal with the effect of poll
tion on streams and with methods of treating was
waters; they are necessarily brief, are addres
primarily to river authorities concerned with fre
water fisheries, and give a sound account of t
elements of the subject. B. A. S.

THE REOPENING OF PULKOVO OBSERVATORY

IN 1835, F. G. W. Struve was commanded by the Emperor Nicholas to superintend the erection, /ithout regard to expense, of an astronomical bservatory at Pulkovo on the summit of the low ills some eleven miles south of St. Petersburg. broad highway already led due south (actually t is a degree away from the true meridian) from he Admiralty spire in the centre of the city, and he site chosen was on the line of this road. The bservatory, which "was acknowledged to surpass ll others of its kind in splendour, efficiency and ompleteness", was opened in August 1839 with truve as director. The renown of the Observatory nainly rests on the incomparable series of meridian bservations, made with great skill and care, without nterruption and with the same instruments—a transit elescope for right ascensions and a vertical circle for eclinations. The value of these observations to ositional astronomy is very great. But its fame also ests on a broader basis, especially in later years.

Pulkovo Observatory maintained its standing hrough the Revolution of 1917, and its traditional ork on fundamental astronomy was continued on a igh level until the Second World War. During the iege of Leningrad in 1942, the Observatory was in the direct line of fire, and its site, commanding the plane of the city and clearly of military importance, was occupied by the enemy. The buildings were completely destroyed, but the smaller instruments, the optical parts of the larger instruments and the more valuable records and books (including the Kepler manuscripts) were moved to safety; among other losses the mounting of the 30-in. refractor was demolished. At the end of the War the Observatory lay in ruins.

The rebuilt and re-equipped Central Observatory of the Academy of Sciences of the U.S.S.R. at Pulkovo (Fig. 1) was formally inaugurated on May 20–22 in the presence of some five hundred astronomers and scientists, including representatives from most countries from China to the United States. The inaugural address was given on the evening of May 20 in the hall of the Academy of Sciences in Leningrad by Academician Bardin, acting on behalf of the president of the Academy, who was ill. On the following day he declared the Observatory open by formally cutting the tape at the entrance to the main building; this ceremony was followed by the presentation of congratulatory addresses and a general inspection of the Observatory. Many of the addresses were in elaborate

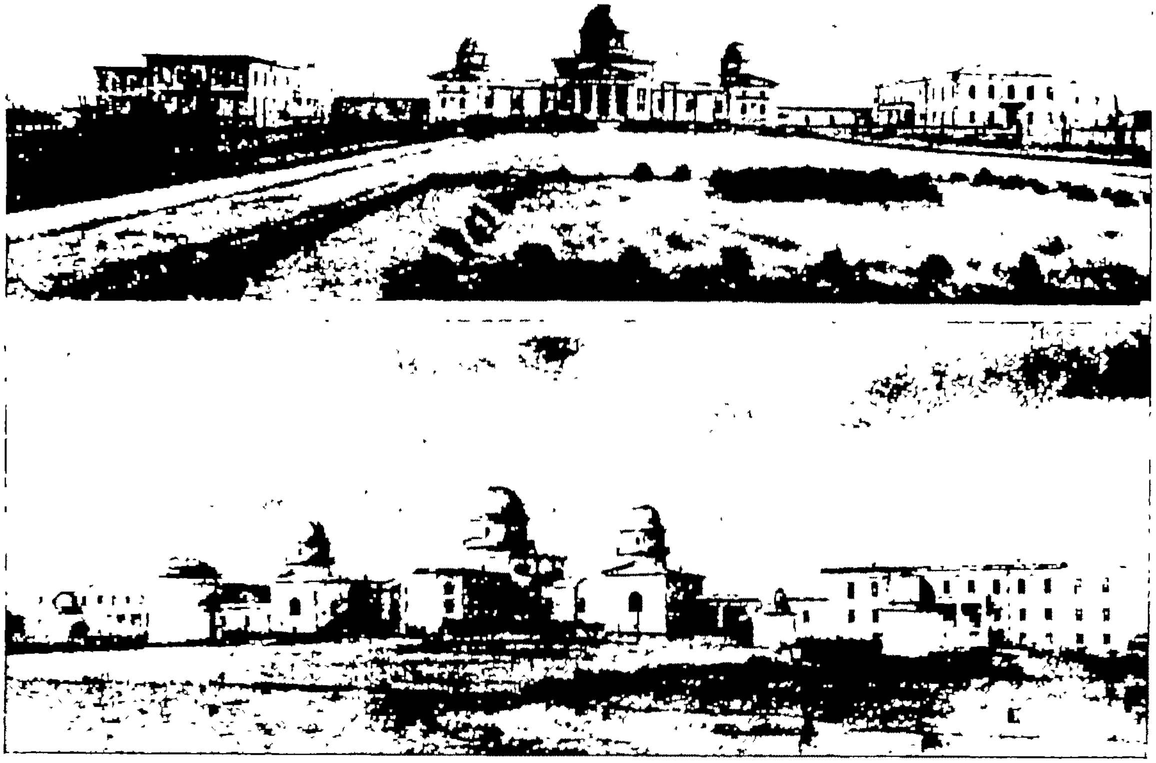

Fig 1. General views of Pulkovo Observatory: above, from the north; below, from the south

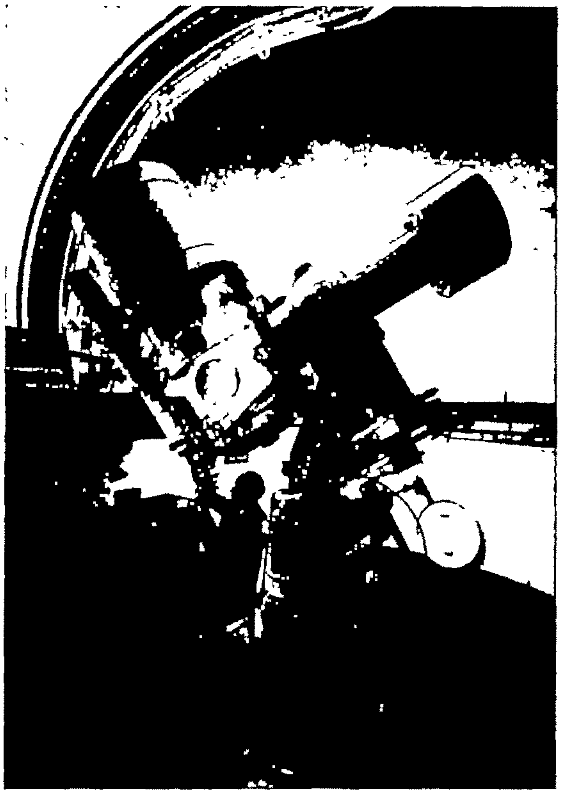

Fig. 2. The Maksutov meniscus telescope. The ultra-violet spectrograph is designed for attachment at the end of the polar axis

bindings, and the Chinese delegation presented a magnificent red and gold silk banner. The following day was devoted to a series of papers describing the work of the Observatory by the astronomers in charge of the different departments.

The main building of the Observatory has been rebuilt exactly as it was (even to the date 1839 over the main entrance), thus preserving the well-known silhouette of the three domes (actually they were turrets in the old building), which is such a fine landmark as seen from Leningrad. But two large wings have been added, containing offices, laboratories, residences for the director and senior staff, and a magnificent conference room; seating more than 250 in tip-up chairs, panelled in marble, with fine curtains, with cinema projectors and screens, it must surely be the finest in any observatory.

In the central building are the two famous old meridian instruments of 1839, restored and in working condition, side by side with new instruments. One of these is a mirror transit in which star passages are observed through fixed north–south telescopes by reflexion from a steel mirror, which is the only moving part; the results are encouraging. At present the three domes contain only minor instruments or are awaiting new ones.

However, there are some twenty other groups of buildings and domes, a few still in course of erection The larger buildings comprise a hotel which can accommodate fifty students or guests, living quarters for the staff, and a hostel for junior staff; there is even a kindergarten. Some of the domes and pavilions contain the pre-war instruments, such as the 7-in meridian circle (1914), the astrographs and the vertical telescope; but there are four or five entirely new instruments. Perhaps the most interesting is the 500-mm. Maksutov meniscus telescope (Fig. 2) designed for use with a spectroscope in the ultra violet; it appears to have been built entirely in the Soviet Union.

Another remarkable instrument is a polar telescope designed by the director, Prof. A. A. Mikhailov. I must be one of the few telescopes with which observations are made through a glass window; this allows the whole building to be thermally insulated The instrument is operated by remote control, so that the observer need not enter the building during the night's observation. Careful measurements show that, by excluding the body-heat of the observer internal refractions in the telescope tube are substantially reduced; there is a still further reduction when the building is left sealed for several days. Fo simplicity the plate is fixed, and exposures are made by means of a rotating shutter in front of the objec glass; the position of the pole is therefore determined on each plate from a series of short arcs for each o four or five stars. The interesting feature is that th Loomis telescope at Yale, adapted for precisely th same programmes, uses an entirely different design the long tube is open to the outside air, and the plate rotates to counteract the earth's rotation. The eventual comparison of results from the two instruments will indicate which choice of desirable an undesirable factors is the better.

A rather revolutionary instrument is an interferometer (looking like a range-finder) designed by Academician Linnik for observing, with extreme accuracy, the horizontal component of the separation of double-stars (see Fig. 3). By observing at differen

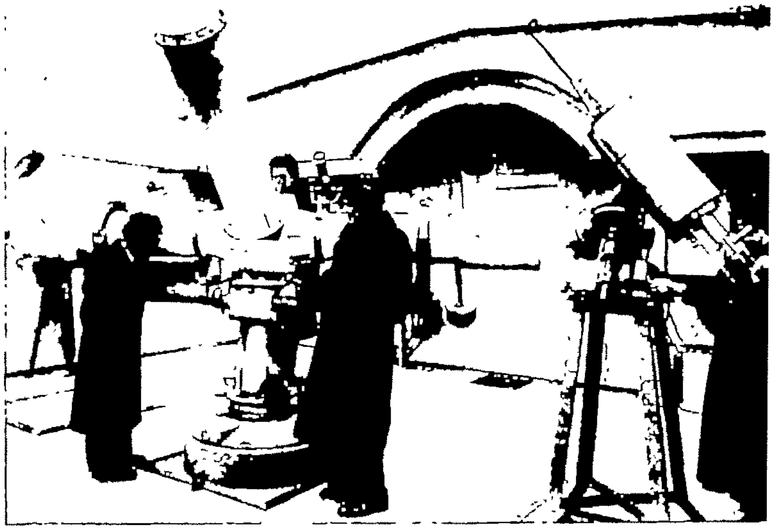

Fig. 3. The Linnik interferometer for measuring the separation of double stars. Academician Linnik is in the centre of the picture

our angles, the actual separation and position angles can thus be calculated.

The horizontal solar telescope with its several different spectrographs is apparently giving good results, due mainly (according to Prof. Krat) to the excellent definition which is a feature of Pulkovo during the early summer. Some of the direct photographs, on a scale of 56 cm. for the sun's diameter, show remarkable surface detail and solar granulation, with individual granules about 0·4″ in diameter.

It has been decided not to remount the 30-in. object glass, and a new 32-in. objective has been constructed in Leningrad; a mounting is being designed.

It is impossible to assess the merit of an observatory, especially one of which the main work is astrometric, from a superficial tour of inspection. To British ideas some of the building work (largely done by women) is rather poor and some of the equipment rather naive. But the general impression is that Pulkovo is a fine observatory, with a wide range of instruments, and, above all, with a first-class staff under the direction of an astronomer who commands world-wide respect; there seems every prospect that Pulkovo will attain the eminence in the future that it has so justly been accorded in the past.

This account would not be complete without recording that the rebuilding of Pulkovo is but one of the many evidences of great astronomical activity in the Soviet Union. For example, the Sternberg Institute and Observatory of the University of Moscow are being rebuilt on a grand scale on the Lenin Hills, in the shadow (as it were) of the towering new university buildings; but the main observing station will be some twenty-five miles south of Moscow. The opening ceremonies were followed by two conferences—one on astrometry and the other on variable stars—both of which were the eleventh of a regular series organized by the Astronomical Council of the Academy of Sciences. The numbers present at these conferences and the reports from the different observatories confirmed the increasing interest in astronomy. Other evidence is the great number of text-books, at all levels, being produced: some are extremely good.

There is not, and perhaps has never been, any doubt as to the genuine desire of the Soviet astronomers themselves to co-operate with those of other countries; the personal contacts at Pulkovo reaffirmed this, and it is greatly to be hoped that freer intercourse will be possible.

The astronomers from the Western countries (two American, one Canadian, two British, two French, one Belgian, two Dutch, one Norwegian, one Swedish and one Italian) are most grateful to the Soviet Academy of Sciences for making possible this meeting with their colleagues in the U.S.S.R., and for its most generous and comprehensive hospitality both in Leningrad and later in Moscow.

D. H. SADLER

A GREAT HAUL OF AMBERGRIS

By ROBERT CLARKE

National Institute of Oceanography, Wormley, Surrey

DURING the last Antarctic whaling season a boulder of ambergris weighing 926 lb. was found in the large intestine of a bull sperm whale (Fig. 1). The whale, which was 49 ft. long, was being worked up on board the floating factory *Southern Harvester* on December 21, 1953, in 58° 23′ S., 14° 13′ W.

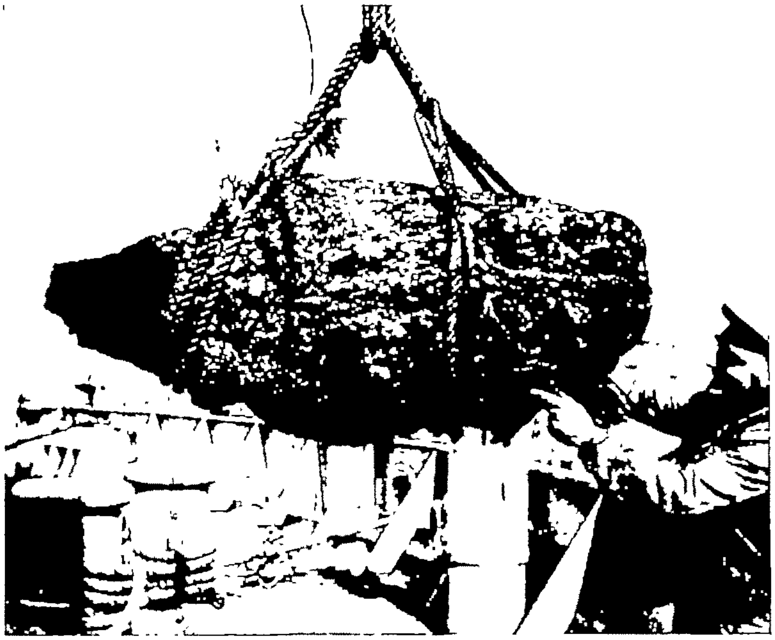

Fig. 1. Ambergris weighing 926 lb taken from a sperm whale in the Antarctic on December 21, 1953. (*Photo by courtesy of Messrs. Chr Salvesen and Co*)

Although this boulder is no doubt the largest single mass to be properly examined and authenticated, the figure of 926 lb. is actually exceeded by four others in the literature. However, when these figures are examined, at least three of them do not necessarily refer to a single mass from one whale: the largest figure is to be found in *The Times* of December 15, 1947, which printed a report that the Brazilian steamer *Araxa* chanced upon ten tons of ambergris at sea. This was described as a "gray, odoriferous mass"; but it is not conceivable that such a quantity could have come from one whale, and, if the substance was ambergris and its weight not exaggerated, then it could only have been an extraordinary drift of numerous lumps of flotsam ambergris close together. The other three figures are more reasonable when judged by the present haul. 983 lb. of ambergris were entered in the manifest of the whaling bark *Splendid* of Dunedin, New Zealand, in 1883 [1]; but this was a production figure at the end of a whaling voyage and so may have included ambergris from more than one whale. The Portuguese Fisheries Statistics record 928 lb. (422 kgm.) from San Miguel, Azores, in 1944; but this may have comprised a lump of 708 lb. (322 kgm.) plus one or more smaller finds[2]. The only figure, in fact, which specifically refers to a single mass of ambergris greater than the present haul is one of 982 lb. and describes ambergris which once belonged to the Dutch East India Company[3]. Even here van Beneden and Gervais (p. 304) thought they should record this gigantic mass cautiously and therefore suggested that it might be an agglomerate of several pieces stuck together while in some plastic state fresh from the sperm whales. But the present haul weighs only 56 lb. less, so it seems reasonable to admit this 982 lb. mass from the Dutch East India Company to be the largest known mass of ambergris, with the present haul of 926 lb. taking second place. A lump practically as large, weighing 924 lb. (420 kgm.), is recorded from a sperm whale taken on the Australian coast many years ago[4].

The present mass is 65 in. long and its greatest diameter measures 30 in. In the same factory ship, on November 21, 1947, and in 55° 59′ S., 03° 32′ E., I had the good fortune to find and examine a smaller, but still notable, boulder of ambergris which weighed 340 lb. and measured 26 in. across its greatest diameter[5]. Presumably because of their size, very large lumps of ambergris have been said to be invariably found in the stomach of the whale and not in the intestine[6]. But both masses from the *Southern Harvester* were found in the large intestine, which is the organ where I have in the Azores once or twice found small 'parcels' of ambergris, and where, indeed, have been made all those ambergris finds inside the whale for which reliable accounts exist. Now, without measurements to hand, I recollect the adult sperm whale's large intestine as measuring 6 or 7 in. in collapsed diameter. These ambergris weights and measurements, combined with a glance at Fig. 1, therefore show how astonishing it is that a sperm whale is able to carry, within an intestine which can distend fourfold without rupturing, such a vast weight in its body and can still maintain its digestive processes and not appear obviously sick. For both these whales had food in their stomachs and both were in good condition, although for nearly two centuries it has been customary to say that ambergris comes only from sick, lean whales.

The nature and origin of this intriguing substance are problems which deserve to be re-examined. Modern text-books either describe ambergris as a "biliary concretion" or as a substance arising from irritation of the intestine by the horny beaks of the squid which form the chief food of the sperm whale. Schwediawer[7], however, in 1783, wrote: "We may therefore define Ambergris to be the praeternaturally hardened dung or faeces of the Physeter Macrocephalus, mixed with some indigestible relics of its food". By the examination of these two great masses, and of smaller finds, and by descriptions in the literature, I am led to a similar conclusion. Local increase in water absorption by the large intestine, and the chemical transformations enacted by the resident intestinal bacteria, probably each play their part in the formation of ambergris from faeces impacted around some matrix of indigestible material.

It may be possible to produce ambergris in the laboratory by incubating sperm whale faeces in suitable conditions. The matter is of some commercial importance because ambergris is still a valuable commodity without equal as a fixative in perfumes.

An account of ambergris is projected which, besides describing its history and mythology, its composition, properties and uses, will attempt to explain its origin in the whale in the way briefly indicated here.

I would like to thank Messrs. Chr. Salvesen and Co., owners of the *Southern Harvester*, for their facilities in 1947–48 and in May of this year when I examined the new find; I am grateful to Mr. Desmond King and to Commander Percy Ashe, R.N., respectively chief chemist and whaling inspector of the vessel, for their kind assistance.

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SOME CHEMICAL ASPECTS OF ABNORMAL GROWTH*

By Prof. F. BERGEL
Chester Beatty Research Institute, Institute of Cancer Research, Royal Cancer Hospital, London, S.W.3

SOME chemical aspects of normal growth and development were considered by me last year[1]; very little has since been published to add to our limited knowledge in these fields. This is particularly so with respect to the fundamental problem of reduplication of specific functional and structural macromolecules in the cell[2–5]. In this article I shall deal with chemical-biological problems connected with abnormalities of growth and development of a non-malignant character. One has to assume that during the normal processes a most admirable harmony prevails between the stimuli and inhibitors which act at the right moment on the correct cell or tissue receptors. When this harmony is upset, disorders of growth, or during embryonic stages, disturbances of differentiation and morphogenesis, or both, are produced. The expert can recognize them on a cellular, tissue, organ or whole-body level[6–8].

Disorders of Growth

One distinguishes between hypertrophic and hyperplastic states, on one side, and atrophic and hypoplastic on the other. The latter, which amount to diminution in size of an organ or muscle, are due to shrinkage of tissue or reduction in the number of cells respectively and are usually connected with lowered metabolism. Whether this is caused by old age, malnutrition, starvation, disuse or traumatic damage, the normal turnover of metabolites, that is, the synthetic and catabolic processes of the cells, has decreased. Often, vitamin deficiencies contribute to these reductions, resulting in irregularities of enzyme functions. In some cases they are the sole primary cause, as in the muscular dystrophy of rodents through vitamin E deficiency[9]. Hormonal deficiencies, apart from their overall effect, often produce glandular atrophies and hypoplasias: for example, pituitary dysfunction causes, under certain conditions, thyroid and adrenal hypoplasia[10]. Hypoplasia seems to be present also in the bone marrow of some anaemic patients; but pernicious anaemia and reticuloses often show the opposite, namely, hyperplasia.

This hyperplastic state, which is due to an increase in the number of cells above the normal, occurs requently together with hypertrophy, meaning an nlargement of cells, fibres and, with them, of tissues nd organs. At other times, hypertrophy can be bserved on its own, and might be of a physiological, daptive or compensatory nature. While the pregnant uterus with its fibres enlarged ten times their ngth and four times their width represents a hysiological case, the over-exercised motor muscle n the 'strong man' illustrates that of the adaptive mechanism. A typical example of the compensatory ype can occur in double organs, such as the kidney, where, after removal or atrophy of one half, the emaining half is enlarged. This hypertrophic reaction can surprisingly be enhanced in rats, ccording to Gross and Meier[11], by dosing them with ortisone, which usually suppresses protein synthesis. Thus the biochemistry of hypertrophy and also of hyperplasia deserves further attention, particularly s the results may throw some light on that of malignancy.

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* Synopsis of two lectures given at the Pharmacology Department, University College, London, on February 4 and 9, 1954.

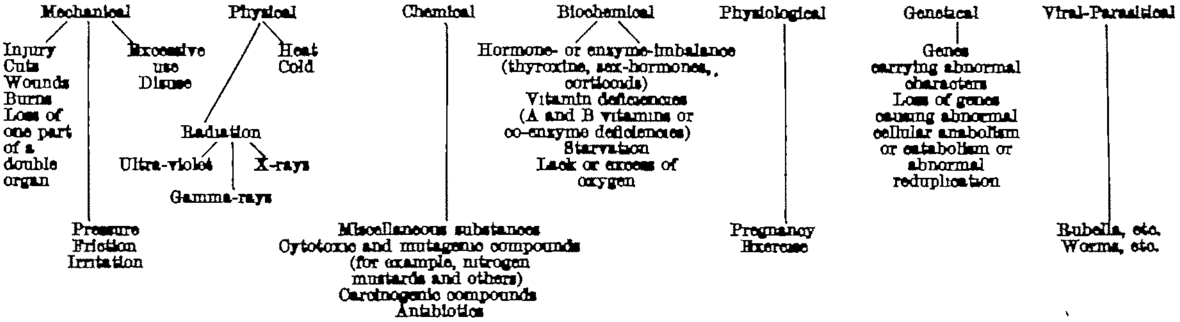
Before giving more details of abnormal growth, it may be useful to mention differences between the wo forms of excessive growth which include benign tumours and neoplasia of a malignant character. Although the dividing line between benign abnormality and cancer is not always well defined, it can be said that the main differences are these: truly neoplastic tissue is capable of invading normal tissue, it can cause secondary tumours or metastases, is, under experimental conditions, transplantable within he same species, and shows histological and cytoogical irregularities. While it has been found that essation of action of a stimulus or an appropriate inhibitor which may be one of the primary causative agents in the formation of hyperplastic and neoplastic issue will lead to regression or even arrest of the former, malignant neoplasia shows irreversibility or autonomy. At present the most favoured hypothesis as to the cause of neoplasia on a cellular level is that he cell has undergone a change in its somatic-genetical characters and is gradually losing some of its differentiation characteristics. It has acquired, instead, the growth potency of immature embryonic cells without obeying, as they do, the controlling nfluence of the tissue to which they belong or the organism as a whole. However, biological and, particularly, chemical differences between cancer cells, abnormal and normal cells are more of a quantitative than a qualitative nature.

Numerous examples of such quantitative differences in biochemical behaviour have been quoted in the iterature[12]. On the whole, benign hypertrophic and hyperplastic abnormalities yield, in several respects, results occupying a medium position between those obtained with normal and malignant material. This s the case[13], for example, with respect to the oxygen consumption in the absence and presence of succinic acid in conformity with Warburg's original observation of the preponderance of aerobic glycolysis in tumours. It also becomes manifest when comparing the amounts of trace elements present in normal, hyperplastic and neoplastic tissue[14,15]. As this problem of trace metals in tissues, particularly in view of the part played by some of them as enzyme activators, deserves further investigations with improved analytical methods, a start has been made by workers at the Chester Beatty Research Institute and the Royal School of Mines, London[16], to assay a great number of normal and abnormal tissues, including malignant tumours, as to their contents of major and minor metallic constituents.

In the following, a few examples of hypertrophic and hyperplastic conditions are given, together with relevant experimental findings. Not only the tissues of animals and man may show abnormalities of growth, but also plants are subject to such disorders, called 'galls'. Crown gall, for example[17], is caused by a microbe, *Agrobacterium tumefaciens*, and simultaneous injury. This plant tumour shows some similarities with mammalian neoplasms as it is autonomous and transplantable. There exist other galls[18] of a more benign nature which are produced by certain insects when laying their eggs, by insertion into the plant tissue. The character of these galls is determined by the insect species or by the active chemicals released by it, and not by the plant species. It would be very desirable if the substances causing these abnormalities could be isolated. This is the more important as growth regulators, such as indole acetic acid, when injected into plant tissue, can initiate the formation of galls having greater likeness to those produced by insects than to the malignant crown galls. But the situation is somewhat complicated by the fact that plant tissue, invaded by *Agrobacterium*, shows an increase in indole acetic acid content, and that early crown gall transfers[19] are suppressed by maleic hydrazide, a typical indole acetic acid antagonist. Although much can be learned from growth abnormalities in plants, their production by insects and relatively simple growth regulators should introduce an element of caution into comparing them directly with animal or human disorders. On the other hand, it has been established that the activity of protozoa, bacteria and viruses can lead to abnormalities in avian or mammalian tissues. This can be demonstrated in human skin[20] where, apart from verruca or warts, caused by mechanical trauma, possibly followed by an infection, a disease called molluscum contagiosum occurs. There the agent producing proliferation is a virus, while, in keratoderma blenorrhagica, cocci are responsible for the histological changes. We are only slowly learning what these changes mean in chemical terms, with regard to enzymes, proteins, nucleic acids and other cellular constituents.

It is not unlikely that continued investigations will reveal that other agents, whether physical or chemical, causing disturbances of growth, produce similar metabolic irregularities in the end. In the case of injury, taking again the skin as an example, where a most admirably ordered process of regeneration takes place normally, the repairing tendency, particularly of the connective tissue, may become exaggerated and collagen synthesis too abundant. The consequence is cheloid formation or scarring. Looking at other parts of the body, such as glands and organs, one finds that hypertrophic or hyperplastic changes can develop due to a number of different factors. In those parts of the body which are under the control of hormones, often an imbalance of hormonal production is at the back of pathological changes. One gland studied in great detail is the thyroid[21], where hyper- or hypo-activity of the iodo-thyronines may lead to various forms of goitre accompanied by other symptoms of ill-health. The sex organs are particularly sensitive to changes in the quantities of steroid derivatives such as œstrogens, androgens and progesterone, either as growth stimulants or inhibitors, and in this connexion it is interesting to note that Boyland *et al.*[22] have succeeded in producing hyperplasia in testes of young cockerels by application of certain sulpha drugs, such as sulpha mezathine.

Fig. 1. POSSIBLE PRIMARY CAUSATIVE AGENTS AND FACTORS OF ABNORMAL GROWTH AND DEVELOPMENT


Mechanical
Injury
Cuts
Wounds
Burns
Loss of one part of a double organ
Excessive use
Disuse
Pressure
Friction
Irritation
Physical
Heat
Cold
Radiation
Ultra-violet
X-rays
Gamma-rays
Chemical
Miscellaneous substances
Cytotoxic and mutagenic compounds (for example, nitrogen mustards and others)
Carcinogenic compounds
Antibiotics
Biochemical
Hormone- or enzyme-imbalance (thyroxine, sex-hormones, corticoids)
Vitamin deficiencies (A and B vitamins or co-enzyme deficiencies)
Starvation
Lack or excess of oxygen
Physiological
Pregnancy
Exercise
Genetical
Genes carrying abnormal characters
Loss of genes causing abnormal cellular anabolism or catabolism or abnormal reduplication
Viral-Parasitical
Rubella, etc.
Worms, etc.

The effect observed is independent of the bacteriostatic action of the drugs and is not neutralized by the administration of *p*-aminobenzoic acid or folic acid. Green[21], when injecting an androgen into goldfish, has succeeded in producing epithelial hypertrophies, which the males develop normally during the breeding season on gill plates and pectoral fins. With regard to œstrogens, numerous results have been reported on their growth-stimulating effects[22]. While the original observation of hyperplasia of the whole uterus in rodents following prolonged application of such œstrogens was extended by Horning[22] in the rabbit to the formation of discrete tumours, so-called fibromyomata or fibroids, others, and particularly Lipschutz[23], found that under certain conditions female guinea pigs developed such fibroids, not only of the uterus but also of other organs in the abdominal cavity. Such proliferations, however, were reversible and regressed when the application of the œstrogenic substance was stopped; only in exceptional cases did they show irreversible and, thus, malignant properties. Lipschutz, who established that fibromatogenic activity went parallel with the œstrogenic activity of the drugs used, discovered that other steroids, among them progesterone, androgens and deoxycorticosterone, showed fibroid-preventing effects. Strangely enough, cortisone and related compounds turned out to be inactive. All these experimental results are, of course, of great value in human medicine, which has known the spontaneous formation of fibroids and non-malignant tumours for a long time. It seems that, in woman, sex hormone imbalance is also one of the causative factors.

There are in man a number of other organs which are prone to benign proliferative abnormalities, such as the intestines, the kidneys, the reticulo-endothelial system and others. Interesting results have been obtained by Haddow[24] when injecting rodents with certain analogues belonging to the group of pteridines and purines. Among others, the naturally occurring xanthopterin produced hypertrophy of the kidneys in experimental animals by stimulation of cell division in the epithelium of the tubules. These effects are reversible and may be due to interference with activity of enzymes. A number of substances synthesized by Timmis, Ross *et al.*[25] were therefore tested as to their inhibition on one of the enzymes of nucleic acid catabolism—namely, xanthine oxidase—and for their kidney effects. Although in some cases the *in vivo* and *in vitro* activities, or their absence in these two effects, showed good correlation, in others no such parallelism could be noted[25]. It is therefore unlikely that the hypertrophy is solely due to the inhibition of xanthine oxidase, and work is continuing on other enzymes and metabolic events.

Disorders of Development and Morphogenesis

Just as disorders of growth are the consequenc of irregularities of cellular and tissue metabolism, s disturbances during the embryonic period and thereafter are followed by disorders of development an morphogenesis and result in malformation.

Last year[1] an attempt was made to summarize th state of the biochemistry of morphogenesis as reviewe by Needham[26], Brachet[27] and others. Space does no permit me to go into details as given during m recent lectures[28], and it must suffice to mention recen findings by Toivonen[29] which seem to confirm th existence of specific evocators, released by organize regions and inducing in competent areas of the ovu the development of neural and mesodermal tissues. Brachet[30] has emphasized the close link betwee morphogenesis and the gradients of ribonucleic acid in the fertilized egg. He has also mentioned the disturbing effects of chemicals or oxygen deficiency leading in extreme cases to the arrest of development It becomes more and more apparent that any disturbance of the interplay between organizers an the growth process of the embryo will produc developmental disasters. Such disasters can be, o course, genetically conditioned in that the sperm o the egg have carried abnormal genes. As genes ar known to control enzyme synthesis and the vita reduplication of other cellular constituents, it i obvious that abnormal ones will bring about abnormalities in the embryo. On the other hand, outsid factors, whether they are of physico-chemical o parasitical nature, can cause maldevelopment an malformations. Thus, temperature, radiation, toxi concentration of ions or drugs do more harm durin this sensitive period than at any other time. Girou and collaborators[31] have demonstrated that sligh vitamin deficiencies in the rat, which do not touc the mother animal, will produce most serious malformations in the embryo. While he has studie mainly the effects of shortcomings in the B group o vitamins, other vitamin deficiencies, such as A, etc., have been shown to cause maldevelopment even i the pig. A temporary lack of oxygen during incubation of chick eggs, as demonstrated by Büchner e *al.*[32], will lead to malformations of the heart and th major blood vessels, and cortisone, again in the same animal, according to Chester Stock *et al.*[33], suppresse overall growth. Forbus[8] describes, with regard t human pathology, a great number of abnormalitie in whole organs and limbs, which are reminiscen of those produced experimentally as already mentioned. Apart from a complete breakdown o development which leads to production of amorphou embryonic masses, abnormal twinning may give ris o the formation of monsters and teratomas which n the old days have often formed the subject of airy tales and sagas. Giants and dwarfs are also lescribed, or men with supernumerary or missing imbs, eyes and features. Each of these abnormalities s known to modern embryologists or pathologists s hyper- and hypo-genesis, including those nalformations which, due to endocrine deficiencies, nay turn up as late as in childhood or even later still.

All these disturbances of development have many eatures in common, in some yet incompletely recognized way, with disorders of cellular and tissue growth. Summarizing, it is permissible to speculate hat they all derive basically from irregularities of cellular constitution or metabolism in the form of ailures of normal protein or nucleic acid synthesis and thus enzyme or hormonal imbalance. Considering the possible primary causative agents and factors of abnormal growth and development, one can arrive entatively at a diagram as shown in Fig. 1. In conclusion, one may state with Ingersoll : "In nature here are neither rewards nor punishment, only consequences".

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OBITUARY

Prof. T. G. Hill

THOMAS GEORGE HILL, emeritus professor of plant physiology in the University of London, died on June 25 at his home at Hambledon near Godalming in his seventy-ninth year.

Born in London in 1876 he was educated at St. Olave's Grammar School and the Royal College of Science. He was for a time demonstrator in biology at St. Thomas's Hospital and in later years seemed very proud of his early connexion with this Hospital. After holding various lectureships in the University of London he became, in 1912, reader in vegetable physiology at University College, London, and following F. W. Oliver's retirement in 1929, professor of plant physiology and head of the Department of Botany.

His Department was a very happy one ; all students who entered it, and not only those reading special botany, were made to feel they were members of the Department. To undergraduates entering his Department for the first time 'T.G.' gave the appearance of being fierce and rather awe-inspiring. But as one got to know him better one realized that beneath the gruffness of manner he was a kindly gentleman—more than a little sentimental and not without his prejudices.

It is perhaps worth recording the advice 'T.G.' gave to one assistant lecturer he had appointed. "Prepare all your lectures carefully and thoroughly and always tear up your notes after you have given your lecture." His own lectures were models for any beginner to follow. He used few notes and spoke lucidly and fluently. It was a delight to listen to him build up an argument in a way that made the topic seem both logical and easy. The important points would be brought out by some telling phrase or striking analogy (generally far removed from botany). The result was a course of lectures which fifteen years later still remain vividly in the mind.

T. G. Hill's botanical researches fall into two parts. The first part of his researches was devoted to plant anatomy, and he never lost his interest in this field. His most important anatomical work was perhaps the series of papers published with Ethel de Fraine on seedling structure. The work was at first based on a phylogenetic point of view ; but the final paper in the series (still worth reading) in the *Annals of Botany*, 1913, marked the end of an era. The point of view had changed ; the varying structure of seedlings was not to be interpreted phylogenetically but physiologically ; the investigation had become a study in causal anatomy.

The second part of Hill's researches concerned plant chemistry and metabolism and was carried out largely in collaboration with Dr. Paul Haas (then reader in plant chemistry). They were the first botanists in Great Britain to study an oxidation-reduction system, hermidin, from *Mercurialis perennis*. Later appeared a long series of biochemical papers on the metabolism of marine algae. This was pioneer work in a field the importance of which is only now being generally realized.

In 1913, with Dr. Haas, he wrote "The Chemistry of Plant Products", which became a standard work. It is now, of course, somewhat out of date, but Vol. 2 on "Metabolic Processes" can still be read by students with profit, for its dynamic method of approach and presentation. It must remain a matter of regret that the authors did not see fit to revise this work.

As a member of F. W. Oliver's Department, Hill paid many visits to Blakeney Point, Norfolk. One result of this was his paper (with J. H. Hanley) on "The Structure and Water Content of Shingle Beaches", as well as studies on the osmotic pressures of salt-marsh plants.

In 1915 he published "The Essentials of Illustration". This book was not without its effect upon the standard of illustrations in biological journals; but it never became well known and indeed was not noticed in any botanical journal. In later years 'T.G.' suggested that this might have been because some of the material he used for his illustrations was rather frivolous.

From 1911 T. G. Hill served in the University of London Officers' Training Corps. He was adjutant during the First World War, became major in 1917 and resigned his commission in 1919. During the Second World War he took his department to Bangor, where he entered into the teaching and demonstratin with a zest which must at times have been a trial t his hosts. He was nearly seventy when he retirec

'T.G.'s retirement was spent at his home i Hambledon. He was well known and liked in th village and will be remembered for his kindnes especially to the children. He was a keen supporte (and critic) of the Hambledon Cricket Club and serve as president. He was also at one time president of th now defunct Hambledon Garden Club.

During the post-war years he became a governo of Guildford Technical College, in which he took great interest. Characteristically, he resigned a fe months ago, when he was no longer able to get to th governors' meetings.

At University College 'T.G.' was well known an well liked in the smoking room. He will be remembered with respect and affection by many studen and colleagues.

D. J. B. White

NEWS and VIEWS

Biochemistry at Oxford :

Sir Rudolph Peters, F.R.S.

Sir Rudolph Peters retires at the end of the present academic year from the Whitley professorship of biochemistry in the University of Oxford, a post he has held since 1923. Peters studied as an undergraduate at Caius College, Cambridge, of which he became Drosier Fellow and Tutor. He took his B.A. in 1911 and graduated M.B., B.Chir. in 1915. After research and lecturing in biochemistry at Cambridge he joined the R.A.M.C., being awarded the M.C. with bar during the First World War. In 1919 he gained the M.D. degree of Cambridge. At Oxford, from 1923 onwards, he built up a flourishing school of dynamic biochemistry and found the first clue to the mode of action of thiamine from a study of its *in vitro* effects on metabolic processes. In the Second World War the development of British Anti-Lewisite, a substance of usefulness in a wide range of metallic poisonings, was a delightful example of the practical outcome of theoretical considerations. More recently, Peters has investigated the toxic action of fluoroacetic acid and has elegantly demonstrated how the incorporation of this substance into constituents of the tricarboxylic acid cycle leads to toxic action.

Peters has earned many distinctions. He was elected a Fellow of the Royal Society in 1935, receiving a Royal Medal in 1949 and delivering the Croonian Lecture in 1951. Many honorary degrees and many distinguished lectureships have been held by him, including the Dunham Lectureship at Harvard University. During 1946–50 he was a member of the Medical Research Council. Caius College elected him an Honorary Fellow in 1951. Fortunately, he will not be lost to the world of science on his retirement from Oxford, since he takes up a post with the Agricultural Research Council at the Institute of Animal Physiology, Babraham.

Prof. H. A. Krebs, F.R.S.

Prof. H. A. Krebs has been appointed to succeed Sir Rudolph Peters as Whitley professor of biochemistry at Oxford. He has been professor of biochemistry in the University of Sheffield since 1945, and the award to him, jointly with Dr. F. Lipmann, of the Nobel Prize for Medicine for 1953, was noted in these columns last year (*Nature*, 172, 837; 195 Prof. Krebs was educated at the Universities Göttingen, Freiburg i. B., Munich and Berlin, bei assistant in the Department of Prof. Otto Warbu at Berlin-Dahlem during 1926–30. He went t Cambridge as a Rockefeller Research Student in 19 and was appointed demonstrator in biochemistry that University in the following year. In 1935 was appointed lecturer in pharmacology in th University of Sheffield, a post which was afterwar converted to that of lecturer in biochemistry a then to professor. Since 1945 he has also be director of the Medical Research Council Unit f Research in Cell Metabolism at Sheffield.

Prof. Krebs's work has largely been concerne with the study of metabolic processes *in vitro*. 1932, in collaboration with Henseleit, he propose a mechanism for the formation of urea in the liv with the participation therein of ornithine, citrulli and arginine by means of a cyclical process, a theo that was afterwards the centre of controvers although it is now widely accepted. In 1937 he p forward his now classical citric acid cycle as a pat way of oxidation of carbohydrate, and it has sin become clear that this cycle is concerned not on with oxidation of carbohydrate but also with th of fat and of protein. Indeed, as the years ha passed, the importance of the citric acid cycle h grown rapidly, and Krebs's original idea has be amplified rather than modified. More recent Krebs and his colleagues have been especially int ested in the movement of substances across me branes, and the significance of such movements metabolic processes in general. His Medical Resear Council Unit will accompany him to Oxford, and is to be hoped that there will be no more than slight interruption of research as the result of th move.

Evidence for the Antiproton

It is firmly believed by most theoretical physici that the antiparticle to a proton can exist. Inde if the proton is to be described by a modification the Dirac equation, the existence of negative ener states is required. This particle should bear the sa relation to a proton as does the positron to an el tron. Should it be possible to create such a parti by a proton–nucleon collision, the incident proton will require a kinetic energy of at least $5 \cdot 6 \times 10^9$ electron volts. At present only one particle accelerator, the Berkeley 'Bevatron', exists which is designed to reach this energy. At this energy the production of antiprotons is not expected to be very copious, and their abundance relative to other particles formed will probably be far smaller than in many cosmic ray phenomena which have already been extensively investigated. The problem of the conclusive identification of the antiproton may be a difficult one for some time to come. A direct mass and sign measurement might be expected to identify it. However, this would require a high precision to distinguish it from known negative heavy mesons of mass greater than half the proton mass. Further, any such direct mass and sign determination could, in itself, always be attributed to a new type of negative heavy meson.

There is a characteristic feature of an antiproton that should render its identification more simple. On coming to rest in matter, an antiproton should be attracted into the nucleus of an atom and annihilate itself and one ordinary proton. This process, liberating as fast mesons (or less probably γ-rays) twice the rest energy of the incident particle, is by definition unique to an antiparticle, and should be readily observed. One cosmic ray event has been seen in a multiplate cloud chamber by DeStaebler, Bridge, Courant and Rossi (*Bull. Amer. Phys. Soc.*, **29**, No. 4, 74; 1954), which is consistent with this process, and hard to reconcile with an alternative explanation. Within the past year the use of large blocks of nuclear emulsions, and the combination of magnet and multiplate cloud chambers, have both greatly increased the amount of information that may be obtained from the observation of a single particle. It is quite possible that with the aid of these techniques conclusive evidence for the existence of the antiproton may be found in the near future. Moreover, it may become possible to identify the annihilation products of machine-produced antiprotons by a counter experiment, even if the particle is not detected.

Recollections of Lord Rutherford

At the request of a number of its Fellows, the Physical Society has reprinted the first five of its Rutherford Lectures in a booklet entitled "Rutherford by those who knew him" (pp. 69; from the Physical Society, 1 Lowther Gardens, London, S.W.7; 1954; 5*s*. to members or 8*s*. 6*d*. to non-members, with 6*d*. postage). All five Lectures are reminiscent in character and are obviously tributes by men who, like so many, if not all, of Rutherford's research workers, had fallen under the magic spell of their chief. There are a number of illustrations, some of which are rather charming in that they are snapshots, for the most part rather poor ones, taken from photographic albums and no doubt highly prized by their owners; unfortunately, the reproductions are very poor. The Lectures are by Prof. H. R. Robinson (Manchester period); Sir John Cockcroft (Cambridge period); Prof. M. L. Oliphant; Dr. E. Marsden; and Dr. A. S. Russell (Manchester period). Perhaps the Lectures by Prof. Robinson, Sir John Cockcroft and Dr. Russell are the more personal, or even anecdotal, of the five; Prof. Oliphant's Lecture is an attempt, in all too short a space, to appraise the impact of Rutherford and his work upon the science and life of the present time, and Dr. Marsden, as befits the only New Zealander, for the most part emphasizes the importance of Rutherford's early New Zealand background in the development of his character. The Lectures make fascinating reading, because their subject was a fascinating personality. Perhaps none has summed up Rutherford better than the late Sir James Jeans in a tribute shortly after Rutherford's death: ". . . In his flair for the right line of approach to a problem, as well as in the simple directness of his methods of attack, he often reminds us of Faraday, but he had two great advantages which Faraday did not possess—first, exuberant bodily health and energy, and second, the opportunity and capacity to direct a band of enthusiastic co-workers. Great though Faraday's output of work was, it seems to me that to match Rutherford's work in quantity, as well as in quality, we must go back to Newton. Rutherford was ever the happy warrior—happy in his work, happy in its outcome, and happy in its human contact".

Nuclear Reactor in Stockholm

On July 13 a nuclear reactor moderated with heavy water and using natural uranium was started in Sweden. The reactor, which is of the *CP* 3 type, has been built by the Atomic Energy Co. in Stockholm, a company jointly owned by the Government and private industry. The reactor is located in an underground room in the neighbourhood of the Royal Institute for Technology. Construction was started in the middle of 1951. The designed power is 300 kW. and the heat is dissipated by circulating the moderator through a heat exchanger, where it is cooled by air.

Work of the British Council

The tribute to the value of the work of the British Council which was paid six years ago by the Select Committee on Estimates was fully endorsed on both sides of the House of Commons in the debate on Overseas Information Services on July 6. That debate arose essentially out of the failure of the Government to reach any decision on the recommendations for the re-organization of these services in the report presented a year ago by Lord Drogheda's Committee. The second annex to that report, of which a summary was published in April last (Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. (Cmd. 9138.) Pp. 56. (London: H.M.S.O., 1954.) 1*s*. 9*d*. net), reviews the work and requirements of the British Council and, while making proposals for curtailment and rearrangement of the Council's work in Europe, stresses the value of the work being done elsewhere. The Drogheda Committee was well impressed with the standard of the staff in those British Council centres it visited, and directs attention in this report to the importance of establishing a long-term programme for British Council work overseas and sticking to it if staff of high quality are to be attracted and freed from the atmosphere of frustration and uncertainty in which the Council works to-day. The recommendations of the Drogheda Committee, including provisions for pensions, staff allowances, etc., would increase the total annual grants to the British Council by about £630,000, thus restoring the position to about what it was during 1948–49. What it believes the British Council needs more than anything else is a five-year programme of development with some guarantee that the necessary funds will be provided for its execution.

This principle of the quinquennial grant found general support in the debate on July 6, and the need for continuity was admitted even by the Government spokesman, Mr. Anthony Nutting, though he declined to commit the Government to any specific action on the report; by implication, he rejected the essential recommendation of the Committee, namely, that information work, whether conducted by the British Broadcasting Corporation, the British Council, the Central Office of Information or individual Government Departments, should be viewed as a whole with its strategy planned and its finances guaranteed over a period of years. While it would thus appear that the Government is unwilling to accept the Drogheda Committee's suggestion of a permanent Advisory Committee, Mr. Nutting joined with other speakers in repudiating emphatically the attacks made on the British Council and its work, particularly those being made in the Beaverbrook press. The British Council Staff Association has recently replied to these attacks by publishing at its own expense a pamphlet entitled "The Beaverbrook Press and the British Council" (pp. 12; 6*d*.), and this pamphlet was commended by the Minister. It is just such occurrences which the Press Council was formed to investigate, and it is to be hoped that the Council will in due course take up the matter.

Ciba Foundation: Support for Gerontological Studies

THE Ciba Foundation has decided to support experimental work and basic investigations into the problems of ageing as an additional item in its general programme for the promotion of international co-operation in medical and chemical research. An extra sum of money has consequently been set aside for gerontological studies over the next five years, and these studies will take the form of regular colloquia, informal discussion meetings, lectures, special awards and travelling fellowships. The recent colloquium on "Aspects of Ageing", held by the Foundation during July 14–16, was the first of a series in this field, and the proceedings of this colloquium will be published as a series of volumes on lines similar to the Foundation's well-known "Colloquia on Endocrinology". When the opportunity occurs, guests staying in the Foundation with special knowledge in gerontology will be invited to open informal discussion meetings. The annual Ciba Foundation Lectureship will be open to distinguished workers in the field. For the Foundation's awards for original researches, candidates are invited to submit unpublished work (though it may be under consideration for publication), and prize-winning entries may be printed in English and bound periodically to form a separate series of volumes representing international progress in the field. It is proposed to make five such awards in the first year, of an average value of £300 each, but the size and number of the awards may be varied according to circumstances. The Foundation will also from time to time make grants for travelling fellowships, especially where it is considered that candidates would benefit from a visit or visits to laboratories in another country.

Cairngorms Nature Reserve

THE declaration by the Nature Conservancy in Edinburgh on July 9 of the Cairngorms Nature Reserve brought into existence much the largest nature reserve in Great Britain and one of the largest in Europe. The 62 square miles, or 39,689 acres, now declared omits Cairngorm but includes the three highest summits and is slightly larger than the 38,000 acre area originally recommended by the Scottish Wild Life Conservation Committee. Only about one-eighth of the area, covering the higher lands of Invereshie, has been bought by the Conservancy. The remainder is brought in under a series of nature reserve agreements which are the first under Section 16 of the National Parks and Access to the Countryside Act, 1949, to be completed between the Nature Conservancy and private landowners. It is also planned later to enlarge the Reserve, which is intended to preserve as nearly as possible unchanged this grand stretch of country and its highly interesting wild life and vegetation for the enjoyment of the present and future generations and for scientific study. There will be no charge as regards access, but formalities will be required for those wishing to undertake research, to take specimens of animals or plants (which will be prohibited except for scientific purposes) or to obtain permits for camping. Applications for collecting or other scientific purposes should be addressed to the Nature Conservancy at 12 Hope Terrace, Edinburgh 2. Two Conservancy wardens are already in residence and will be glad to inform and assist visitors. Deer-stalking, grouse-shooting and the destruction of a few undesirable pests will continue, but special protection zones have been arranged for ptarmigan, and no birds of prey except sparrowhawks will be killed.

A strong Cairngorms Consultative Panel has been established to advise the Conservancy on all matters affecting public rights and interests, including mountain rescue arrangements, and the Conservancy hopes to assist in the provision of footbridges and the care of mountain shelters. The programme of scientific investigations will probably include the natural regeneration of native Scots pine in the remnants of the Caledonian Forest, the ecology of mountain birds, plants and insects, and high-altitude meteorology. The primary object of the Reserve, however, is to safeguard its characteristic Highland wild-life, including the golden eagle, ptarmigan, dotterel, snowbunting, blackcock, greenshank, crested tit and Scottish crossbill, as well as red deer and roedeer, wild cat and other mammals, and more than two hundred species of flowering plants and hundreds of species of non-flowering plants and invertebrates, many of which are of considerable rarity and interest.

Society for the Promotion of Nature Reserves

THE 1953 handbook of the Society for the Promotion of Nature Reserves gives an account of the eight reserves administered by the Society: Woodwalton Fen (Huntingdonshire), Dancer's End (Buckinghamshire), Meathop Moss (Westmorland), Badgeworth Marsh (Gloucestershire), the Coward Memorial Reserves (Cheshire), Mickfield Meadow (Suffolk), Sharpham Moor (Somerset) and Bellairs Great Wood (Essex). All these reserves were established in order to preserve certain rare plants, insects or birds, and each year their value becomes greater with increasing housing development and the consequent destruction of areas of interest to the naturalist. Among the species protected in the reserves are *Fritillaria meleagris*, *Ranunculus ophioglossifolius*, *Carex evoluta* and *Salvia pratensis*. The international aspect of Nature protection is described in the report of the meeting at Salzburg of the International Union for the Protection of Nature which was attended by more than a hundred people of thirteen different nationalities who met to discuss the effect of tourism on Nature protection and protection of fauna and flora in high altitudes. The handbook, price 5s., can be obtained from the Honorary Secretary, Society for the Promotion of Nature Reserves, British Museum (Natural History), Cromwell Road, London, S.W.7.

The Marsupial 'Tiger Cat'

EXCEPT for their uniquely spotted coats, in outward appearance and their flesh-eating habits the pouched dasyures or native 'cats' of Australia most nearly resemble foreign carnivores of the weasel family. Excellent photographs have been taken of a male and female of the much larger and generally fiercer 'tiger cat' which had been caught in the act of raiding poultry yards in Sydney; these are described by Ellis Troughton in a recent issue of the *Australian Museum Magazine* (11, No. 5; March 1954). Their captor, Mr. H. Grant, a retired sergeant of police, not only tamed these habitual raiders of the bush but also reduced them to a remarkable state of docile affection. After their capture about six months ago, five young were discovered attached to teats within the shallow-edged pouch of the mother. Their lusty growth gave opportunity for most interesting observations in captivity. The yellowish-brown tiger cat, which is the largest of the native cat group, attaining a length of 4 ft. from nose to tail-tip, is distinguished by having the creamy white spots extending down the tail, instead of being restricted to the body as in all the smaller native cats. Despite size, the tiger cat is an expert climber with a well-developed great-toe which is lacking in he more terrestrial native cats. It has been seen to eap from topmost branches of trees to catch roosting owls by the neck, killing them in the act of falling with the body to the ground. The tiger cat is plentiful in Tasmania, which has become the last refuge of he largest known marsupial carnivore, the 'pouched wolf' or 'tiger'. It inhabits eastern Australia from he southern border of South Australia to the Cairns egion of Queensland, where a smaller geographical ace (*gracilis*) is known to occur.

Diseases and Pests on Horticultural Planting Materials

THE Ministry of Agriculture and Fisheries has prepared a special guide, by Mr. P. Aitkenhead and Dr. J. A. Tomlinson, entitled "Diseases and Pests on Horticultural Planting Material: a Guide to their Recognition" (pp. 38. London: H.M.S.O., 1953; s. net), designed primarily for the information f the Ministry's inspectors in their new duties under the Plant Protection Convention, 1951, of the Food and Agriculture Organization, which requires, among other things, inspection of consignments of plants moving in international traffic. A large number of insect pests and fungus diseases is described n the guide. The style is almost terse, but quite dequate for the purposes of a field-book setting orth to give a specific *ad hoc* determination against general background of phytopathological knowedge. Host plants are, most conveniently, listed lphabetically, and the guide deals with the semi-ormant planting forms of ornamental and useful lants. Perhaps the most useful feature, however, will be the eighty-three excellent half-tone illustrations; these are from many sources, and certainly enhance the booklet.

Bell Solar Battery

THE June number of the *Bell Laboratories Record*, the semi-popular journal published by the Bell Telephone Laboratories, Inc., of New York, is of unusual topical interest by reason of some articles on transistors, and especially of an account of a new silicon device termed the Bell solar battery. The recent use of silicon in semi-conducting devices is the culmination of more than twenty years of work at the Bell Laboratories, and the solar battery is the result of the development by G. L. Pearson, C. S. Fuller and D. M. Chapin—physicist, chemist and electrical engineer, respectively—of a successful device for converting the sun's energy into electricity. In its present experimental form, the battery has an efficiency of 6 per cent and is expected to reach 10 per cent, in contrast with other photo-electric devices which have never achieved more than 1 per cent. The battery is constructed of wafer-thin silicon strips about the size of razor blades; these are linked together electrically to deliver power from the sun at the rate of 50 W. per square yard of surface. Illustrations accompanying the article refer to possible applications to the driving of a small electric motor and to the operation of a mobile radio transmitter.

International Scientific Radio Union

THE eleventh General Assembly of the International Scientific Radio Union (U.R.S.I.) will be held in The Hague during August 23–September 2. A report on the previous meeting, which was held in Sydney, was published in *Nature* (171, 628; 1953), and this included a full list of the officers of the Union elected for the forthcoming assembly. The Union is composed of national committees which contribute by subscription to its income, and, as a result, are entitled to official representation and participation in the scientific work before and during each General Assembly. The British National Committee for Scientific Radio is organized under the auspices of the Royal Society with Sir Edward Appleton as chairman. This committee has nominated a British delegation comprising a number of scientists directly interested in various aspects of measurements and standardization, radio-wave propagation, atmospherics, radio astronomy and the scientific problems of electronics, waves and circuits. Some of these delegates will be responsible for submitting, on behalf of the British National Committee, reports to the General Assembly reviewing the advances made in the United Kingdom in each of the fields of research indicated by the seven commissions of the Union. These reports and the corresponding ones submitted by other national delegates will be supplemented by other original contributions describing recent research work of direct interest to the international aspects of scientific radio. The General Assembly will also be considering the proposals for enhanced radio observations during the International Geophysical Year, 1957–58, as already incorporated in the preliminary programme drawn up by the special committee composed of representatives of all the international scientific unions interested in this work.

Physical Society: Forthcoming Meetings

A CONFERENCE on "The Physics of the Ionosphere" has been arranged by the Physical Society and will take place at the Cavendish Laboratory, Cambridge, during September 6–9. The Conference, which is being organized by Mr. J. A. Ratcliffe, will be devoted mainly to a discussion of the following topics: (*a*) the lowest ionosphere; (*b*) irregularities and movements in the ionosphere; (*c*) the ionospheric *F*2 layer; (*d*) the mathematics of wave propagation through the ionosphere. Accommodation can be provided at Cambridge; application forms, which are obtainable from the offices of the Physical Society, should be returned to the Cavendish Laboratory, Cambridge, before August 16.

The seventh Rutherford Lecture of the Physical Society will be delivered by Prof. P. M. S. Blackett on November 26 in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7, at 5 p.m. His subject will be "The Organization of Scientific Discovery". At a Science Meeting of the Society to be held on November 5, at 5 p.m., in the Lecture Room, Royal Astronomical Society, Burlington House, London, W.1, the Duddell Lecture will be delivered by Prof. A. C. B. Lovell on "The Development and Use of Large Radio Telescopes", and the Charles Vernon Boys Lecture will be given by Dr. J. S. Courtney-Pratt on "Some New Methods of Fast Photography". These lectures are open to non-members of the Society.

United States Fellowships for British Scientists

NINE fellowships for research in American institutions have been awarded to British scientists under a technical assistance programme sponsored by the United States Foreign Operations Administration. This will bring to eleven the number of fellowships awarded to British scientists since the inception last year of this programme, which provides for about a hundred and fifty younger scientists from fourteen Western European countries to undertake advanced study at American universities and research institutions, about twenty-five of the total being from the United Kingdom. The latest British awards, which have been made by the National Academy of Sciences, Washington, D.C., on the nomination of the Royal Society of London, are to the following for study at the institutions indicated: Dr. D. R. Bowsher (assistant lecturer in anatomy, University of Liverpool), Harvard Medical School; L. Castillejo (lecturer in physics, University College, London), Cornell University; Dr. B. R. Coles (lecturer in metal physics, Imperial College of Science and Technology, London), Carnegie Institute of Technology; Dr. F. M. Dean (lecturer in organic chemistry, University of Liverpool), University of California; Dr. R. F. Evans (Chemical Research Laboratory, Teddington), Purdue University; Dr. V. A. Knivett (Chemical Research Laboratory, Teddington), University of Wisconsin; A. G. Milnes (Royal Aircraft Establishment, Farnborough), United States Naval Ordnance Laboratory, Silver Spring, Maryland; Dr. J. Owen (Magdalen College, Oxford), University of California; and Dr. E. M. Thain (Lister Institute of Preventive Medicine, London), University of California.

Heriot-Watt College, Edinburgh: Fellowships

HONORARY fellowship of the Heriot-Watt College, Edinburgh, has been conferred on the following, all of whom are former students of the College: Mr. C. Batey, printer to the University of Oxford; Mr. R. C. M. Dickson, Scottish representative director of Boots Pure Drug Co., Ltd.; Mr. W. B. Laing, general manager of Bruce Peebles and Co., Ltd., Edinburgh; Sir William Paterson, chairman and managing director of the Paterson Engineering Co., Ltd., London; and Dr. Rameshawr P. Sinha, principal of Dhanbad School of Mines, India. Fellowships by thesis have been awarded to the following: Ralph A. Aitken (enzymolysis of cell-wall material with special reference to the malting process), and Sailendra N. Ghosh (new network analyser).

Society for Applied Bacteriology: Officers

THE following have been elected officers of th Society for Applied Bacteriology: *President*, Mr S. B. Thomas; *Secretary*, Mr. G. Sykes (Boots Pur Drug Co., Ltd., Microbiology Division, Nottingham) *Treasurer*, Mr. C. S. Miles; *Editors*, Dr. S. E. Jacob and Dr. L. F. L. Clegg; *Publications Manager*, Mr E. A. Whitlock; *Advertising Manager*, Mr. E. J Mann; *Ordinary Members of the Committee*, Dr L. A. Allen, Mr. K. R. Butlin, Mr. J. W. Egdell Dr. L. D. Galloway, Dr. A. Hirsch, Dr. M. Ingram Mr. D. A. McKenzie, Mrs. A. C. Stirling and Dr Helen R. B. White.

Announcements

THE Scientific Instrument Manufacturers' Association has elected as its president for 1954–55 Mr C. E. T. Cridland, chairman and managing directo of a group of companies which includes Aldi Brothers, Ltd., of Birmingham. Mr. Cridland wa trained as an electrical engineer, and has bee connected with engineering industry all his life particularly electrical and aeronautical engineering.

THE Committee representing the Royal Society and the Armourers and Brasiers' Company ha appointed Mr. K. E. Puttick to be Armourers an Brasiers' Company Research Fellow from October 1 1954, to work at the H. H. Wills Physical Laboratory, University of Bristol, on the structure and deformation of pearlite.

THE Council of the Royal Society has awarde Mr. and Mrs. John Jaffe Donation Studentships fro October 1, 1954, to the following: Dr. Eileen N. Richardson, to work at the Physical Chemistry Laboratory, University of Oxford, on the kinetics o bromination of selected aromatic compounds; an Mr. A. Korner, to work at the Department of Biochemistry, University of Cambridge, on the influenc of hormones on metabolism.

AN award under the Royal Society and Nuffiel Foundation Commonwealth Bursaries Scheme together with financial support from the Board of th Dairy Research Institute, Palmerston North, Ne Zealand, has been made to Dr. S. Y. Thompson, o the National Institute for Research in Dairying Reading, to enable him to visit the former Institut in 1955 in order to study factors controlling th vitamin A potency of New Zealand butter.

THE University of Padua is offering a Gabriell Zuccari scholarship of 300,000 lire for research of a least six months duration at the Zoological Statio Naples, during the academic year 1954–55. Th scholarship is open to any person who wishes t undertake research in zoology, comparative anatomy physiology or embryology. Application forms (to b returned by October 30) can be obtained fro the Secretariat of the University of Padua.

ERRATUM. In the communication of May 15 p. 956, on the "Life-history of the Rat Lung-wor and its Migration through the Brain of its Host' by Dr. M. Josephine Mackerras and Miss Dorothea F Sandars, the two illustrations should be interchange

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1952–53

THE "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1952–53"*, issued by the University Grants Committee, shows a further decline of 1,984 in the number of full-time students—to 81,474, compared with 83,458 in 1951–52 and 85,314 in 1950–51. In the English universities, full-time men students decreased by 1,231, but women students increased by 282; for Wales the corresponding figures were 259 and 17, while for Scotland there were 694 fewer men and 99 fewer women. Overseas students from within the British Commonwealth increased by 318 to 4,239 full-time and 1,842 part-time students, and students from foreign countries by 190 to 3,229 full-time and 1,302 part-time students. While there was no significant change in the percentage distribution of full-time students among the faculties, there was no evidence of any increase where it appears to be required in the national interest. Arts students decreased by 1,020 to 34,916, but those in pure science decreased by 52 to 17,001 and those in technology by 222 to 9,993. Students of medicine decreased by 399 to 13,511, of dentistry by 174 to 2,715, of agriculture by 139 to 2,279, and those of veterinary science increased by 22 to 1,059. Full-time advanced students of pure science, however, increased by 187 to 3,045, and those of technology by 52 to 1,157 and of agriculture by 7 to 281; students of medicine and dentistry decreased by 44 to 963, of veterinary science by 3 to 7, and of arts by 10 to 3,304, while those working for a teacher's diploma decreased by 76 to 2,900. Of the full-time students, 64,753 were reading for a first degree, 5,064 for a first diploma and 11,657 were engaged in research or other advanced work, the corresponding figures for 1951–52 being 66,409, 5,505 and 11,544, respectively.

The proportion of assisted students was slightly smaller (70·4 per cent compared with 72·4 per cent during 1951–52); for England as a whole, it decreased only from 73·8 to 72·9 per cent, but in Wales it decreased from 88·3 to 81·1 per cent, and in Scotland from 61·6 to 55·7 per cent. The dependence on Parliamentary grants, however, continued to increase and is now 69·6 per cent of recurrent income, only 12·7 per cent coming from fees, 4·4 per cent from endowments, 3·6 per cent from local-authority grants and 1·6 per cent from donations and subscriptions. Two years ago (1950–51) the corresponding figures were 16·6, 5·2, 4·1 and 1·9 per cent, respectively, with 64·9 per cent from Parliamentary grants. The ratio of staff to students continued to improve, the full-time teaching staff being now 9,098, compared with 8,952 during 1951–52 and 8,603 during 1950–51. The increase was chiefly in readers, assistant professors and independent lecturers (38), senior lecturers (71) and lecturers (364), with a further decrease of 255 in assistant lecturers and demonstrators to 1,282.

Of the full-time students, 62,635 were in England, 4,621 in Wales and 14,218 in Scotland. Of these, 14,717 were at Oxford and Cambridge, 18,199 at London and 29,719 at other English universities and university colleges. There were slight decreases at all universities and university colleges, except Bristol (+ 9), Reading (+ 60), Exeter (+ 35) and North Staffordshire University College (+ 117), but only at Cambridge (– 152), Oxford (– 119) and Liverpool (– 182) was the decrease more than one hundred. The proportion of full-time students residing in colleges and halls of residence increased to 27·3 per cent; of these 22,269 students, 7,977 were at Oxford and Cambridge, 11,367 at other English institutions and only 1,188 in Wales and 1,737 in Scotland. The proportion of men in residence was 22·9 per cent and of women 41·3 per cent, while 32,559 students (40 per cent) were in lodgings and 26,646 (32·7 per cent) at home, compared with 39·6 per cent and 34·5 per cent during the previous year. Of the 21,355 students admitted for the first time during 1952–53 (a decrease of 1,059 on 1951–52), 19,683 were reading for a first degree, and 1,672 for a first diploma; and of those reading for a first degree, 1,612 were under eighteen years of age, and 10,679 were nineteen or more. Of the full-time students, 35,057 out of 48,044 men and 10,607 out of 14,591 women in England were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds; for Wales the corresponding figures are 2,588 out of 3,287 men and 1,161 out of 1,334 women; and for Scotland 5,942 out of 10,455 men and 1,980 out of 3,763 women. Of 61,786 full-time men students, 36·3 per cent were in arts, 21·9 per cent in pure science, 17·2 per cent in medicine and 15·9 per cent in technology; for the 19,688 women students the corresponding figures are 63·4, 17·5, 14·7 and 0·9 per cent, respectively. Medicine and dentistry claimed 49·1 per cent of the part-time advanced students, arts 33·8, technology 9·0, and pure science 7·5 per cent, compared with 51·1, 33·0, 8·0 and 8·7 per cent, respectively, during 1951–52.

The recurrent income of the universities and university colleges of Great Britain increased by £3,950,084 to £29,698,083, of which £20,682,415 was from Parliamentary grants, £3,764,749 from fees, £1,311,884 from endowments, £1,065,913 from grants from local authorities and £483,416 from donations and subscriptions. Of the total income from public funds of £21,748,328, and £7,949,755 from other sources, the University of London received £6,660,992 from public and £2,330,982 from other sources; the University of Cambridge similarly received £1,358,177 and £1,278,658; for Oxford, the corresponding figures are £1,220,380 and £733,576; Manchester, £1,068,409 and £265,774; Leeds, £891,496 and £259,220; Durham, £961,460 and £342,640; Birmingham, £856,834 and £252,077; Liverpool, £866,006 and £236,745; Bristol, £777,240 and £316,801; Sheffield, £544,693 and £165,201; Reading, £513,506 and £61,316; and Nottingham, £478,565 and £106,604. No other English university or university college had an income exceeding half a million pounds; but for the four universities in Scotland the corresponding figures were: Aberdeen £494,000 and £136,754; Edinburgh, £1,039,430 and £346,812; Glasgow, £1,021,000 and £349,223; and St. Andrews, including Dundee University College, £529,000 and £109,658. The University of Wales, including the Welsh National School of Medicine, received £1,096,545 from public funds and £309,189 from other sources.

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* University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1952–53. (Cmd. 9130.) Pp. 44. (London: H.M.S.O. 1954.) 2s. 6d.

Of the total expenditure of £28,700,434, an increase of £2,568,312 or 9·8 per cent on 1951–52, administration accounted for 7·7 per cent, departmental maintenance 68·9 per cent, maintenance of premises 12·5 per cent, and miscellaneous expenditure 9·7 per cent. Capital expenditure met from income amounted to £334,516, and allocations to reserve to £334,015; for 1951–52 these figures were £258,963 and £222,536, respectively. Departmental maintenance, which includes salaries of teaching staff, payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc., increased by £1,665,428 to £19,761,880, and expenditure on the maintenance of buildings increased by 26·4 per cent. Salaries and superannuation amounted to £13,169,879 compared with £12,542,994 during 1951–52, the increase being 5 per cent for the teaching staff and 18·5 per cent for technicians and laboratory assistants.

Library expenditure, excluding general maintenance of library buildings, etc., rates, heat, light, repairs, etc., amounted to £1,118,428, or 3·9 per cent of the total expenditure, compared with 3·8 per cent during 1951–52 and 3·7 per cent during 1950–51. Of this total, £557,656 was for salaries and wages, £135,907 on periodicals and £90,072 on bindings. Of the £276,852 expended on books, £174,548 was in the schools and colleges of the University of London, including £9,800 at the Central Library, £7,222 at University College, £6,883 at the London School of Economics and £5,846 at the School of Oriental and African Studies. The University of Oxford spent £39,404 on books, Cambridge £16,014, Manchester £12,955, Liverpool £10,016, and Durham £10,265. The University of Bristol spent £9,739 on books, and the University of Southampton's expenditure of £9,152 is noteworthy in view of its smaller number of students; but although expenditure on books and periodicals continued to increase slightly, the upward trend was scarcely in proportion to the mounting costs of both books and periodicals. Only the Universities of London (£38,582), Cambridge (£10,247) and Oxford (£11,417) spent more than £10,000 on periodicals, and only Birmingham (£5,770), Leeds (£5,055) and Manchester (£5,460) more than £5,000. The University of Wales spent £11,869 on books and £7,987 on periodicals; in Scotland, Edinburgh spent £13,625 on books and £6,071 on periodicals; Glasgow, £13,421 and £7,711; Aberdeen, £6,619 and £3,733; and St. Andrews, £8,113 and £4,350.

SCIENCE IN THE EXTRA-MURAL WORK OF UNIVERSITIES

A SURVEY of some aspect of adult education from the pen of the *doyen* of heads of university extra-mural departments* is bound to attract attention and interest, and it is to be hoped that this essay will be carefully studied in responsible quarters. It will repay careful study, for there is much wisdom and good sense in its pages; but at the same time there is little to inspire, and the tone is cautious, almost apologetic. Thus, on p. 9 are set out the figures for courses in the sciences in relation to the total number of courses arranged by the universities and the Workers' Educational Association during the session 1952–53. Science provides 10 per cent of the total, and, while acknowledging that this represents "a considerable advance" on the 4 per cent of an earlier survey in 1925–26, Prof. Peers describes it as "remarkably low". In fact, however, an examination of the figures for all subjects scarcely confirms this judgment. In a total number of courses of 3,755 the physical and biological sciences, with 378, are exceeded by language and literature (623), the arts (599), history (597) and social studies (459). But the sciences in turn exceed international affairs (289), psychology (231), philosophy (186), religion (180) and government (128): biology alone provides more courses than philosophy, religion or government, and the physical sciences, with 167 courses, fall little short of religion. Given the inherent difficulties, which Prof. Peers does not fail to bring out, the position is less unsatisfactory than he suggests. Something must be allowed for variations in length of courses; but it remains remarkable that, in times like the present, international affairs should be less well represented. The student quoted by Prof. Peers who preferred "not to know the details" of the atom bomb that might blow her to pieces would seem to be as critical of international affairs as a subject of study. Here, perhaps, Prof. Peers's judgment is understandably coloured by the fact that his Department has a greater number of courses in international affairs than any other in the kingdom.

Nevertheless, Prof. Peers's approach is a sound one: "The real case for science as part of the general education of the adult citizen is exactly the same as the case for history, literature and the social sciences . . . without a knowledge of science he cannot live the best and most satisfying life of which he is capable: a whole range of experience, æsthetic as well as practical, is closed to him". This is well said, and the point is developed in some valuable paragraphs (pp. 6–7). It is doubtful, however, whether this view is sufficiently widely held in adult education circles. Prof. Peers quotes a science tutor's opinion as to the disadvantages caused by the unfamiliarity of organizers and administrators with science, only to brush it aside. He does not, however, seem to make sufficient allowance for the existence of latent demand. His argument that "it is not the business of Extra-mural Departments to use methods of persuasion to induce adult groups to choose one subject rather than another" begs the question, and reflects the conditions of an earlier period when 'demand' could be more easily recognized and satisfied. The task of the present in adult education, despite the great increase in the number of courses, is not to meet a recognizable and clamant demand, but to investigate society in order to ascertain where and how the universities, and other providers, can both stimulate and satisfy needs and interests. Prof. Peers offers some observations, based on the experience of several universities, on this aspect of the problem; but the investigation needs to be carried further and to be illustrated with actual syllabuses. His conclusion that little can be done "until science is given its proper place in the general curriculum of the schools" is open to question. Despite the arguments he offers, it is doubtful whether recollection of studies at school often encourages adult students to attend courses in any subject. Nor is his criticism of "the absence of suitable text books" particularly valid, while his concern with "expensive microscopes and micro-projectors" as "a *sine qua non* of effective work" suggests a limited and specialist approach. It may be questioned, too, whether the claim that "the same objective methods" are used in the social sciences as in the physical can altogether be justified, while the criticism that the scientist is not necessarily dispassionate in his political or sociological judgments does not get us far: few of us would care to make even academic philosophers our kings.

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* Science in the Extra-Mural Work of Universities. By Prof. Robert Peers. Pp. 19. (Bristol: Universities Council for Adult Education, 1954.)

Yet Prof. Peers offers some useful suggestions as to the development of courses in the sciences, and puts the subject in its proper perspective by proposing the establishment of science sub-departments of extra-mural departments, with the aim, above all, of achieving "the reintegration of science as an indispensable part of a liberal education". As a non-scientist he has rendered a valuable service in opening the subject for discussion: it is to the scientists in adult education that we now look for a more developed statement.

NUTRITION AND THE LIVER

SYMPOSIUM IN GLASGOW

On May 8 the Scottish Group of the Nutrition Society held a symposium on "Nutrition and the Liver" in the Biochemistry Department of the University of Glasgow under the chairmanship of Prof. J. N. Davidson, head of the Department. This meeting provided an opportunity for workers in fields ranging from academic biochemistry to clinical medicine to pool their knowledge. Prof. Davidson introduced the subject with a short paper entitled "The Chemical Architecture of the Liver Cell", in which he described the technique of differential centrifugation, by means of which liver cells may be separated into a nuclear fraction, mitochondria, microsomes and the cell sap. He pointed out that mitochondria isolated in this way are morphologically different from mitochondria as seen in the living cell; furthermore, they are not a homogeneous population, since they can be subdivided into several chemically and enzymologically distinct fractions. The microsomal fraction is composed of minute particles, but these may represent the disintegration products of a reticulum in the cytoplasm of the living cell. Prof. Davidson then demonstrated that, although most chemical constituents of the liver are considerably affected by variations in nutritional status, the total amount of one component, deoxyribonucleic acid, remains unchanged even in the face of extreme dietary variations; the quantity of this component is determined solely by the number of cells present. Consequently, deoxyribonucleic acid can be used as a reference standard against which changes in other liver cell constituents can be measured. Examples were given of the misleading results which may be obtained when liver composition is expressed per 100 gm. of fresh tissue, and the clarification in interpretation which follows the expression of results in relation to deoxyribonucleic acid.

The influence of the protein and energy content of the diet on liver composition was considered by Dr. H. N. Munro (Department of Biochemistry, Glasgow). The amount of protein in the liver is considerably affected both by the level of protein and of energy intake. These changes in protein content occur much more rapidly and extensively in the liver than in most other tissues of the body. This has led to the supposition that the liver may contain a store of protein which is readily depleted under adverse nutritional conditions; but attempts to demonstrate a chemically discrete storage protein have not met with success. In parallel with changes in the protein content of the liver, there are also variations in ribonucleic acid and phospholipid content. These changes occur without any alteration in cell number, and the material so gained or lost has been named "labile liver cytoplasm" (Kosterlitz). By means of differential centrifugation of the liver into fractions, it has been shown that a reduction in protein intake causes a loss of protein from all parts of the liver cell, of ribonucleic acid principally from the microsomes, and of phospholipid from the microsomes and cell sap. Thus the material lost from various parts of the liver cell is not uniform in composition. Although the amount of ribonucleic acid is reduced by protein deficiency, its rate of synthesis seems to be independent of protein intake and to be determined by the level of energy intake. Dr. Munro concluded by suggesting that the failure to identify the labile protein of the liver with any single chemical or morphological entity within the liver cell could be readily explained if differences in the rates of protein synthesis in different tissues are considered. Such differences in rate will determine the speed with which these tissues adjust their protein content to altered dietary conditions. The liver, being among the most active in protein synthesis, will become rapidly adjusted, giving the impression of gaining or losing a labile protein component.

Dr. J. M. Naftalin (Rowett Research Institute) dealt with the production of liver necrosis in rats by dietary means. In summarizing the history of this subject, he pointed out that the two dietary conditions generally believed to be necessary for the production of liver necrosis are deficiency of sulphur-containing amino-acids and lack of vitamin E. His own investigations were aimed at determining the influence of restriction of food intake and of environmental temperature on the incidence of liver necrosis among animals receiving necrogenic diets. He observed that 70–78° F. (21·1–25·6° C.) is the optimal temperature for producing necrosis on diets deficient in vitamin E and low in sulphur-containing amino-acids, the incidence being considerably less at temperatures higher or lower than this. In addition, caloric restriction with the same diet reduces the frequency of necrosis. A sufficient degree of food restriction prevents liver necrosis at all environmental temperatures, but too severe restriction leads to death without necrosis. Variations in the incidence of necrosis also occur when different preparations of casein are used as the protein source in the necrogenic diet. The incidence of necrosis was found to depend on the origin of the casein and to be independent of alcohol–ether treatment used for the removal of vitamin contaminants. It is not yet known whether caseins differ in necrogenicity because of the presence of a toxic factor in the high-incidence preparations or of a protective factor in the low-incidence preparations.

Dr. E. Kodicek (Dunn Nutritional Laboratory, Cambridge) contributed a paper on the storage of vitamins in the liver which summarized much recent work on the subject. He defined storage as the amount of a particular vitamin laid down in excess of the physiological level needed for normal functioning. From this point of view, the vitamins fall into two classes. The first group comprises those which occur in coenzymes or the prosthetic groups of enzymes, and for this group Dr. Kodicek proposed the name 'prosthetins'. Even with massive dosage, their concentration in the liver does not exceed a certain limit which probably represents saturation of the apoenzyme with the prosthetic group. Deficiency reduces the amount in the liver, but never to very low levels. These features are to be contrasted with the behaviour of the other group, the fat-soluble vitamins. Their concentration in the liver can be enormously increased by dosage (for example, to a hundred times the physiological level) or reduced to virtually zero by deficiency. The pattern of storage varies for the different fat-soluble vitamins. On dosage with vitamin A the efficiency of utilization can reach a maximum of 80 per cent of the amount fed, very high doses being toxic and leading to less efficient storage. By contrast, only a small fraction of administered vitamin D is stored in the body, most of it in the liver. Vitamin E is mainly found in the body fat; but dosage with this vitamin leads to a temporary increase in the liver concentration. It has recently been shown by Dam and his colleagues that deposition of vitamin K in the livers of chicks occurs only in response to dosage with the natural vitamin and not after administration of vitamin K substitutes; this may have therapeutic importance.

Dr. J. Waterlow (University College of the West Indies) described his experiences with disorders of the liver found in tropical countries in association with malnutrition. The chief forms of liver disease which are common in tropical climates are fatty liver and cirrhosis; massive necrosis is not more frequent than elsewhere. Fatty liver is found in very young children, and a severe form of fatty liver is a prominent feature of the kwashiorkor syndrome. The condition is nutritional in origin, probably the result of protein malnutrition in particular. In cases of fatty liver there is evidence of protein depletion, and Dr. Waterlow made the point that stigmata of protein insufficiency are not limited to the liver but are generalized, the organs most severely affected being those with the highest turnover of protein. Deposition of fat in the liver does not appear to be the fundamental factor determining the severity of the disease, which is probably dependent on the degree of protein depletion. The other common tropical liver condition, cirrhosis, does not appear to be an end-result of fatty infiltration, as has been demonstrated experimentally in rats. Geographically, there is little correspondence between the incidence of juvenile cirrhosis and of fatty livers in tropical countries. Dr. Waterlow suggested that juvenile cirrhosis may be produced by a combination of factors, one of which is malnutrition. Thus the occurrence of cirrhosis among West African children may result from a combination of malaria and malnutrition, the malnutrition being responsible for damage to the parenchymal cells and the malaria for overgrowth of fibrous tissue. In the West Indies the combination may be one of malnutrition and dietary toxins, arising from the widespread use of decoctions of plants ('bush tea').

The place of diet in the treatment of liver disease was discussed by Dr. A. L. Latner (Department of Chemical Pathology, Royal Victoria Infirmary, Newcastle upon Tyne), who described the nutritional principles underlying such treatment. He pointed out that, while a generous supply of protein in the diet is desirable for the regeneration of liver cells after the acute phase of liver damage is ended, the intravenous use of protein hydrolysates is irrational since the blood during severe liver damage already contains excessive amounts of amino-acids. There is, however, a good case for giving ample amounts of the vitamins. An interesting point made by Dr. Latner in this connexion was that the macrocytic anæmia associated with liver disease is relieved by folic acid but not by vitamin B_{12}. He also emphasized that liver diseases often cause profound disturbances of electrolyte metabolism which require correction. In acute liver failure Dr. Latner has obtained a high recovery rate by the intravenous use of glucose, saline, potassium chloride and massive doses of thiamine, nicotinamide and riboflavine, together with intramuscular injections of vitamins E and K. The dietetic treatment of some less acute forms of liver disease was also described.

Dr. A. J. Hale provided a microscopical demonstration of the minute anatomy of the liver for those attending the meeting. The communications will be published in the *Proceedings of the Nutrition Society*.

H. N. MUNRO

THIRD INTERNATIONAL RUBBER TECHNOLOGY CONFERENCE

THE Third International Rubber Technology Conference, held in London at Church House, Westminster, during June 22–25, under the auspices of the Institution of the Rubber Industry, was attended by some six hundred and twenty delegates from eighteen countries. About seventy-five of the delegates were accompanied by their wives, for whom a separate social programme of visits to places of interest had been arranged.

In declaring the Conference open, its patron, the Marquess of Salisbury, who was introduced by the president of the Institution of the Rubber Industry, Lord Baillieu, welcomed the delegates on behalf of the British Government. He recalled that it was six years since the last Conference of this type, and that the matters to be discussed interested many parts of the world and would be concerned with such important matters as synthetic rubber, combinations of synthetic with natural rubber, and chemical modifications of natural rubber itself. After the official opening, the chair was taken by Dr. W. J. S. Naunton, the chairman of the Conference, who announced that there would be in all seven sessions, each having its sectional chairman, who would be a well-known authority on the subjects to be discussed. Fifty papers covering a wide range of subjects, some highly scientific and others purely technological, had been pre-printed and already circulated to the delegates. These papers had been selected from the ninety offered as being likely to provide a source of stimulating discussion.

The first session, under the chairmanship of Mr. E. A. Murphy, consisted of eight papers on the properties of natural rubber latex. The subjects discussed included the variability of *Hevea* latex, with articular reference to differences in the phosphate/nagnesium ratios of different clonal latices, and the tructure of *Hevea* latex together with the influence f various chemical additives and treatments on its iscosity. Other papers dealt with the effect of arious naturally occurring mineral elements on field atex; and with the destabilization of ammoniated atex and soap-stabilized emulsions in the presence of omplex zinc diammine ions, which was suggested to e due to a decrease in hydration of the zinc diammine lilaurate, formed at the surface of the rubber particles. In an interesting paper E. W. Madge, H. M. ollier and J. L. M. Newnham described the study f viscosity changes in concentrated latex under lifferent experimental conditions to determine the nechanism of the thickening of latex by zinc xide. Small variations in the amount of natural oap have been found to be of great importance. ther papers described the peptizing of rubber by he addition of organic mercaptans to fresh latex, he production of improved rubbers by the enzymatic leproteinization of skim latex and the occurrence of nicrogel in latex and sheet rubber.

Two periods were devoted to the second session for he discussion of nine papers on synthetic rubbers, he chair being taken by Dr. Naunton himself. A aper which aroused much interest was one in which . F. Bloomfield, F. M. Merrett, F. J. Popham and . McL. Swift reported recent work on graft polymers lerived from natural rubber, thus still further arrowing the gap between natural and synthetic ubbers and indicating how man may modify and ometimes improve naturally occurring high polymer ydrocarbons. A somewhat related paper by D. H. offey and T. J. Meyrick described the preparation nd properties of condensation block copolymers of he polyester type. A paper entitled "How Synthetic Rubbers Affect You", by Mr. I. D. Patterson, lescribed synthetic rubber progress in terms of a ondensed time-scale and gave many interesting tatistics of production and use, concluding with he apt quotation from Browning, "The best is et to be". This paper provoked considerable liscussion.

Prof. A. A. Morton, well known for his considerable vork on the Wurtz reaction, presented a paper on he cation and anion influence in the 'Alfin' reagent or the polymerization of butadiene. He substantiated his remarks by producing from butadiene nd 'Alfin' catalyst a piece of synthetic rubber having molecular weight of about ten million, the whole rocedure taking less than five minutes, and in full iew of the audience. Among newer types of synthetic rubbers described were those derived from utadiene copolymerized with unsaturated ketones nd with 2-methyl-5-vinylpyridine, the last-mentioned type being capable of cross-linking by a quaternizing' reaction with organic halides. Other apers dealt with such subjects as the structure and olution properties of butadiene styrene copolymers f high molecular weight and the oil resistance f synthetic rubbers over periods up to fourteen ears.

The next session, under the chairmanship of Dr. . C. Bateman, was concerned with the chemistry of ubber. Six papers were introduced by their authors nd covered a wide field, including such subjects as article surface reactions, vulcanization by sulphur nkage and by atomic energy radiation, oxygen bsorption, and chemical reactions of antioxidants sed in vulcanized rubber. A paper on infra-red spectroscopic analysis of elastomers was also discussed in this section.

In the session dealing with the physics of rubber, the chair was taken by Dr. J. R. Scott, and six papers were discussed, while in the case of two papers, the authors of which were not present, written comments or questions were invited. A wide variety of topics in this section included such subjects as permeability, reinforcement, elasticity, effect of nuclear magnetism, compounds for low-temperature service, elastic behaviour of filler-reinforced rubbers, dynamic properties and time-dependent effects in tyre cords.

The chairman for the session on developments in testing methods was Mr. J. M. Buist, and six papers were presented for comment and discussion. The first, by B. Pickup, described a new apparatus for assessing tear-down adhesion. E. F. Powell and S. W. Gough gave interesting information on the constant power principle in abrasion testing, while the paper by J. I. S. Williams and R. G. Clifton gave information on the methods of testing pneumatic tyres. Still other papers dealt with tyre cord fatigue, changes in electrical resistance with different black loadings, and a test for easily measuring the degree of vulcanization of rubber.

The sixth session (chairman, Dr. D. Parkinson) concerned itself with the theory and practice of compounding, and eight papers were delivered on many subjects, such as reinforcement by various means, oil-extending of natural rubber and the interaction of rubber and fillers during milling. As would be expected, several of the papers dealt with properties of various carbon blacks in rubber. An outstanding paper in this section was that by Dr. I. Drogin, who gave clearly and concisely a mass of detail on the properties of the various carbon blacks.

The final session dealt with miscellaneous technology, with Dr. J. G. Mackay taking the chair. Four papers all concerned with, or related to, tyres were grouped in this section, the individual titles being as follows: abraded filament tyre cords; effect of heat setting on the physical properties of 'Terylene'; wave phenomena in tyres at high speed; and tread wear and fuel consumption of tyres.

An exhibition of instruments, selected principally to show some of the developments in rubber testing which have taken place since the last Conference, in 1948, was arranged in conjunction with the present Conference, there being seventy-six items, arranged in twelve groups. The organizations responsible for the development and manufacture of the instruments were indicated in the exhibition catalogue, and references to the literature were also given. In many cases, where appropriate, the instruments could be operated by turning a switch. The exhibition also contained a display of samples made from modified natural rubber, and a stand showing recent books dealing with rubber science and technology. Mr. B. J. A. Martin, who was responsible for the organization and arrangements of this exhibition, is to be highly commended for a most successful and interesting display. The proceedings of the Conference are to be published as a single volume, and the important task of collecting the many papers and discussions is in the capable hands of the editor-in-chief, Mr. T. H. Messenger. There is no doubt that this volume, when issued, will form a valuable record of the 1954 Rubber Technology Conference.

F. A. JONES

STANFORD RESEARCH INSTITUTE, CALIFORNIA

REPORT FOR 1953

THE report for 1953 of the Stanford Research Institute, California*, states that contract research at the Institute increased by 18 per cent to 6·5 million dollars, the percentage of government research declined from 61 per cent in the first quarter to 49 per cent at the end of the year, while industrial research projects increased by 7·9 per cent on 1952 and 78·5 per cent on 1951. Of the 382 projects carried on during the year, 234 were for commercial clients and 109 for government agencies, while 39 studies were initiated or continued by the Institute as part of its plan for aiding the technological development of the region. Some 9 per cent of the Institute's revenue during the past three years has been expended on international activities, while a 30 per cent expansion in staff brought the total to 674 at the end of the year, the increase in professional staff in 1953 being 126.

The present research programmes are in physical and biological sciences, engineering, economics, and certain applications of industrial psychology and sociology. Much effort in 1953 was directed towards the automatic assembly of equipment, control of processes and handling of large amounts of standardized data. Automatic processing and control were applied to a number of instruments, and a major programme was concerned with the development of improved machines and methods for the automatic fabrication of electronic equipment. A preliminary exploration of the possibility of constructing an input–output table for the flow of goods and services in the economy of the eleven western States of the United States was initiated, as well as a study of the impact of the aluminium industry on the economy of the Pacific North-West. A continuous process in which sawdust is held in fluidized suspension in a reactor is facilitating the preparation of chemicals from wood waste, while new lubricants for application at high temperatures have been developed experimentally and the physical properties of moulding resins were being correlated with structure to permit the preparation of new products with the desired combination of properties. A fundamental study of shock-wave behaviour in solid materials has led to a continuing programme on the application of the general laws of explosive shock waves to specific problems.

Another study is concerned with systematizing the use of selected common weeds as indicators of atmospheric pollution, while several field studies were concerned with the nature of the damage to commercial crops and vegetation by fluorides. A new instrument has been developed, utilizing a tape impregnated with a substance that loses its fluorescence on contact with gaseous fluorides, which gives an accurate record of atmospheric fluorides. Tracer techniques have made it possible to determine the contribution made by contaminants from a particular source to the total atmospheric contaminants in a given area. An extensive study of the requirements for airborne antennæ used in a long-range air-to-ground communications on military aircraft was completed during the year, while the Institute continued to participate in the applicatio of operational research techniques both in defenc problems and in industrial problems. Besides th development of new research techniques and instruments, the Institute has organized a techno-economi approach for assessing quickly the potential prospect of new products and markets.

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[*] Stanford Research Institute. Annual Report. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1954.)

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1953

THE report of the Chemistry Research Board signed by the chairman, Prof. E. L. Hirst, an the report of the director of the Chemical Researc Laboratory, Teddington, Dr. D. D. Pratt, compris the publication entitled "Chemistry Research 1953"*, which has recently appeared. To these are appende lists of committees of the Board, of staff of th Laboratory on December 31, 1953, of publication and patents in 1953, of metals held by the Pur Metals Committee, of standard substances availabl and of species in the National Collection of Industrial Bacteria. During the year the Chemistry Research Board endorsed a recommendation that chemical engineering should be added to the programme o the Laboratory, and, although such activities are a present planned on a modest scale, the Board point out that considerable additions to staff and accommodation will be required. The Board has also endorsed the recommendation of the Microbiolog Committee that the Laboratory should pursue it investigations on the microbiological production o sulphur using sewage sludge as source of carbo as far as laboratory large-scale experiments t provide data for pilot-plant operation, and experiments have also been made on the simultaneou production of carbon and methane, which shoul offer considerable savings in capital and operatin costs.

Commenting on the provision of standard material by the Laboratory, the director points out that since the National Collection of Industrial Bacteri was formed in 1950, 2,505 cultures have been distributed; and, of the 814 distributed in 1953, 53 were to research and educational and 279 to industrial establishments. Some effort is now bein devoted to research on the maintenance of thes cultures, particularly with reference to the viabilit of the organisms under freeze-drying conditions. Th Laboratory has now forty-one reference specimens o organic compounds available, including five adde during the year, and supplied 355 samples compare with 256 in 1952. The Board regards this work as most valuable contribution to the nation's scientif work. A stock of twenty-six pure metals is als maintained, and the Pure Metals Committee ha noted, as a result of scientific developments in th field of semi-conductors, a growing demand fo metals of a much higher degree of purity (99·999 pe cent). Among the advisory work of the Laborator the director's report specially mentions that o immersed corrosion, underground corrosion an atmospheric corrosion in which services have bee rendered to industrial firms and public bodies

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[*] Department of Scientific and Industrial Research. Report of th Chemistry Research Board with the Report of the Director of th Chemical Research Laboratory, for the year 1953. Pp. iv+7. (London: H.M.S.O., 1954.) 2s. 6d. net.

Britain, the Middle East, South and East Africa and elsewhere. Samples of organic compounds have been analysed for some eighteen firms by infra-red spectrometry; in radiochemistry some twenty firms were assisted by the Radiochemical Group, and the Microbiology Group gave advice on problems connected with sulphate-reducing bacteria to many authorities including county and urban councils, stations of the Department of Scientific and Industrial Research and industry. The director's report notes that an increasing proportion of the time of the Corrosion of Metals Group is given to such extra-mural *ad hoc* problems. Apart from this, the Group has continued its study of the mechanism of corrosion inhibition, using mild steel immersed in potassium chromate solutions labelled with chromium. The capacitance method of evaluating the water uptake of paint films has been applied to coatings on nickel immersed in sea-water, and the test possesses advantages of speed, simplicity, continuity and non-destructiveness; but there appears to be no clear relation between the type of paint formulation and the degree of agreement with values obtained by the gravimetric method; for some paints and media agreement is close, whereas for others the values differed markedly. The Group is also investigating the corrosion of mild steel tubes in Scotch marine boilers; but its advisory work has limited its laboratory work largely to underground and microbiological corrosion and to examinations of corroded pipes, electrical power cables and soil samples, although it has been shown that mild oxidation increases the toxicity of commercially available tannins towards sulphate-reducing bacteria, and an explanation has been advanced of the formation of the geological deposits consisting of clay, sand or gravel cemented by iron oxides into a hard mass known as iron pan. An investigation of the oxidation of mild-steel sheet at 200° C. has thrown light on the mechanism of oxidation and on other phenomena at that temperature. Following further tests, the Becker-type condensation apparatus has been recommended to the parent committee of the Institute of Petroleum as a standard test for the evaluation of temporary protectives, and an apparatus embodying the same principle but capable of testing more and larger specimens has been designed at the request of the British Standards Institution.

The work of the Inorganic Group has been concentrated on the examination of waste and low-grade materials for the presence and recovery of valuable constituents and the preparation of elements and derivatives to a high degree of purity. The search for selenium in waste products continued, and, in view of difficulties experienced in obtaining consistent analytical results, much effort was given to securing analytical procedures more applicable to the variety of products and their wide range of selenium content. A method has been developed for the determination of small amounts of phosphorus in vanadium concentrates based on volatilization of the vanadium as vanadyl trichloride by heating at 420° C. in a slow stream of dry hydrogen chloride. Other work has been concerned with the recovery of sulphur from low-grade sulphur ores and of copper from flash-roasted pyrites cinders, while concentration studies have related to the behaviour of gold and other metals in adsorption and elution from 'Amberlite IRA 400', the behaviour of molybdate, chromate, vanadate, arsenate and tungstate with basic resins and the evaluation of new ion-exchange resins for separating metals. A chromatographic separation process for niobium, tantalum, copper, cobalt, uranium and lead in soils, for use in the field, the operation being completed in less than thirty minutes, has been designed, and the partition of thorium nitrate between ether and water at varying concentrations of thorium nitrate and nitric acid has been determined. A scintillation counter for use with carbon compounds containing carbon-14 has been completed and tested, as well as an apparatus for testing the behaviour of ion-exchange resins under repeated treatment with a series of solutions.

In the Organic Chemistry Group vapour-pressure and boiling-point measurements on phenol have nearly been completed, and the densities at 20° C. and 30° C. of pyridine and of four of its homologues have been determined, as well as the refractive indices of fourteen mixtures of pyridine and water, thus permitting the analysis of such mixtures with high precision from refractive index measurements. This system has also been re-examined over the whole range of concentrations with a vapour–liquid equilibrium still, operated isothermally, at 70° C. and at 90° C. Results of a combined investigation with the National Physical Laboratory of the construction, use and long-term behaviour of triple-point water cells indicate that the triple point of water is reproducible to 0·0001 deg. C. and that the triple-point cells do not deteriorate even after several years of use. Preparative work has been concerned mainly with carboxylation by means of carbon dioxide, particularly of phenols and of epoxides; the preparation and applications of isotopically labelled carbon compounds; and the exploration of new ion-exchange resins containing chelating groups. Under the first, a brief study of 4-hydroxy*iso*phthalic acid has indicated a tendency for the carboxyl group to be eliminated in substitution reactions, and high yields of ethylene carbonate have been obtained from carbon dioxide and ethylene oxide under pressure in the presence of catalysts. Sulphur dioxide similarly yielded a linear polymeric sulphate, depolymerized to the cyclic monomer on heating, while ethylene oxide and phosgene give by exothermal reaction, first, β-chloroethyl chloroformate, which with more ethylene oxide yields di-β-chloroethyl carbonate. Work continued on the preparation of resins containing complex-forming functional groups, from formaldehyde and resorcinol derivatives, while the Arbuzov reaction has been used to prepare ion-exchange resins containing the phosphonic acid group. The randomization of carbon-14 in methylcyclohexane has been developed into a useful method for the synthesis of labelled aromatic compounds, and the technique of filling ampoules with gases or liquids has been developed and a Podbielniak fractional distillation unit installed.

The High Polymers Group concentrated its effort on ion-exchange and allied properties of cross-linked polymers and semi-permeable membranes, and their applications. A detailed study of the relative affinities of alkali metal cations for sulphonated polystyrenes of different cross-linking has been completed, but no further work on strongly acidic cation-exchangers is proposed. By chloromethylation of styrene – divinylbenzene copolymers and subsequent animation in dioxan, methyl ethyl ketone or benzene, a range of anion-exchange resins has been prepared the properties of which may be systematically varied with respect to functional group, degree of cross-linking and ion-exchange capacity. Work has also continued on resins containing chelating groups, and a study of factors determining the semi-permeability of poly (vinyl alcohol) films in non-aqueous systems has shown that membranes of low permeability can be used to determine the molecular weights of simple compounds of known structure; work on the development of membranes for use in aqueous systems has commenced.

Besides the work already noted, the Microbiology Group continued its fundamental studies of sulphate-reducing bacteria, particularly their metabolism, and the continuous process for bacterial sulphate reduction, and started some studies of the bacterial oxidation of aromatic compounds, particularly the microbiological breakdown of phthalate, a process of industrial importance in the disposal of effluents.

THE ICE AGES AND PAST VARIATIONS OF THE EARTH'S CLIMATE

During the past sixteen years, Dr. E. J. Öpik has written extensively on climatic changes in a number of publications, and in Contribution No. 9 of Armagh Observatory, entitled "A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate"*, he has written a paper which largely embodies the main points in his studies.

As might be expected, Dr. Öpik rejects the old astronomical theories of the fluctuations of climate—the changes in the obliquity of the ecliptic and the eccentricity of the earth's orbit. About half a century ago these were shown to be utterly inadequate to account for glaciations and warm interglacial climates, but from time to time they have been revived. Simpson's theory of the ice ages, which was advocated a quarter of a century ago—that they are caused primarily by an increase in solar radiation which in turn leads to a rise of the mean global temperature and an increase of the absolute moisture content of the atmosphere, followed by more precipitation in the form of snow in the polar regions and an advance of glaciers—is dismissed with very little criticism. It is pointed out that there is an absurdity in the theory which postulates the melting of the glaciers and the retreat of the ice when the greater heat takes control, because both the advance and the retreat of the glaciers are explained by the same cause. In addition, climatological and other evidence points to the conclusion that the glaciers of Greenland retreated during the past century, in close response to the increased global temperature.

Dr. Öpik maintains that an interpretation of climatic changes cannot be made without a clear quantitative understanding of the heat balance of the earth, and he develops a method of quantitative analysis of the climatic heat balance, based on the equation $Q = I + E$. In this, Q, I and E represent respectively the net radiation to space, the net insolation or the absorbed solar radiation, and the heat supplied by other sources; the last-named includes convective interchanges with other parts of the earth's surface, such as atmospheric and oceanic currents, or released from that stored in the soil, the water or the atmosphere. On this basis and with certain further assumptions, standard mean radiation curves, in dependence on the mean surface temperature, are calculated for summer and winter as well as for clear and cloudy sky, and the results are given in the paper. Two sections, comprising twenty pages, are devoted to "Variations of Solar Luminosity" and "The Mechanism of Solar Long-Term Variability" and contain references to Öpik's work on these problems during the past fifteen years or more. Regarding the latter section, it appears that a temporary increase of the energy production near the sun's centre will lead to a decrease of solar radiation and to an ice age if the decrease is deep enough. A qualitative picture is sketched of the way in which repeated disturbances in the interior of a dwarf star like the sun can be produced, and it is just possible that here may be an explanation of the mechanism by which major ice ages were recurrent phenomena of a periodicity of about 240 million years. Of course, there is necessarily a considerable amount of speculation in all this, and it is very difficult to make many definite deductions in such matters.

Towards the end of the paper, under "The Problems of Pre-Tertiary Climate", Dr. Öpik confirms his views expressed in 1938 that, although Wegner's theory of continental drift, postulating a corresponding displacement in latitude, cannot explain the last ice age, nevertheless there can be little doubt about the reality of large-scale horizontal displacements (Alpine foldings) in the earth's crust. The opinion is expressed that even if the strange phenomena of Carbo-Permian glaciation can be partly explained by continental drift (and this glaciation is an inducement to regard Wegner's theory favourably), this explanation completely fails for the earlier Cambrian glaciation.

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* Contributions from the Armagh Observatory, No. 9: A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate. By E. J. Öpik. Pp. 79 (distributed by Blackwell Scientific Publications, Ltd., Oxford, 1953). 10s. 6d. net.

WINCHESTER COLLEGE NATURAL HISTORY SOCIETY

It is regrettable that the reports of the Winchester College Natural History Society can be published only once every three years owing to increased costs of printing, etc., for the report before us (1950–53) is well produced and makes very encouraging reading. However, duplicated summaries of observations on birds, insects and plants are issued every year.

The Society itself is very active, and the report reveals a variety of interests from general field observations to more specialized studies. Three specialized sections of the Society have now been formed—birds, insects and plants—and others may follow.

The report opens with an account by the warden, J. A. L. Myres, of the Viscount Grey Nature Reserve, "Fallodon", which is a part of Watermeads, a piece of land belonging to the College. It is quite clear that enthusiastic boys of the College have done much to render this nature reserve a really valuable asset since the War, during which its upkeep proved impossible.

P. J. Chadder gives an excellent account of the birds' nests (fifteen nests of seven different species) he examined in Fallodon during 1953. This is followed by a numerical analysis of the seasonal changes in birds in that reserve by D. E. D. Campbell.

He concluded that the number of birds were the same in summer as in winter, but that there were considerable decreases during early spring and autumn. The population also varied from week to week during the winter, but was constant during the summer. H. E. Norton publishes a commendable study of the territorial life of the blackbird—a long paper accompanied by six maps. He also presents the bird records for September 1949–July 1953. The bird-ringing report is made by J. A. L. Myres. Interest in birds is also enhanced in this report by a short account of the birds of Australia by J. E. Mollison.

A record of butterflies and moths around Winchester during 1950–53 is given by P. O'B. Harris. W. H. Dowdeswell describes the numerous visits made to Fisher's Pond, a pond which is proving ideal for the study of freshwater life. Molluscs, arthropods and birds were the main subjects of investigation. Another long paper is contributed by R. G. Borneman, writing on the movements and changes in a freshwater plankton community. This is accompanied by two figures and a table of results. Botanical activities are recorded by J. B. Poynton.

During the season reported about forty lectures and film exhibitions were arranged.

This report is one of several which reveal the active interest shown in some schools in field natural history where young students are able to make first-hand studies in ecology, taxonomy, behaviour, etc. Winchester College, with some of our more enthusiastic schools, is leading the way in a fuller appreciation of the true import and value of biological studies.

FORESTRY IN NEW ZEALAND

THE critical position of the indigenous forests of New Zealand has been known for some years and discussed in the annual reports of the Director of Forestry, New Zealand Forest Service. The annual report for the year April 1952–March 1953 (pp. 80. Wellington: New Zealand Forest Service, 1953) deals at some length in its opening pages with this question in its relation to the large area of exotic softwood coniferous forests now existing in the Islands. The position appears to be whether to sanction cutting out in a comparatively few years the remaining existing indigenous forest to maintain the saw-mill industry and industries dependent on indigenous timber and other vested interests, or to reduce the cut so as to maintain a portion at least of the natural forest of the Islands. The Forest Service correctly advocates the latter policy; but there appears to be a considerable body of public opinion against it.

New Zealand is not the only country in the world faced with this question in varying aspects, not excluding Great Britain. The time would appear to be approaching, if indeed it has not been already reached, when the world as a whole will have to make up its mind so far as forestry is concerned (which, in fact, is Nature herself) whether the forest soils of any country capable of maintaining its indigenous forest and species of trees should not rigidly be confined to this purpose; fast-growing exotics showing quick financial returns would then only be used when obviously useful or to fill a temporary gap in supplies, due to past mismanagement by man of the natural forests.

In New Zealand, as the report says, "The exotic forests were established to conserve the indigenous forests; therefore it is putting the cart before the horse to suggest that the Forest Service is seeking a ready sale for exotics by curtailing the cutting of native timber. It would be more correct to say that the production of exotics has been expanded in order to make it possible to reduce the sale of indigenous timber. . . . Experience has shown in foreign countries . . . that exotic species have definite limitations and for this reason the national policy must envisage the management of the indigenous forest to secure their maximum favourable production of timber". To this might have been added their management by the Forest Service in perpetuity, since there can be no question that this is the correct forest and economic policy for the indigenous forests.

E. P. STEBBING

NEW OBSERVATIONS ON THE CHEMISTRY OF N-CARBOXY-ALPHA-AMINO-ACID ANHYDRIDES

By D. G. H. BALLARD, DR. C. H. BAMFORD
AND
DR. F. J. WEYMOUTH
Research Laboratory, Courtaulds, Ltd., Maidenhead, Berks.

THE polymerization of N-carboxy-α-amino-acid anhydrides initiated by primary and secondary bases has been studied in some detail, and the main features of the chemistry of the reactions occurring are fairly well understood[1]. In these cases the main products are linear polypeptides. When primary or secondary base initiation has not been used, other products have occasionally been observed, including cyclic peptides and substituted derivatives of hydantoin 3-acetic acid[2,3]. The exact experimental conditions favouring the formation of these substances are not established in the literature, and no detailed mechanism of the reactions has been put forward. We have recently investigated the behaviour of a number of N-carboxy-α-amino-acid anhydrides in highly polar organic media, and have observed some interesting phenomena which lead to a clearer understanding of the general chemistry of these compounds. Our main observations, on the effects produced by the addition of inorganic salts and tertiary bases, are summarized here.

Catalysis by Inorganic Salts

Many N-carboxy-α-amino-acid anhydrides are stable, or react only slowly when dissolved in highly polar organic liquids such as NN-dimethylformamide or NN-dimethylacetamide. Addition of a soluble anhydrous inorganic salt, however, has been found to produce a rapid reaction. Fig. 1 shows typical results with glycine, C-phenyl glycine and DL-phenylalanine N-carbonic anhydrides in NN-dimethylformamide. In the case of C-phenyl glycine N-carbonic anhydride there was no detectable reaction before the addition of lithium chloride; after addition, rapid evolution of carbon dioxide occurred. Glycine and DL-phenylalanine N-carbonic anhydrides gave

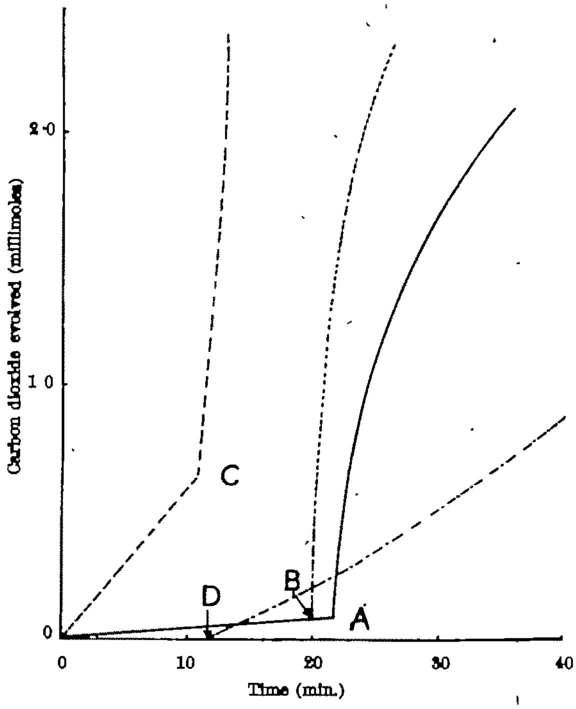


Fig. 1. Salt-catalysed reactions in N : N-dimethylformamide solution

———, Glycine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 50° C Sodium iodide (3 c.c. of a 0 8 *M* solution in dimethylformamide) added at *A*

- - - - - -, Glycine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 50° C. Lithium chloride (25 millimoles) added at *B*

— — —, DL-Phenylalanine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 27° C. Lithium chloride (25 millimoles) added at *C*

- · - · - · -, DL-C-Phenyl glycine N-carbonic anhydride (10 millimoles) in dimethylformamide (10 c.c.) at 50° C. Lithium chloride (25 millimoles) added at *D*

measurable reaction-rates in the absence of salts, but these were accelerated by factors up to 200 on addition of lithium chloride or sodium iodide.

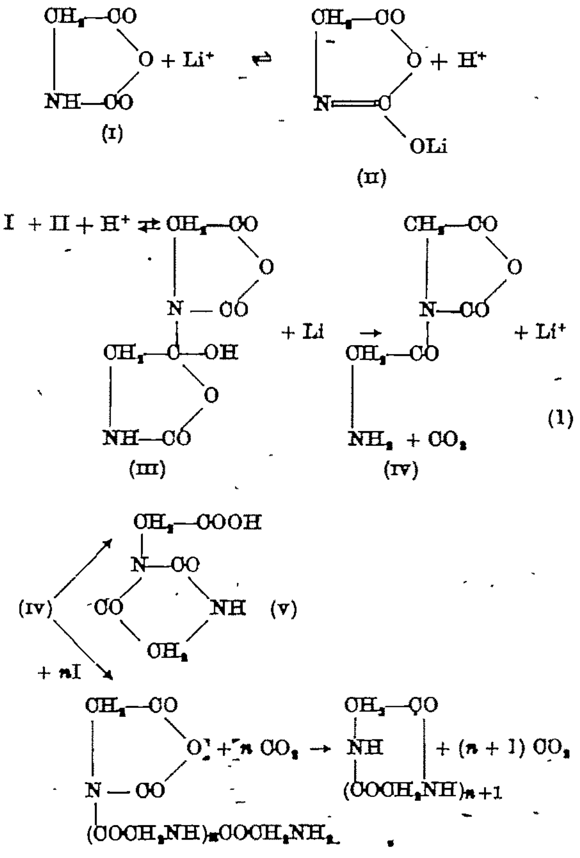
Examination of the liquids after reaction revealed that the main products are cyclic polypeptides and derivatives of hydantoin 3-acetic acid corresponding to the anhydride used. Table 1 gives representative results for the yields of the hydantoin derivatives; the remainder of the anhydride forms mainly cyclic peptides. No 2 : 5-diketopiperazines have been identified. With glycine, the hydantoin 3-acetic acid (V) was estimated colorimetrically with alkaline picric acid and by titration, the two methods giving concordant results. For the other anhydrides the results given are based on titration results only, and would therefore include other compounds containing —COOH, for example, carboxyl-terminated polymers containing ureido groups. As may be seen from Table 1, the yield of the hydantoin derivative may be considerable.

A brief study of the main kinetic features of the lithium chloride catalysed reactions of glycine N-carbonic anhydride has been made. The initial rate of reaction is not affected significantly by the presence of water, and does not depend upon the method adopted for purifying the salt. Acids have a strong inhibitory effect on the reaction, this being particularly marked at the lower salt concentrations. A trace of acid present initially produces an induction period. The hydantoin 3-acetic acid produced is a comparatively strong acid ($pK_a \sim 3$), so that the reaction is self-inhibiting at quite small conversions. At salt concentrations greater than 0·1 *N* the rate shows second-order dependence on monomer concentration, and is independent of the concentration of lithium chloride. The rate falls off with decreasing concentration of lithium chloride below about 0·1 *N*.

Table 1. SALT-CATALYSED REACTIONS IN NN-DIMETHYLFORMAMIDE SOLUTION

N-Carbonic anhydride of	Initial concentration (mol l.$^{-1}$)	Salt concentration (mol.l $^{-1}$)	T °C	Per cent of anhydride converted to hydantoin 3-acetic acid
Glycine	0·53	$1·6 \times 10^{-2}$ (LiCl)	27	7·6
,,	0·17		27	11·2
,,	0·52	$1·6 \times 10^{-2}$ (LiCl)	27	10·2
,,	0·08		27	17·4
,,	0·6	2·5 (LiCl)	50	20
,,	1·0	0·8 (NaI)	50	30
C-Phenyl glycine	1·0	2·5 (LiCl)	50	40
DL-Phenylalanine	1·0	,,	50	17

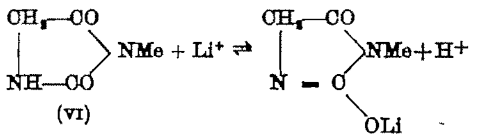
The catalytic effect of salts is apparently connected with the presence of an —NH— group in the N-carbonic anhydride molecule. N-methyl glycine N-carbonic anhydride (sarcosine N-carbonic anhydride) does not react when dissolved in NN-dimethyl-formamide–lithium chloride mixtures, but a rapid reaction ensues if 3-methyl hydantoin (VI) is added. This latter substance has structural similarities with glycine N-carbonic anhydride and probably interacts with lithium salts in an analogous manner. The products of this reaction are then



capable of initiating the polymerization of the sarcosine N-carbonic anhydride. The overall reaction yields polypeptides with basic groups, which titrate like those in linear polysarcosines. This reaction, like that of the glycine N-carbonic anhydride, is powerfully inhibited by traces of acids.

We consider that the catalytic effect of salts such as lithium chloride is to be attributed to complex formation between the anhydride, or hydantoin, and the cation, resulting in the displacement of a proton and the formation of a molecule in which the nitrogen atom has basic properties sufficient to allow reaction with N-carboxy-α-amino-acid anhydrides. Thus the reactions with glycine N-carbonic anhydride (I) may be envisaged as shown in scheme (1).

These reactions may be shown to be consistent with the kinetic observations. An important feature of the mechanism is that the formation of hydantoin 3-acetic acid and cyclic polyglycine from (IV) is accomplished without postulating improbable cyclizations. A study of models of (IV) shows that production of 2 : 5-diketopiperazine by direct cyclization is most unlikely and, as we have already mentioned, this compound does not seem to be formed. The primary reactions of sarcosine N-carbonic anhydride in the presence of lithium chloride and 3-methyl hydantoin are probably similar, the first step, (2), being followed by formation of compounds analogous to (III) and (IV):



(VI) (2)

It is interesting to note that a cyclic structure is necessary for initiation of this kind; the open-chain analogue of (VI)—acetyl *sym*-dimethyl urea—is ineffective.

Since the reaction-rate is independent of the concentration of lithium chloride, the exact nature of the ionic species reacting with the N-carbonic anhydride is uncertain; this may be an ion pair such as Li^+Cl^- or a partly or wholly solvated cation.

Catalysis by Tertiary Bases

N-carboxy-α-amino-acid anhydrides which are not N-substituted appear to react readily in the presence of tertiary bases, particularly in polar media. Again, the products contain considerable amounts of hydantoin 3-acetic acid derivatives, as shown in Table 2.

Table 2. REACTIONS CATALYSED BY TERTIARY BASES. 27° C.

N-Carbonic anhydride of	Solvent	Per cent anhydride converted to hydantoin 3-acetic acid derivative
Glycine	NN-Dimethylformamide	60
,,	Nitrobenzene	8
,,	Acetonitrile	28
* ,,	Pyridine	2
* ,,	NN-Dimethylformamide + 10 % pyridine	40
C-Phenyl glycine	NN-Dimethylformamide	17
DL-Leucine	,,	25
DL-Phenylalanine	,,	16

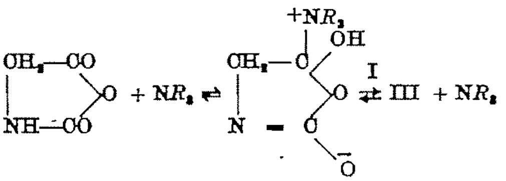
Initial concentration of the anhydride was 0 2 *M*; the initiator was triethylamine in concentration 0 008 *M*, except where marked *, when no triethylamine was added

The only other major products are cyclic peptides, which in the case of glycine N-carbonic anhydride have been isolated in crystalline form. Of these, cyclic hexaglycine predominates. No 2 : 5-diketopiperazine has been detected.

The relative yields of hydantoin derivative and cyclic peptide clearly depend on the nature of the solvent. One important factor is the polarity of the latter, as shown by a comparison of the two experiments with pyridine given in Table 2. A high polarity favours hydantoin formation; but the results with dimethylformamide and nitrobenzene show that other factors are also involved.

No reaction has been observed in any solvent between pure sarcosine N-carbonic anhydride and tertiary bases. This is in sharp contrast to the results obtained by Wessely and co-workers[3]; we have been unable to confirm the claims made by these authors that N-substituted N-carboxy-α-amino-acid anhydrides react readily in pure pyridine.

The results obtained with tertiary bases obviously resemble those with lithium salts in polar media, and a corresponding mechanism may be postulated. For example, equilibria such as those shown in (3) may exist, leading to reactions analogous to those in (1):



(3)

Essentially similar mechanisms leading to the intermediate formation of the dimer (III) may be proposed for the spontaneous decomposition of N-carboxy-α-amino-acid anhydrides in polar organic solvents. (The formation of high polymers in non-polar solvents probably results from initiation by traces of water or other impurities.) We have observed that the presence of traces of water leads to an increase in the proportion of hydantoin 3-acetic acid formed during the decomposition of the glycine N-carbonic anhydride in dimethylformamide. With larger amounts of water, however, hydantoin formation decreases until in pure water or in aqueous lithium bromide solution no hydantoin-3-acetic acid is formed. Thus in the presence of high concentrations of water, normal initiation by the latter appears to predominate. Parallel results are obtained with the lower aliphatic alcohols, hydantoin 3-acetic acid when formed appearing as the free acid and not as the ester. This latter observation is consistent with our mechanism for the spontaneous decomposition of the N-carboxy-α-amino-acid anhydrides, which is probably operative under these conditions.

To summarize, we consider that the nitrogen atom of an N-carboxy-α-amino-acid anhydride may in some circumstances assume basic properties without rupture of the heterocyclic ring. This leads to a variety of reactions which are of predominant importance in highly polar media, and which may also account for the minor products observed under different conditions by other workers. [March 8.

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LETTERS TO THE EDITORS

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Radio Observations of Ionized Hydrogen Nebulæ and Other Discrete Sources at a Wave-length of 9·4 cm.

In recent attempts[1-3] to account for the general radio emission from the Galaxy as the integrated radiation of discrete galactic radio sources, it was found necessary to introduce the effect of ionized interstellar hydrogen, H II regions, to fit the observed radio isophotes at various frequencies. Scheuer and Ryle[4] detected, at wave-lengths of 1·4 and 3·7 m., a bright band of emission confined within 2° of the galactic equator superimposed on the general radiation. They identified the bright band with thermal emission from a distribution of H II regions. H II regions are strongly concentrated in the galactic plane. The large source, Cygnus X, has been tentatively described as thermal emission[5], perhaps from several bright H II regions surrounding γ Cygni[5], or from the integrated radiation of all the H II regions in the spiral arm in the direction of Cygnus[3]. However, Baldwin[6] attempted unsuccessfully to detect, at a wave-length of 1·4 m., a very bright individual H II region, the Orion nebula. Observations of discrete sources have been almost entirely confined to metre wave-lengths, where spectra of more than twenty sources have been obtained[7]. Piddington and Minnett[5,8] observed five discrete sources at a wave-length of 25 cm. and the emission at 25 and 10 cm. from a region near the galactic centre. This was an appreciable extension of the short-wave limit of source spectra.

We recently reported[9] the further extension, to a wave-length of 9·4 cm., of the spectra of six well-known sources and the detection of four bright galactic nebulæ: the Orion, Omega, Trifid and Lagoon nebulæ, bright individual H II regions. Diffuse nebulæ had not been previously identified as radio sources. Evidence was given for the thermal origin of the observed radiation from the Orion nebula, thereby supporting the assumption of thermal emission from a distribution of H II regions. Recen measurements[10] at a wave-length of 21 cm. by Hagen, McClain and Hepburn have been made on the Orion nebula and several other H II regions. The Orion nebula flux density was, as predicted by the therma model, the same as that observed at a wave-length of 9·4 cm.

This communication reports a second survey a wave-length 9·4 cm. undertaken during March 10–18 1954, principally of known H II regions[11]. The 50-ft diameter paraboloidal reflector[12] and microwav radiometer was again employed. The antenna bean was 0·45° × 0·40° between half-intensity points Table 1 summarizes preliminary results of both surveys. The estimated accuracy of the antenna temperature, T_A, is 2° K. and of the flux density 25 per cent. The brightness temperature of a source averaged over the beam equals 1·7 T_A. The position of sources are estimated to be accurate to 0·2 min in R.A. and 5′ in Dec. for the first eight sources an to 1 min. in R.A. and 15 in Dec. for the remainder except for the large sources which subtend about 2 (Nos. 9, 16, 21 and 24). The N.G.C. number give the New General Catalogue, or Index Catalogue number of the celestial object previously identified with or suggested here as the radio source. Messie objects are also numbered.

Sources Nos. 1–11 were detected in the first survey and were mentioned above. Source No. 5 lies in the direction of the galactic centre (galactic longitude 327·6°, latitude −1·46°). Further measurements o Nos. 10 and 11 give revised values for T_A an indicate that they are discrete sources, perhaps superimposed on radiation from the galactic plane Source No. 12 also appears to be superimposed upo radiation from the galactic plane. No. 24 wa obtained from a drift of the galactic plane through the antenna beam. These findings indicate that a narrow band of galactic radiation at wave-length 9·4 cm. extends at least 10° along the galactic plane through the galactic centre (No. 9) where it i brightest. This may be identified with the brigh

Table 1. Radio Sources observed at 9·4-cm. Wave-length

No.	Constellation	T_A (°K.)	Flux density* (watt. m.$^{-2}$ (c./s.)$^{-1}$ × 10^{-26})	R.A. (1950) h.	R.A. (1950) m.	Dec. (1950) °	Dec. (1950) ′	N.G.C. number	Remarks
1	Cassiopeia	58	150	23	21·2	58	32	—	Unusual galactic nebulosity†
2	Taurus	23	80	05	31·4	21	54	1952	*M*1, Crab Nebula, supernova remnant†
3	Cygnus	25	70	19	57·6	40	34·5	—	Colliding galaxies†
4	Sagittarius	24	68	18	17·9	−16	14	6618	*M*17, Omega Nebula‡
5	Sagittarius	17	48	17	42·5	−29	01	—	Unidentified, near galactic centre§
6	Orion	16	45	05	33	−05	27	1976	*M*42, Orion Nebula‡
7	Centaurus	7	20	13	22·1	−42	50	5128	Unusual galaxy†
8	Virgo	5	14	12	28·2	12	37·5	4486	*M*87, unusual galaxy†
9	Sagittarius	6	—	17	42·5	−29	00	—	Galactic background under No. 5‡
10	Sagittarius	4	11	17	59	−23	02	6514	*M*20, Trifid Nebula‡, revised values
11	Sagittarius	7	20	18	01	−24	23	6523	*M*8, Lagoon Nebula‡, revised values
12	Scorpius	14	40	17	22	−34	09	6357	Contains a Wolf-Rayet star‡
13	Scorpius	9	25	17	17	−36	00	6334	‡
14	Serpens	5·5	16	18	16	−13	48	6611	*M*16‡
15	Cassiopeia	4	11	02	30	61	14	*IC*1805	‡
16	Cygnus	4	—	20	20	40	00	—	Large radio source, Cygnus X‡
17	Serpens	3·5	10	18	15	−12	16	6604	‡
18	Sagittarius	2·5	7	18	14	−16	45	*IC*4701	‡
19	Scorpius	2·5	7	16	36	−48	55	6188	‡
20	Scorpius	2	5·5	16	53	−40	23	—	Near galactic cluster *H*12‡
21	Cygnus	2	—	20	55	44	45	7000	North American Nebula, large source‡
22	Gemini	2	5·5	06	14	22	30	*IC* 443	Unusual galactic nebulosity
23	Cassiopeia	(1·5)	(4)	23	14	59	46	—	Radio detection uncertain‡
24	Sagittarius	(4·7)	—	17	47	−27	00	—	Galactic background

* The flux density given is twice the maximum observed in the 0·40° × 0·45° beam in one plane of polarization. It has not been corrected for the finite size of the source.

† See Baade, W., and Minkowski, R., *Astrophys. J.*, 119, 206, 215 (1954).

‡ Bright hydrogen emission nebula, an H II region.

§ See McGee, R. X., and Bolton, J. G., *Nature*, 173, 985 (1954).

band observed at metre wave-lengths mentioned earlier.

Eleven additional H II. regions (Nos. 12–21 and 23) were detected during the second survey. Eight of these (Nos. 12, 13, 15, 18–21 and 23) appear to have been previously undetected at radio wave-lengths. The intensity of the Cygnus X source at wave-length 9·4 cm. agrees with the thermal-type emission spectrum found at longer wave-lengths[9]. No. 22 is a non-thermal source recently detected at metre wave-lengths and identified with the rare type of nebulosity similar to the double-loop nebula in Cygnus[13].

This work will be described in more detail elsewhere.

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Ferromagnetic Resonance in Ferrites

FERROMAGNETIC resonance studies have been made on polycrystalline specimens of the ferromagnetic systems $(1-x)(\mathrm{LiFe_5O_8})x(\mathrm{CdFe_2O_4})$, $\mathrm{Li(Fe_{1-x}Al_x)_5O_8}$, $\mathrm{Ni_{1-x}Zn_xFe_2O_4}$ placed in resonant cavities operating at frequencies of 9,470, 23,940 and 34,400 Mc./sec.

The component oxides were mixed and pre-fired at 200 deg. below the final sintering temperature for 7 hr. The product was re-ground, pressed at 45 tons per square inch and sintered in air for 40 hr. at a temperature of 1,000° C. for the lithium–cadmium ferrites and 1,400° C. for the others. The furnace was then switched off and allowed to cool. Specimen densities of 90–97 per cent X-ray density were obtained. Spherical specimens produced in a device similar to that described by Bond[1] and ranging in diameter from 0·20 mm. to 1·40 mm. were mounted on a fine glass support which could be moved along the axis of a microwave cavity formed from a rectangular wave-guide. The strength of the externally applied magnetic field necessary to induce peak resonance loss, H_{res}, and the resonance line-width were studied as functions of frequency, specimen size, and position of the specimen along the cavity axis. The frequency/resonance field value for each resonance was determined by comparison with the ratio for the substance α-α-phenyl β-picryl hydrazyl, for which $g = 2{\cdot}0037 \pm 0{\cdot}0002$[2]. These studies have yielded the following information.

(1) The placing of a specimen directly on the cavity end wall increases the value of H_{res} below that necessary when the specimen is located at a magnetic antinode away from the cavity walls by an amount of the order of $\frac{1}{3}M_s$, where M_s is the saturation magnetization per unit volume of the specimen material. The wall effect may be considered to be due to the presence of a magnetic dipole induced in the end wall and is insensitive to variations in both frequency and specimen size. Resonance line-widths are not significantly affected.

(2) Measurements on specimens located at the first magnetic antinode from the end wall have shown that, before the onset of skin effects[3], the value of H_{res} varies with specimen size according to the law

$$H_{(\omega,\,r)} = H_{(\omega,\,0)} + h_0\,(r/\lambda_i)^2,$$

where r is the radius of the specimen, λ_i is the effective internal wave-length for propagation in the material at an angular frequency ω, and h_0 is a constant. It is believed that the concentration of the oscillatory field along the axis of a specimen produces an effective shape of specimen deviating progressively with increasing radius from that of a sphere. The recognition of this relationship improves the extrapolation of resonance fields to zero radius of specimen.

(3) The extrapolated values of $H_{(\omega,\,0)}$ have been found to fit, to within the experimental error of ± 10 Oe. at 9,470 Mc./sec., ± 20 Oe. at 23,940 Mc./sec. and ± 30 Oe. at 34,400 Mc./sec., a resonance relationship of the form reported by Okamura *et al.*[4], namely:

$$\omega = \frac{ge}{2mc}\,(H + H_i),$$

and yield the values for g and H_i given in Fig. 1 and Table 1. Magnetization measurements (unpublished) have shown that the cadmium ions in lithium cadmium ferrites enter tetrahedral sites, while the aluminium ions in lithium ferrite-aluminates for the most part enter octahedral sites leading to an anti-ferromagnetic structure for about 35 per cent aluminium replacement. The measured values of g tend to rise as this composition is approached, and the interpretation of this factor as the spectroscopic splitting factor, having regard to ferrite-sub-lattice effects[5], leads to the conclusion that the value of g for a ferric ion depends on the particular lattice site which it occupies. For lithium ferrite, the values of g for ferric ions on either tetrahedral or octahedral sites must be at least 0·03 less than that for the spin

Table 1. VALUES OF g AND H_i DERIVED FROM RESONANCE MEASUREMENTS ON POLYCRYSTALLINE SPECIMENS

Composition of specimen	g		H_i (Oe.)		$-0{\cdot}2\,K_1/M_s$
$\mathrm{LiFe_5O_8}$	1·96 (5)	± 0 006	450	± 15	—
$0{\cdot}75\,(\mathrm{LiFe_5O_8})\,0{\cdot}25\,(\mathrm{CdFe_2O_4})$	1·97 (0)		320		—
$0\;65\,(\mathrm{LiFe_5O_8})\,0\;35\,(\mathrm{CdFe_2O_4})$	1·96 (9)		290		—
$0{\cdot}50\,(\mathrm{LiFe_5O_8})\,0{\cdot}50\,(\mathrm{CdFe_2O_4})$	1 97 (7)		350		—
$0{\cdot}25\,(\mathrm{LiFe_5O_8})\,0{\cdot}75\,(\mathrm{CdFe_2O_4})$	1 99 (9)		90		—
$\mathrm{Li(Fe_{0\cdot9}Al_{0\cdot1})_5O_8}$	1·97 (1)	± 0 008	320	± 20	—
$\mathrm{Li(Fe_{0\cdot8}Al_{0\cdot2})_5O_8}$	1·99 (0)		290		—
$\mathrm{Li(Fe_{0\cdot7}Al_{0\cdot3})_5O_8}$	2 01 (1)		270		—
$\mathrm{NiFe_2O_4}$	2 17 (8)	± 0 006	170	± 15	46
$\mathrm{Ni_{0\cdot75}Zn_{0\cdot25}Fe_2O_4}$	2·07 (1)		230		20
$\mathrm{Ni_{0\cdot50}Zn_{0\cdot50}Fe_2O_4}$	2 05 (9)		190		21
$\mathrm{Ni_{0\cdot25}Zn_{0\cdot75}Fe_2O_4}$	2 03 (6)		60		—

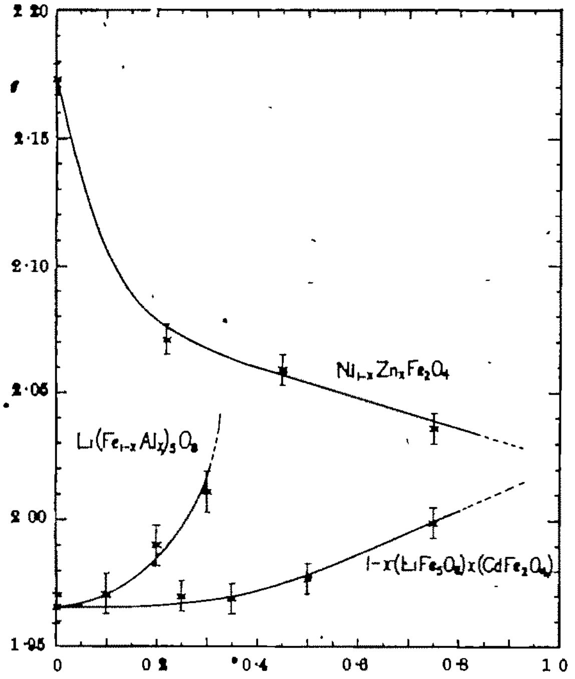

Fig. 1. Variation with ferrite composition of the g-factor derived from the resonance relationship $\omega = ge(H + H_i)/2mc$

only, namely, 2·00. Further consideration of the values for the cadmium- and zinc-substituted systems indicates that the effective values of g may also depend on the nature of the surrounding ions.

The treatment of a polycrystalline specimen as an aggregate of spherical non-interacting, randomly oriented crystallites shows that magneto-crystalline anisotropy may give rise to an effective field of the order of $-0\cdot2\ K_1/M_s$, where K_1 is the first-order anisotropy constant, assumed negative. Measurements on single crystals (unpublished) have given the values of this factor for three nickel–zinc ferrites and these are seen from the table to account for not more than a third of the field H_i.

(4) Resonance measurements at high levels of microwave power have shown a behaviour similar to that observed[6] in other ferrite systems. The resonance peak is reduced to half the low-field value for microwave field-strengths of the order of 10–100 Oe. when specimens absorb energy at rates of the order of 10^{12} ergs/c.c./sec. The resonance line-width does not appear to be a measure of the relaxation time associated with the interchange of energy between the absorbing mechanism and its surroundings, but may be considered as setting a lower limit to this time. If the concept of spin-wave excitation is used, the spin-wave states available for excitation must extend into the spin wave-number range of 10^6–10^7 cm.$^{-1}$, in which range a considerable contribution to the energy of excitation is normally to be expected from exchange effects. It is nevertheless possible that the resonance absorption proceeds by the induction of transitions between spin-wave states of this order of wave number, which at ordinary temperature would be the only ones vacant and therefore able to be excited. The formation of two spin waves of wave numbers $\bar{l}$ and $\bar{m}$ from one of wave number $\bar{k}$ in a cubic matrix with lattice constant a of ions of spin S and exchange integral J would require the energy:

$$\hbar\omega = \Delta E = \hbar\gamma H + 2SJa^2 (l^2 + m^2 - k^2),$$

with $\bar{k} = \bar{l} + \bar{m}$. This expression is of the form $\omega = \gamma(H + H_i)$, where:

$$H_i = 2SJa^2 (l^2 + m^2 - k^2)/\hbar\gamma.$$

Values of k, l and m, all of the order of 10^6–10^7 cm.$^{-1}$, may be chosen to yield values of H_i consistent with experiment. On this interpretation the resonance line-width would then be determined in part by the distribution of transition probabilities for various values of H_i.

This work will be discussed in more detail in a later publication.

The materials used in this investigation were prepared by Dr. A. E. Carter, Messrs. P. E. Gallant and W. C. Greenstreet under the direction of Dr. A. J. E. Welch, in the Chemistry Department, Royal College of Science, London. I wish to thank Dr. Willis Jackson, at whose instigation this work was begun, for his interest and encouragement throughout its course.

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Use of X-Ray Film for comparing Radioactivities

ALTHOUGH the initial discovery of radioactivity resulted from its action on a photographic plate, electronic instruments have to-day become accepted as the first choice for detecting, and more particularly for measuring, radioactivity. It has, however, been shown that photographic emulsions can, with suitable methods for internal calibration, be used for giving reasonably accurate comparisons of radioactivity[1]. The present communication is concerned with a direct comparison of the accuracy obtained with a counter and with X-ray film, when used for comparing the radiation per unit area from a number of different sources. These were prepared by converting images from a photographic step-wedge quantitatively into silver iodide in the presence of iodine-131[2]. The relative quantities of silver, and hence of radioactivity, in the sources were compared: (*a*) by direct chemical analysis; (*b*) by a Geiger–Müller counter using a count of at least ten thousand for each specimen; (*c*) by making a series of autoradiographs with accurately determined exposure times and deriving the relative activity of each source from plots of density against log-exposure time; (*d*) by using visual density matching to determine (from the same autoradiographs) the exposure time needed by

Table 1.

Relative silver masses determined by chemical analysis	Relative radioactivities (and hence silver masses) determined by: Geiger counter	Autoradiography and density measurement	Autoradiography and visual estimation: Observer 1	Observer 2
16·1	13·9	15·1	17	17
38·6	37·0	39·5	42	35
58·8	58·7	59·4	59	52
77·5	76·3	77·8	79	70
91·3	92·2	93·3	91	79
100	100	100	100	100

ach source to give a standard (but not measured) lensity. The quantities in the weaker sources were hen expressed as percentages of the strongest source.

Table 1 shows that method (c) gave an accuracy omparable with that obtained by counting, while ven without a densitometer accuracy adequate for emi-quantitative work was achieved.

Apart from its obvious usefulness in laboratories ot equipped with a counter, autoradiography has ertain other advantages: in its simplest form it equires no special equipment; it produces a permanent record of relative activities; in the sense that ne sheet of film can be simultaneously exposed to a arge number of specimens, it is equivalent to the use f a whole battery of counters, and as a result, autoadiography can simplify, or make unnecessary, orrections for decay. It also facilitates more accurate ssessment of isotopes having short half-lives, and akes practicable comparisons of very weak sources vhich would each require a long time on a counter.

A full account of this work is being prepared for ublication elsewhere.

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Bond-Lengths and Force Constants for Methane, Silane and Germane

In a recent paper by one of us (N. H. M.[1]), a etailed discussion of the electron distributions and otential fields for molecules of high symmetry was iven on the basis of the Thomas–Fermi theory. In his work the nuclei of the outer atoms were smeared ut over the surface of a sphere and the electrons hen regarded as moving in the resulting spherically ymmetrical field. A general discussion of the energy vas also given, and the existence of a minimum in the nergy curves was demonstrated. However, the heoretical bond-lengths were in poor agreement with he experimental values, and it was suggested that his might be due to the neglect of exchange.

We have now considered in detail the effect of xchange on the energy curves for methane (CH_4), ilane (SiH_4) and germane (GeH_4), for which moleules the smoothing approximation referred to above eems physically very reasonable. The Thomas–ermi electron densities obtained previously have een used as variation functions for calculating the nergy including exchange, this being analogous to the procedure introduced by Scott[2] in his successful calculation of binding-energies for atoms. We are thus enabled to calculate the bond-lengths and the force constants for the totally symmetric vibrations of these three molecules, and the results are recorded in Table 1. For comparison, we also give the bond-length for methane when exchange is ignored[1] (the bond-lengths for silane and germane will be somewhat greater than this), together with an approximate value for the force constant for methane obtained by using the formula of Bowers[3] slightly outside its proper range of validity.

Table 1

Bond-lengths (in A.)

	Experimental	Thomas–Fermi	Thomas–Fermi with exchange
CH_4	1·09	2·1	1·38
SiH_4	1·46	—	1·62
GeH_4	1·48	—	1·9

Force constants (in units of 10^5 dynes/cm.)

	Experimental	Thomas–Fermi	Thomas–Fermi with exchange
CH_4	20	1	9
SiH_4	11	—	5
GeH_4	10	—	3

It can be seen that the bond-lengths are improved considerably by the inclusion of exchange, the errors in the calculated bond-lengths for methane and silane being 27 and 11 per cent respectively. However, for germane the error increases again to about 25 per cent, which at first sight seems surprising in view of the fact that the Thomas–Fermi method should become more reliable as the number of electrons increases. Heath, Linnett and Wheatley[4], however, have concluded previously from a study of regularities in bond-lengths and force constants for a number of molecules that the bond in germane is probably "abnormally strong and short". If this is so, then it is not very reasonable to expect the Thomas–Fermi method, which distinguishes different atoms only by virtue of a change of scale depending on their atomic numbers, to be able to deal accurately with such a case. It is not so surprising, therefore, that by this method we find a larger deviation from the observed value for germane than in the case of silane.

As one would expect, the force constants are less satisfactory than the bond-lengths. Again, however, it is clear that exchange has a marked effect, the force constant for methane being improved by a factor of 9.

What has emerged from our calculations is that the exchange energy plays an essential part in determining bond-lengths and force constants from the present theory. Considering the simplified nature of the treatment, agreement with experiment is very reasonable. There is, however, some indication that the model we are using is least satisfactory for germane, in which the bonding is rather 'abnormal'. We are now investigating the application of the method to other molecules, and a detailed account of the work will be published later.

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Some 2 : 4-Diaminopteridines as Folinic Acid Antagonists

Burchenal and his colleagues have reported that 4-amino-10-methylpteroylglutamic acid (amethopterin) prolongs the lives of mice implanted experimentally with leukæmia[1], and that folinic acid antagonizes this therapeutic effect more potently than does pteroylglutamic acid[2]. Accepting the view that the antifolinic acid activity of amethopterin is related to its therapeutic effect in leukæmia, we have explored for such activity a number of 2 : 4-diaminopteridines[3,4,5] already known to be antagonists of pteroylglutamic acid[6], with the view of their possible clinical use.

Tests were carried out in a basal medium differing from that used by Barton-Wright *et al.*[7] in the use of 10 gm. sodium acetate, 6 gm. acid-hydrolysed casein, 200 µgm. riboflavin, 500 µgm. calcium pantothenate, 0·4 µgm. biotin, 100 µgm. aneurin, and 60 mgm. l-tryptophan per 500 ml. Diaminopteridines, named in the table, were diluted serially by two in tubes containing this double-strength medium, autoclaved, and the medium brought to single strength by sterile glass-distilled water containing appropriate levels of synthetic folinic acid (5-formyl-5 : 6 : 7 : 8-tetrahydropteroylglutamic acid). After sowing with a standardized inoculum of washed cells of *Leuconostoc citrovorum* (N.C.T.C. 7837), the tubes were incubated at 37° C. for 65 hr., when the acid produced was titrated with $N/10$ sodium hydroxide.

From these titrations we obtained the concentration of diaminopteridine required to inhibit acid production by 50 per cent, from which an inhibition factor was calculated as the ratio of molar concentrations of diaminopteridine to folinic acid in the medium. The geometric means of the inhibition factors obtained in two or more separate experiments (at each level of folinic acid) are expressed in the table.

Inhibition of Acid Production of *Leuc. citrovorum* by 2 : 4-Diaminopteridines at Various Levels of Synthetic Folinic Acid

Serial No.	Substituents in 6 : 7 position	Synthetic folinic acid (ngm./ml.)	Mean inhibition factor*
0/154	None	5	> 58,390
0/58	dimethyl	5	22,880
0/69	diethyl	5	2,224
0/71	di-*n*-propyl	5	1,202
0/129	di*iso*propyl	1	90
,,	,,	5	98
,,	,,	25	90
,,	,,	125	84
,,	,,	625	10
0/128	di-*n*-butyl	5	1,495
0/113	di*iso*butyl	5	1,464
0/142	di-*sec*.butyl	5	69
0/97	di-*n*-amyl	5	315
0/108	di-*n*-hexyl	5	1,429
0/104	di-(*cyclo*hexylmethyl)	5	> 7,256
0/173	indolo-(2′,3′)-	5	> 1,979
0/120/74	1′-methylindolo-(3′,2′)-	5	241
0/120/91	1′-methylindolo-(2′,3′)-	5	364
0/164	1′-ethylindolo-(2′,3′)-	5	314
0/168	1′-*n*-propylindolo-(2′,3′)-	1	230
,,	,,	5	143
,,	,,	25	106
0/207	1-*n*-amylindolo-(2′,3′)-	5	307
0/181	benzylindolo-(2′,3′)-	5	4,932
0/63	diphenyl	5	2,088
0/137	dibenzyl	5	> 3,480
	4-amino-10-methylpteroylglutamic acid (amethopterin)	0·2	237
	,, ,, ,,	1	232
	,, ,, ,,	5	91
	,, ,, ,,	25	65
	,, ,, ,,	125	44
	4-amino-pteroylglutamic acid (aminopterin)	5	315

* Inhibition factor = ratio of molar concentrations of diaminopteridine to folinic acid to inhibit acid production by 50 per cent.

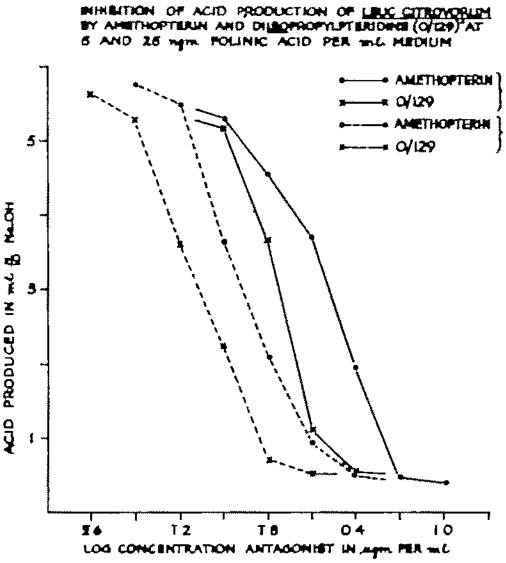

Fig. 1

It will be seen that at the levels of 1, 5 and 25 ngm. of folinic acid per ml., the inhibition factor of di*iso*propylpteridine was constant. This indicates a competitive inhibition of the type first described by Woods[8] for sulphanilamide against *para*-aminobenzoic acid. The inhibition ceases to be competitive and becomes irreversible by folinic acid when higher concentrations of the di*iso*propylpteridine are used.

In the present group of compounds, potency as folinic acid antagonists closely depends on structural details in the 6 and 7 positions of the pteridine ring. In the dialkyl series, peak activity was seen at the di*sec*.butyl-(0/142) and di*iso*propyl-(0/129) pteridines and in the indole series at the N-*n*-propyl (0/168). Activity was slight in the dimethylpteridine (0/58) and and in the diphenyl (0/63): it was not detected at al in unsubstituted diaminopteridine (0/154). The las three compounds, which were first synthesized by Mallette, Taylor and Cain[9], were found by Burchena *et al.*[1] to be inactive against mouse leukæmia. Albert Brown and Cheeseman[10] have prepared 2-amino 6 : 7-diethylpteridine and the corresponding 4-amino compound. We have found that the inhibition factor of these two monoaminopteridines at 5 ngm. folinic acid per ml. exceeded 60,000, while that of 2 : 4 diamino-6 : 7-diethylpteridine (0/69) was about 2,000 This indicates that the omission of one amino-grou from the type of compound under investigatio reduces antifolinic acid activity.

Since it has been reported that certain anti malarials, such as pyrimethamine[11] and 4 : 6-diamino 1-(*p*-chlorphenyl) - 1 : 2-dihydro-2 : 2-dimethyl-*s*-tri azine[12], possess antifolinic acid activity, it is no surprising that many of the pteridines here discusse are also potent antimalarials. In the present serie however, there does not appear to be any correlatio between antifolinic acid activity, evaluated wit *Leuconostoc citrovorum*, and ability to suppres *Plasmodium berghei* infections of mice. For example di*cyclo*hexylmethyl-(0/104), di-*n*-butyl-(0/128) an di*iso*propyl-(0/129) pteridines are roughly equal i antimalarial activity[13], although they differ widely a folinic acid antagonists.

It will be seen from the table that there is littl difference between the inhibition factors of th i*sec*.butyl- and di*iso*propyl-pteridines and of ametho-terin at the level of 5 ngm. folinic acid per ml. A comparison of the activities of 0/129 and ametho-terin at two levels of folinic acid is illustrated in ig. 1.

We wish to thank Miss M. Boothroyd and Mrs. . Harris for technical assistance, the American yanamid Company for supplies of synthetic folinic acid ('Leucovorin') and of amethopterin and amino-terin, Prof. A. Albert for the mono-amino-pteridines, nd the directors of Allen and Hanburys, Ltd., for ermission to publish this communication.

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A Chromatographic Method for the Estimation of Oleic and Linoleic Acids in the Presence of Straight-chain Saturated Fatty Acids

Two communications have recently appeared in *ature* on the chromatographic separation of naturally occurring fatty acids or their esters. Nijkamp[1] uses a silica gel column for the separation of C_{10} to C_{18} saturated acids. Cropper and Heywood[2] have volved a rapid vapour-phase technique for the eparation of the methyl esters of saturated acids which they state will be investigated for use in the eparation of linolenic, linoleic and oleic acids. In the course of investigations on the biochemical changes occurring during ripening of oil palm fruits, nd during germination of oil palm and water melon seeds, we have developed a chromatographic method or estimating oleic and linoleic acids in the presence f saturated straight-chain acids from C_8 to C_{20}. his is based on the reversed-phase chromatographic rocedure of Howard and Martin[3], later modified by opják and Tietz[4] for the analysis of saturated acids rom C_{10} to C_{18}, and by Silk and Hahn[5] for similar acids from C_{16} to C_{24}. Acetone–water mixtures varying rom 45 per cent acetone (C_{10}) to 90 per cent acetone (C_{24}) have been recommended as eluting agents, the acids being estimated by titration with 0·01 *N* alcoholic potassium hydroxide to a bromthymol blue nd-point.

Standard titrations on pure acids, without passage through the column, show that recoveries are influenced by the concentration of non-aqueous solvent. These titration curves indicate that the green end-point (*p*H 6·8–7·0 in aqueous solution) usually recommended gives incomplete neutralization for the longer-chain acids, and we have therefore adopted a blue-green end-point (*p*H 7·4 in aqueous solution). Results, after correction for reagent blank, then range from 99·2 per cent (caproic acid in 35 per cent acetone) to 95·4 per cent (stearic acid in 75 per cent acetone). Recoveries from the column agree well with these figures, indicating no significant loss by retention on the column. The amount of total fatty acid used varied from 2 to 50 mgm.

Using a 1·3 cm. × 30 cm. column, linoleic and oleic acids can be separated satisfactorily from one another but not from the saturated acids. Although linoleic is eluted slightly more slowly than myristic acid, mixtures of the two (in any proportions) form a single peak: oleic has the same R_F value as palmitic acid. Figures can therefore be obtained for the total quantities of (i) myristic + linoleic acids, and (ii) palmitic + oleic acids.

Various methods were considered for the separation of these saturated and unsaturated acids. The standard lead salt method is unsatisfactory in the presence of myristic acid. Chromatographic separation of the unsaturated acids as the 2.4-dinitrobenzenesulphenyl chloride derivatives[6] proved difficult and was rejected. The final method adopted was a Bertram[7] (alkaline permanganate) oxidation to destroy the unsaturated acids, followed by estimation of the remaining saturated acids by chromatography. Experiments with pure oleic and linoleic acids indicated complete loss of the original acid peaks after oxidation at room temperature for 16–18 hr. Both acids were converted into products which were either not extracted by light petrol (b.p. 40°–60°) at the end of the Bertram oxidation or which had a high R_F value and could be separated completely from the C_{12} or longer-chain saturated acids. After oxidation under these conditions, palmitic acid can be recovered in 95–98 per cent yield, and myristic acid in 90–96 per cent yield. The results for the analyses of different mixtures can be seen from Table 1. Amounts used in the oxidation varied from 15 to 100 mgm. of total fatty acid; an aliquot of this containing 8–25 mgm. was then chromatographed. Further details of this method will be published elsewhere. We are extending it to the analysis of other unsaturated acids.

Table 1. Total Fatty Acids (per cent)

		Lauric	Myristic	Linoleic	Palmitic	Oleic
Oleic acid	Composition	—	—	—	—	100
	Found	—	—	—	—	94 3
Linoleic acid	Composition	—	—	98·5*	—	—
	Found	—	—	94 8	—	—
Mixture 1	Composition	11·7	28·0	—	35·1	25·2
	Found	11 2	27·6	—	31·4	27 6
Mixture 2 (high oleic)	Composition	—	13·3	9·7	7·2	68·9
	Found	—	13·4	9·3	7·7	66·2
Mixture 3 (high linoleic)	Composition	—	9·6	59 9	12 2	18·9
	Found	—	8·4	58 1	11 7	19·0

* Calculated from iodine value (Woburn), and checked by ultraviolet spectrophotometric method (ref. 8).

In this brief communication it is impossible to acknowledge all the help we have received from various sources; but we should like to express our indebtedness to Prof. W. T. Williams for his encouragement, and to Prof. N. K. Adam for a gift of pure fatty acids.

Since submitting the above, our attention has been directed to a paper by Savary and Desnuelle[9], who employ a slightly different oxidation procedure for the estimation of oleic and linoleic acids in simpler mixtures. It is hoped to examine this method more fully in a later communication.

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Effect of Cortisone on the Neonatal Rat

NEONATAL rats have been treated with cortisone acetate (Merck ; Roussel) in doses of 0·25–5 mgm./day subcutaneously, control litter mates being given the same dosage of suspending medium. The experiments were undertaken primarily to test the effect upon microglial immigration and transformation in the brain. Hortega's neonatal 'fountains' were found to be completely suppressed within 24–36 hr. of a single dose of 2·5 mgm. of cortisone, and in older animals myelination was retarded.

The treated animals showed a striking failure to grow, or in some cases a retarded growth followed by loss of body weight ending in death (Fig. 1). Such animals presented all the signs of pituitary failure (Fig. 2). They were small and shrivelled, with very little subcutaneous fat and a marked failure of hair growth. Without exception they showed a considerable degree of exophthalmos. In some cases their eyes actually opened before those of the control litter mates. Their appearance corresponded with that produced in chick embryos by Karnofsky *et al.*[1] by cortisone treatment. There was a general decrease in lymphoid tissue, and pituitaries were small an degenerate on histological examination. A detaile account of these changes will be published elsewhere

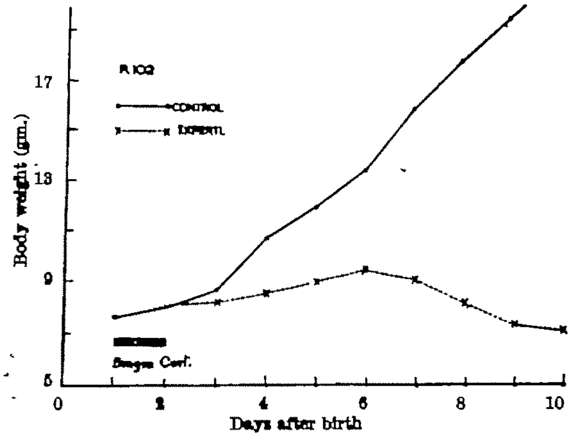

Fig. 1

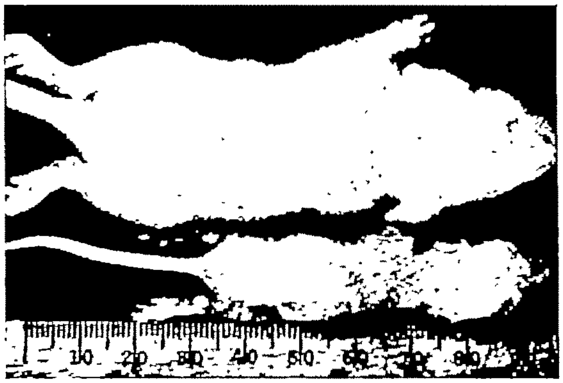

Fig. 2

Cortisone is known to depress adrenocorticotrophi activity of the anterior lobe of the pituitary gland[2] It is also known to inhibit growth of the embry chick after the eighth to tenth day of incubation[1] On the other hand, it has been held not to diminis thyrotrophic secretion of the adenohypophysis bu possibly, indeed, to increase it[3].

Exophthalmos has been produced in adult rats b prolonged exhibition of cortisone[4]. Such treatmen may produce thyroid depression—"corticogenic hypothyroidism"—so that the exophthalmos might b attributable to thyrotrophic activity of the pituitary since the thyrotrophic hormone is known to b capable of producing the condition in rats[5]. Aterma and Greenberg[4], however, are inclined to attribut the exophthalmos produced by cortisone in the ra to a direct alteration of the physico-chemical stat of the tissues within the orbit, and there is then n necessity for assuming a stimulating effect of cortison on thyrotrophic activity of the adenohypophysis i the present experiments.

Two points may be considered: (1) the simultaneous 'damping down' by cortisone of adrenotrophi activity and growth hormone of the anterior pituitar invites the speculation that the two principles may under physiological conditions, be part of an articulated complex at the time of their elaboration[6] (2) there may be a possibility of utilizing 'functionall hypophysectomized' neonatal rats as test anima for adrenocorticotrophic hormone activity—a modification of the method of Sayers, Sayers and Woodbury[7].

I wish to thank Dr. Max Reiss for helpful discussio of results. The cortisone used was supplied by th Medical Research Council, and the work was carrie out while in receipt of financial aid from th Council.

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Role of High-molecular Weight Components in the Respiratory Activity of Cell-free Extracts of *Aerobacter aerogenes*

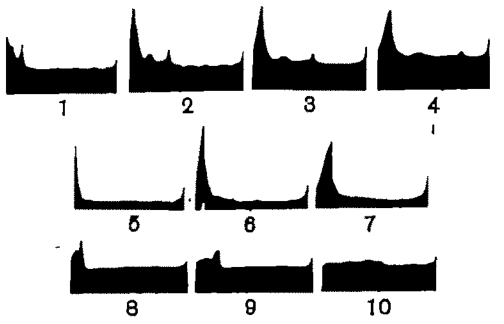
It has been shown that clear cell-free extracts from strain of *Aerobacter aerogenes* catalyse the oxidation of glucose, glucose-6-phosphate, hexose diphosphate, pyruvate and succinate[1]. As the rate of oxidation with these substrates was not appreciably modified by 20-min. centrifugation in a field of 15,000 *g*, and as the extract was transparent by transmitted light, it was obvious that the enzyme systems concerned were attached to very small elements.

The experiments reported here show that the bulk of the succinic oxidase system, in these cell-free extracts, is bound to one, or possibly two, high-molecular weight components, which have sedimentation constants of approximately 40 and 22 *S* respectively. The same components are also necessary, in addition to soluble factors, for the oxidation of glucose, pyruvate, citrate, α-ketoglutarate and fumarate.

The strain of *Aerobacter aerogenes* used and the methods of cultivation have been described previously[1]. The bacteria from a 24-hr. culture were washed three times with twenty volumes of distilled water by centrifugation and the well-packed cells were ground by hand in a cold mortar for 2–3 min. with three parts (w/w) of a very fine 'Pyrex' glass powder (passed through a 200-mesh sieve) and extracted with 2·5 parts (w/v) of ice-cold distilled water. A first centrifugation at 4,000 *g* for 20 min. removed the glass powder, the intact cells and the larger cell debris, and the supernatant was centrifuged again at 18,000 *g* for 20 min., to give a clear supernatant (Sup. 1). This fraction was again centrifuged for 90 min. at about 110,000 *g* in a model *L* Spinco centrifuge, yielding a supernatant (Sup. 2) and a small gelatinous pellet which was resuspended in one-fifth the volume of Sup. 1 of 0·05 *M* phosphate buffer *p*H 7·0 to give fraction *P*. The preparation was kept at 0–4° C. throughout these manipulations.

The various fractions Sup. 1, Sup. 2 and *P* were examined in the ultracentrifuge. As seen in Figs. 1–4, three major components were found in Sup. 1, with sedimentation constants of about 40, 22 and 9 *S* respectively. In Sup. 2 (Figs. 5–7) only the third component (9 *S*) was present, while fraction *P* contained the two larger components only (40 and 22 *S*, Figs. 8–10). Thus, by centrifugation at about 110,000 *g* for 90 min., it was possible to separate the two larger components from the rest of the extract. Of these two components, that of 40 *S* was the major one; it showed a sharp boundary in the ultracentrifuge, and its molecular weight, based on ultracentrifugal data, is of the order of 1–3 millions. Further experiments are required to determine accurately the molecular weights and to study the homogeneity of both the 40 and 22 *S* components.

Schachman, Pardee and Stanier[2] found that cell-free extracts prepared by different methods and from different species of bacteria all gave essentially similar patterns on examination in the ultracentrifuge. The extracts contained four major components with sedimentation constants of about 40, 20–30, 9 and 5 *S*. An electron micrograph of the purified 40 *S* fraction showed that it was formed of particles which appeared to be spherical with a diameter of about 150 A., and the molecular weight of these elements, calculated either from ultracentrifugal or electron microscopic data, was about one million. Although they did not give any data on the matter, Schachman *et al.*[2] stated that the 40 *S* fraction contained "considerable amounts of ribonuclease, catalase, apyrase, formic dehydrogenase and succinodehydrogenase". Siegel, Singer and Wildman[3], in the course of their study of high-molecular weight components of normal and infected *E. coli* cells, observed very similar ultracentrifugal patterns, and the data presented here are in good agreement with those given by both groups of authors.



Ultracentrifugal patterns of Sup. 1 (1–4, time interval 600 sec., average speed 38,400 r.p.m. increased after picture 3 to 43,100 r.p.m.); Sup. 2 (5–7, time interval 840 sec., average speed 43,000 r.p.m.); and *P* (8–10, time interval 800 sec. between 8 and 9, and 900 sec. between 9 and 10, average speed 39,600 r.p.m.)

The ability of Sup. 1, Sup. 2 and *P* to oxidize various substrates was tested in Barcroft differential manometers at 36° C., in the presence of 0·05 *M* phosphate buffer *p*H 7·0 and with potassium hydroxide in the centre well. 1·5 ml. of either Sup. 1 or Sup. 2 and 0·3 ml. of *P* were used in each manometric flask in a total volume of 3 ml. The results, presented in Table 1, show that Sup. 1 contained the catalysts necessary for the oxidation of glucose, pyruvate, citrate, α-ketoglutarate, fumarate and succinate. Sup. 2 alone was inactive in the oxidation of these substrates, while *P* contained the bulk of the succinic oxidase system present in Sup. 1. Further fractionation of *P* will show whether the 40 *S* component alone carries all the enzymes of the succinic oxidase system. Whatever the answer, however, the experiments reported here show that the very fine particles—or macromolecules—of fraction *P*, of which the largest have a molecular weight of the order of 1–3 millions, support a complete succinic oxidase system, and, with the soluble factors found in Sup. 1, are able to catalyse the oxidation of some intermediates of the citric acid cycle.

It has been known for some time that clear cell-free extracts from some bacterial species are able to catalyse the oxidation of various substrates, including Krebs-cycle intermediates. Thus Stone and Wilson[4]

Table 1. OXIDATION OF VARIOUS SUBSTRATES BY FRACTIONS FROM CLEAR CELL-FREE EXTRACTS OF *Aerobacter aerogenes*.

Results given as Q_{O_2} (μl. oxygen uptake/mgm. protein/hr.) corrected for blanks. Substrate concentration: 0·03 *M*. Experimental conditions: see text

	Sup. 1	Sup. 2	*P*
Glucose (with 0·04 m.mol. diphosphopyridine nucleotide	49	4	0
Pyruvate (with 0·04 m.mol. diphosphopyridine nucleotide and 36 units of coenzyme A)	16	1	0
Pyruvate (with 0·04 m.mol. diphosphopyridine nucleotide, no coenzyme A)	10	1	0
Citrate	5·5	0	0
α-Ketoglutarate	6	0·7	0
Fumarate	8	0	0
Succinate	8	0	42

presented evidence that in an extract from *Azotobacter* the citric acid cycle was operating. As this extract was said to be translucent, and in view of the results of Schachman *et al.*[2] with different species of bacteria, it is not unlikely that the largest particles were of the same order of magnitude as those found in Sup. 1.

It is of great interest that some of the reactions, which in animal tissues are known to depend upon the integrity of the mitochondria, can take place in a bacterial extract in which the largest element would have a diameter of about 150 A., and therefore a volume of nearly one-millionth that of a mitochondrion.

However, as the activity of these bacterial extracts in the oxidation of some of the citric acid cycle intermediates is low compared with that of mitochondria, it is not inconceivable that when the cells are disrupted a cellular organization, necessary for optimum activity of the enzyme systems concerned, is disturbed.

I am indebted to Dr. P. Johnson for carrying out the experiments in the analytical ultracentrifuge and to Miss J. Moyle for her assistance in running the preparative Spinco centrifuge.

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Effects of Intraventricular Administration of Substance P

The presence of substance P in the central nervous system was first shown by Euler and Gaddum[1]. According to recent work on the distribution of this substance in the brain[2,3], the largest amounts are found in the basal ganglia, the hypothalamus, the midbrain and the grey matter of the spinal cord. Nothing is known about the action and function of substance P in the nervous system. We have now observed tachypnœa and hyperpnœa produced by substance P injected into the third ventricle of the rabbit and the cat.

Substance P was prepared and purified by the method of Euler[4] and Pernow[3]. Cow intestine was cut into pieces, boiled in water at *p*H 4 and the filtrate concentrated and precipitated with ammonium sulphate at 70 per cent saturation. The precipitate was purified by adsorption on aluminium oxide and elution with methanol. The activity of the preparation, tested on isolated guinea pig ileum, was 100–150 units per mgm. Substance P was dissolved in Ringer's solution. The volume injected varied between 0·05 and 0·2 ml. A preparation of substance P inactivated with crystalline chymotrypsin was used as a control solution.

The animals were anæsthetized with urethane (rabbit) and 'Nembutal' (cat). Substance P was injected through a cannula inserted in the intersection of the coronal and sagittal sutures at right angles to the vertex of the skull. The position of the tip of the cannula in the third ventricle was checked after each experiment by injection of aniline blue. Respiration was measured quantitatively by using a body-plethysmograph.

Intraventricular injection of 5 units of substance P produced, after a latent period of about five minutes, a successively increased rate of respiration of 30–50 per cent with a maximal effect occurring after 10–15 min. With 20 units the effect was even more pronounced. There was also an increase in the amplitude of the respiratory movements. Usually the injections produced a slight, gradual rise in the blood pressure of about 10 mm. mercury. These effects lasted from 20 min. to more than two hours. A pronounced tachypnœa and increased respiratory amplitude were also observed in unanæsthetized rabbits after injection of 10 units of substance P. No effect was obtained with control injections o Ringer's solution or inactive solutions of substance P.

When injections were made into paraventricular tissue and the solution did not enter the ventricular system, no consistent or lasting effects upon the respiration were recorded.

Recently, the effects of intraventricular injections of different drugs have been studied by Feldberg and Sherwood[5]. Tachypnœa was observed after injections of histamine, 5-hydroxytryptamine, adenosine triphosphate, hexamethonium, *d*-tubocurarine and atropine.

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Development of Tolerance to Ganglion Blockade by Methonium Compounds

The clinical observation that tolerance follows the repeated administration of hexamethonium salts was reported by Smirk and others[1]; and Smirk[2] has reported that the tolerance to hexamethonium salts was effective also in reducing the effects of other methonium salts. No reports concerning similar phenomena in animals have been found, and I have not found published observations as to the mechanism whereby tolerance occurs. This preliminary report is concerned with the mechanism by which tolerance is developed to the ganglion-blocking action o methonium salts.

Studies of the mydriatic effect of these agents in mice, and of blockade of the superior cervical sympathetic ganglia in the cat, indicate that tolerance o the ganglia to the effects of these substances follows their repeated administration to the whole animal. The local application of methonium compounds to isolated autonomic ganglia, however, did not give rise to any tolerance; but similar isolated preparations taken from animals which had previously been made tolerant by repeated doses of methonium salts were found to have become almost insensitive to these substances. The application of blood from tolerant animals and patients was found to confer tolerance on isolated ganglia from non-tolerant animals.

The superior cervical ganglia of bilaterally nephrectomized cats recovered from the effect of a intravenous injection of hexamethonium, although the recovery was slower than in normal animals. In nephrectomized cats, tolerance occurred as rapidly as in normal animals. By contrast, the ganglia of eviscerated or dehepatized cats did not develop tolerance after an intravenous injection of hexamethonium; but, when by a cross-circulation experiment the isolated liver of another animal was incorporated into the circulation, tolerance developed as in the whole animal.

Solutions of hexamethonium were assayed for this substance biologically and by a modified bromphenol blue method[3] before and after perfusion through an isolated liver, and before and after the solution was incubated with liver homogenates. The concentration of hexamethonium was rapidly reduced until none could be detected. The solution of hexamethonium treated with liver homogenate, when applied to isolated ganglion, produced resistance to the effects of further hexamethonium. It was concluded that the action of the liver on hexamethonium gave rise to a substance which competed with hexamethonium at the ganglion without itself producing any important degree of ganglionic block.

Studies on the nature of the liver principle which inactivated hexamethonium suggested that it is an enzyme, in that alterations in pH, temperature and the action of certain chemical substances reduced its activity and it is completely inactivated by trypsin digestion. The principle has been isolated in comparatively pure form, and is very active in destroying hexamethonium.

Estimations carried out on the excretion of hexamethonium have suggested that about 60 per cent of a parenteral dose is excreted in the urine. Evidence is available suggesting that the remainder is metabolized, presumably in the liver.

The work has given information which throws light on the mechanism of the development of toleration to the ganglion-blocking action of methonium compounds, and may throw light on the mode of the production of the ganglionic-blocking effects of these agents.

Papers embodying the results of this investigation will be published elsewhere.

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Galactopoietic Action of Thyroxine in Cattle kept in Subtropical Countries

A perusal of the available literature shows that no systematic work has been so far carried out to study the effects of the oral administration of thyroxine on the daily milk yield of different indigenous breeds of buffaloes and cows, bred in subtropical countries such as western Pakistan[1]. Two preliminary experiments were carried out to study the effects of the daily feeding of thyroxine in suitable doses, for a period of four weeks, on the daily milk yield in a six-year old Murrah buffalo and a five-year old Shaiwal cow kept in Lahore during October–November 1953.

The experimental animals (two buffaloes and two cows) were selected in such a way that the age of the animals, number and stage of lactation and the milk yield of the experimental animals were very close to that of the controls. The experiments were started about eight and twenty weeks after calving in the buffaloes and cows respectively. The animals were given orally 15 gm. of thyroprotein (containing 0·75 per cent *l*-thyroxine on bioassay) per animal. Thyroprotein under the registered name of 'Protamone' was kindly supplied by Cerophyl Laboratories, Kansas City, U.S.A. This preparation was adopted because it affords a ready means of administration of thyroxine by farm workers. The animals were milked twice a day and the daily milk yield of each animal was recorded. As the body temperature gives some indication of the physiological state of the animal body, the rectal temperatures of the animals were recorded daily. The mean minimum and maximum atmospheric temperatures for the months of October and November were 63·0° and 93·9° and 50·0° and 82·0° F. respectively, and the mean relative humidities were 56 and 69 per cent.

During the four-week period, the daily yields of the control and treated buffaloes were 22·7 ± 0·027 and 27·1 ± 0·018 lb. respectively. Statistical analysis of the results showed that thyroxine therapy resulted in a highly significant increase in the daily milk yield of the experimental buffalo ($t = 16·815$). The average daily milk yields of the control and experimental cows were 12·0 ± 0·11 and 13·7 ± 0·24 lb. and the increase was not significant.

The mean daily temperatures of the experimental animals, when compared with those of their respective controls, did not show any significant difference throughout the experimental period, indicating that the administration of thyroxine did not affect the animal body adversely.

There are some indications that an optimal increase in the daily milk yield of the lactating animals can only be obtained if thyroxine therapy is started at an early stage of lactation.

This work is being continued.

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Occurrence of *trans*-Acids in Animal Fats

Bertram's discovery[1] that ox and sheep fats, and butterfat, contain traces of *trans*-Δ^{11} octadecenoic (vaccenic) acid has been confirmed by other investigators[2,3], who have shown that this acid also occurs in traces in lard.

Using infra-red absorption technique, Swern *et al.*[4] recently found that beef fat contained not traces, but 5–10 per cent of *trans*-acids. These consisted of a mixture of Δ^{9} and Δ^{11} octadecenoic acids. By a similar procedure Cornwell *et al.*[5] found 5·0–9·7 per cent of *trans*-acids in butterfat. In the present work, undertaken to elucidate the origin of these *trans*-acids, we have estimated by infra-red absorption their content in the body fats of various animal species.

The table shows a marked difference in the *trans*-acid content of ruminants as compared with non-ruminants. The small amounts of *trans*-acids in pig fat could be derived from the skim-milk diet, as

Trans-UNSATURATED-ACID CONTENT OF ANIMAL DEPOT FATS

Species	Diet	Fat	Percentage *trans*-acid
Non-ruminants			
Rat	High carbohydrate 'fat-free'	Total body-fat	Not detected
Horse	Pasture	External and internal fatty tissues	Not detected
Pig	Skim-milk	Perinephric	0·9
Rabbit	Pasture	Abdominal cavity	Not detected
Ruminants			
Ox	Pasture	Beef tallow	4·5
Sheep	Pasture	Mutton tallow	11·2
Deer	Pasture	Perinephric	3·5

butterfat contains *trans*-acids, and it has been previously shown by Sinclair[6] that *trans*-acids (elaidic acid) when present in the diet are deposited in the depot fat.

Swern *et al.*[4] suggested that the *trans*-acids present in depot fat may have been produced endogenously from a *cis* monoethenoid (oleic) acid by oxidases. If this were so, then from the *trans*-acid contents of the fats shown in the table one could infer that such oxidases are present in ruminants, but not in non-ruminants. However, oxidases have been found in the tissues of rats, pigs and rabbits[7]. We consider, therefore, that the presence of *trans*-acids in ruminant depot fats could be better explained on the basis of bacterial action in the rumen.

We have found about 9 per cent of *trans*-acids in the fatty acids isolated from the rumen contents of pasture-fed sheep. (The rumen contents of living sheep were obtained through the courtesy of Dr. A. T. Johns, of the Department of Scientific and Industrial Research, Grasslands Division, Palmerston North, New Zealand.) No appreciable amounts of *trans*-acids were found in pasture lipids.

The mechanism of *trans*-acid formation in the rumen can be deduced from the work of Reiser[8], who showed that rumen bacteria hydrogenate linolenic acid to linoleic acid. Hydrogenation of unsaturated acids is accompanied by partial formation of *trans*-isomers, and this could explain the presence of *trans*-acids in the rumen.

This work is in progress, and the detailed results will be published elsewhere. In the meanwhile, the results now recorded serve to accentuate even more sharply the wide differences between the fat metabolism of ruminants and of non-ruminants, already referred to by one of us[9].

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Relation of Nitrogen Supply to the Molybdenum Requirement of Tomato Plants grown in Sand Culture

AGARWALA[1] has shown that molybdenum deficiency decreased the growth and ascorbic acid content of cauliflowers grown in sand culture, irrespective of whether nitrogen was given as nitrate, or as nitrite, ammonium compounds or urea. Except with nitrite, molybdenum deficiency also induced symptoms of whiptail[2] which serve as criteria for the diagnosis of molybdenum deficiency. In later work[3], molybdenum deficiency induced whiptail also in plants given nitrite or glutamic acid. As the whiptail condition is apparently confined to brassica crops[2,4] and might indicate a special role for molybdenum for this genus, it was desirable to investigate the relation of molybdenum requirement to nitrogen source in some other plant where symptoms of molybdenum deficiency are of a different type. Tomato was chosen as it is a sensitive and well-known indicator for molybdenum deficiency[4].

Plants were grown in sand culture by methods already described[3]. Purified calcium carbonate was mixed in the sand to prevent injury by ammonia, and all nutrient salts including the different nitrogen compounds were purified by treatment with copper sulphate and hydrogen sulphide. Nitrogen sources were: nitrate, nitrite, ammonium sulphate, ammonium nitrate, ammonium nitrite, urea or glutamic acid.

Growth was markedly reduced by omission of molybdenum irrespective of nitrogen source ($p < 0{\cdot}001$ for all treatments, except ammonium sulphate $p < 0{\cdot}05$). The percentage dry matter in leaves was also reduced with most nitrogen sources ($p < 0{\cdot}05$–$0{\cdot}001$) but was quite unaffected by molybdenum supply in the presence of urea or glutamic acid. Ascorbic acid[5] and dehydroascorbic acid were both similarly decreased by molybdenum deficiency irrespective of nitrogen source, but to differing degrees of significance as follows: nitrate, ammonium nitrate ($p < 0{\cdot}001$); ammonium sulphate, ammonium nitrite ($p < 0{\cdot}01$); glutamic acid ($p < 0{\cdot}05$); urea, nitrite ($p > 0{\cdot}05$). The ratio of ascorbic to dehydroascorbic acids was remarkably constant, remaining about 1 : 1·1 irrespective of treatments.

Total chlorophyll content was markedly decreased by molybdenum deficiency *only* in the nitrate or ammonium nitrate treatments ($p < 0{\cdot}001$). There were slight decreases or increases in most other treatments, but with ammonium sulphate there was a notable increase with omission of molybdenum ($p < 0{\cdot}01$).

In all sets of data there was a marked difference between the magnitude of the molybdenum effects in the presence of nitrate or ammonium nitrate and those produced with the other nitrogen sources. In each instance the nitrogen to molybdenum interaction was highly significant ($p < 0{\cdot}001$), except dehydroascorbic acid ($p < 0{\cdot}01$).

Thus, although evident generally in all treatments, the molybdenum effect and possibly its requirement are significantly less with non-nitrate sources of nitrogen than in the presence of nitrate. It is concluded at present that chlorophyll production is independent of molybdenum supply unless nitrate is present.

The visual symptoms observed in this experiment merit special note. Severe symptoms typical of nolybdenum deficiency[4] were clearly recognizable *nly* in the nitrate and ammonium nitrate treatments. 'hey were similar in both except for a somewhat arker colour of the green areas in the latter treatment. In the other treatments plants were practically ymptomless and normal in appearance though maller, except for occasional sporadic incidence of ither dark brown marginal areas in old leaves (mainly vith glutamic acid), or sudden wilting and withering vithout loss of chlorophyll in apical leaflets of mid-stem leaves (mainly with urea or nitrite). These ymptoms were relatively slight in extent and were onfined to plants given non-nitrate sources of itrogen and no extra molybdenum.

The evidence presented here supports the conclusion that molybdenum is essential for tomato, rrespective of whether nitrogen is given as nitrate r in a number of other forms at different stages of eduction, but that relative requirements depend on he nitrogen source. Full details and results of work ow in progress will be reported elsewhere.

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Copper Sulphate as an Aquatic Herbicide

DURING the course of an experiment in the use of opper sulphate against bilharzia snail hosts in the eason 1951–52, it was noted that the water-weed egetation appeared to be affected by the treatment.

Two canals, branching off the general Gezira rigation system at the same point, were hand-eeded in July 1951 and treated with 30 parts per illion of crystalline commercial copper sulphate for nail control. Three canvas bags containing copper lphate crystals were then hung in the flowing water st below the head regulator of the first canal, and filled as required. The second canal received no rther treatment. It is estimated that throughout e watering season, all water entering the first canal as treated at an average rate of 1 part per million ith copper sulphate. By March 1952, towards the d of the watering season, it was apparent that ere were large differences in both weed and snail pulations in the two canals under experiment, and survey carried out at that time showed that though e second canal had a heavy population of both ails and pondweed species, neither weeds nor snails ere to be found in the first, throughout the whole ¼ km. of its length.

During the period April–July 1952 a certain re-owth of weed occurred, no doubt owing to the terrupted flow of water (for domestic purposes ly) during this 'closed' period. In July 1952, with e resumption of watering for the new crop, the plication point of the copper sulphate was removed km. upstream so as to command a small branched stem including the two canals of the previous ear's experiment. This was all, except the 'second' nal referred to, treated again with 30 p.p.m. of copper sulphate, and then continuously with an amount afterwards estimated at 2 p.p.m. No weeding was carried out until March 1953, when an examination revealed that (1) no weeds grew nearer than 3 km. downstream of the point of application; (2) only patches of *Potamogeton nodosus* appeared able to grow within 10 km. of the point of application, though (3) at points below this some *Najas pectinata* and a little *Chara globularis* were found; (4) no bilharzia snails were found; (5) at no time were watering difficulties encountered on account of weed growth.

Further experiments are being carried out by the Sudan Ministry of Irrigation in order to ascertain if modifications of this method are practicable as a weed control treatment.

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Culture of Insect Tissues

GOODCHILD[1] has recently described attempts to culture *in vitro* the tissues of *Rhodnius prolixus*, and suggested two possibilities that might enable the successful establishment of cultures. The two suggestions are (1) to replace glass surfaces by mica, or cover them with a film of wax, and (2) to enrich the culture medium with an extract of *R. prolixus* embryos. Similar suggestions were included in a series of experiments that I have recently performed. Cultures capable of growth and of yielding subcultures have not so far been established, and it appears that the problems of insect tissue culture are more complex than has hitherto been appreciated.

Attempts have been made to culture the following tissues: hæmocytes (from cetoniid larvæ), *Bombyx mori* L. pupæ, and from *Periplaneta americana* L. nymphs and adults; gonads from *B. mori* pupæ; embryonic cells from eggs of *Drosophila melanogaster* Meig. two hours old; imaginal disks (eye, leg, wing, antenna) of *D. melanogaster*; epidermal cells of cetoniid larvæ; fore and midgut of *P. americana*.

The following media were used: (1) *B. mori* pupal blood, (2) aqueous extracts of *Drosophila* pupal and adult tissues, (3) Trager's[2] medium, (4) adult and embryonic insect tissue extracts in various combinations with vitamins, glutathione, cystine, cholesterol, concentrations of free amino-acids approaching those of insect blood[3], fowl plasma and chick embryo extract, (5) fowl plasma and chick embryo extract.

The following techniques were used: hanging drops of fluid; hanging drops with solid clots of fowl plasma and other ingredients; perforated 'Cellophane' sheets covered by liquid medium on cover slips; cover slips containing a drop of agar on which were placed drops of liquid medium. All the cultures were incubated at 25° C.

The antibiotics chloromycetin and sodium sulphadiazine were used in some media. They did not appear to have any effect on the tissues.

Survival of various tissues up to a week was observed, but continued growth was not obtained. In certain tissues, notably *Bombyx* hæmocytes, a syncytium was formed within 24 hr. of setting up the cultures and survived for six days. Long processes from fat-body cells were produced within 24 hr., resembling vertebrate fibroblast cultures, but no mitoses were observed in them and they did not increase in size during a six-day survival period.

The reasons for the difficulty in establishing insect tissue cultures are worthy of further investigation. I consider it unlikely that technical improvements in conventional methods such as Goodchild[1] has mentioned will be sufficient to establish insect tissue cultures. Further developments would appear to demand greater knowledge of hormone balance, tissue continuity and growth substances of insects.

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Occurrence of Two East American Species of Crabs in European Waters

Recently, two species of crabs, widely distributed on the Atlantic coast of the United States of America, were found in Danish waters. Since there is a possibility that especially one of them may be living in Britain and elsewhere but has been overlooked, I report here some details of the recent and of previous finds of the two species.

(1) Blue crab or common edible crab, *Callinectes sapidus* Rathbun. On September 20, 1951, a live female of the blue crab was caught in a plaice net in the Sound north-east of Copenhagen. It was kept alive for almost a year and moulted one month after the capture, increasing its width from 141 to 177 mm.

There are a few previous records from Europe. In 1900 a male was taken in south-west France[1]. Den Hartog and Holthuis[2] give two certain records from Holland (River Zaan and Amsterdam), and in a letter Dr. L. B. Holthuis, Leyden, has informed me that in July 1951 a specimen (about 120 mm.) was caught by a fisherman in the Nordzeekanaal.

In America the blue crab ranges from Nova Scotia to Uruguay, but is common only along the American coast from Cape Cod to Louisiana. Especially the young prefer sheltered bays or estuaries, and are occasionally found in fresh water. Correspondingly, all the five European records are from fresh water or more or less brackish water.

(2) *Rhithropanopeus harrisi* (Gould). In November 1953 Mr. Erik Rasmussen found plenty of crabs of this species on piles in the South Harbour of Copenhagen. They were all quite small (6–7 mm.). In the middle of t ice winter another visit to the known localit in the harbour only gave four specimens in a ranging in width from 6·8 to 10·5 mm. This pa of the harbour was the only area free of ice, becau waste water from a nearby factory raised t temperature to 6° C.

In eastern America this species occurs locally estuaries from Nova Scotia to Mexico. Previo records outside this area are: (1) San Francis Bay[3]; (2) Coos Bay, Oregon[4]; (3) Holland, whe until 1949 the crab was regarded as endemic (it w known as the Zuiderzee crab, *Heteropanope tridenta* Maitland, but is now considered a subspecies, *R. tridentata* Maitland)[5]; (4) Flemhuder Lake near t Kiel Canal in North Germany[6]; (5) estuaries of t Rivers Dnieper and Bug in the Black Sea[7].

Transportation of *Callinectes sapidus* to Europ and of *Rhithropanopeus harrisi* to Holland (befo 1874, when the Zuiderzee crab was described) and the Black Sea may have taken place in various wa Many examples are known of crabs clinging to shi sides or living in growths of algae, etc., on ships' hu (*Pachygrapsus transversus*, *Plagusia chabrus*, *depressa* and *P. tuberculata*, *Planes minutus*, *Ca cinides maenas*, *Menippe convexa*, etc.). In m opinion, this mode of transportation does n however, apply either to *C. sapidus* or to *R. harri* The former never occurs on piles, etc., or see shelter in crevices (as do the species mentioned abov and the latter is a brackish-water crab which cou scarcely withstand transportation for several wee through sea water of high salinity. It is more like that the two species have crossed the Atlantic in t ballast tanks of ships. This was probably the w in which the mitten crab (*Eriocheir sinensis*) w brought to Europe, as shown very convincingly Peters and Panning[8]. Another possibility in the ca of the blue crab may be active swimming, presumab in the shadow of floating sea weeds or wood, tr trunks, etc., carried by the Gulf Stream. During t

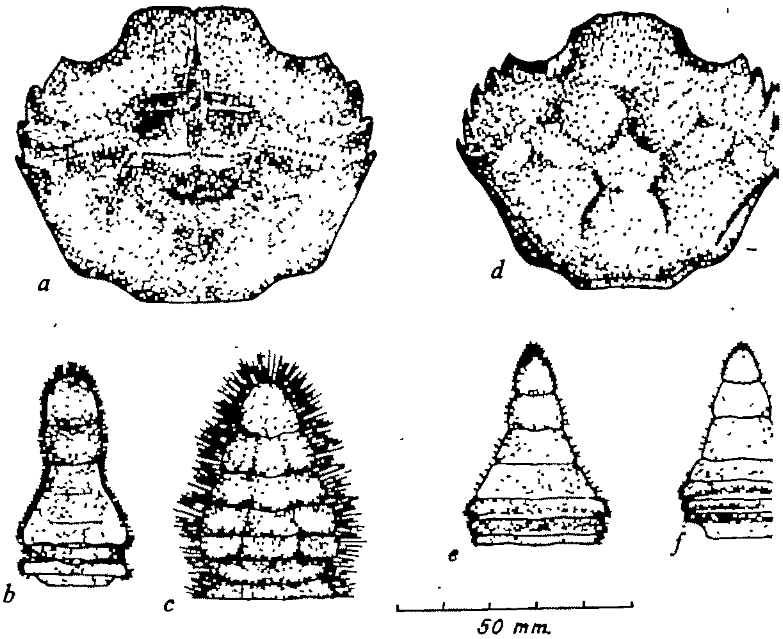

Fig. 1. (*a–c*) *Rhithropanopeus harrisi*; (*d–f*) *Carcinides maenas*; (*a, d*) carapace; (*b, e*) male abdomen; (*c, f*) female abdomen

alathea Deep Sea Expedition, I several times saw astal swimming crabs together with numerous astal fish, other Crustacea, etc., seeking shelter nd shadow under such floating objects, far from nd.

It is reasonable to suppose that finds of *Callinectes pidus* are normally recorded, since this crab is so g and conspicuous. But *Rhithropanopeus harrisi* ever exceeds some 25 mm. and can easily be istaken for a juvenile shore crab, *Carcinides maenas*. can be distinguished by the presence of only three ntero-lateral teeth and the conspicuous lines of ranules on the carapace (Fig. 1*a* and *d*).

In Holland the two species are known to occur gether[6]; but at Copenhagen *Rhithropanopeus* seems fill an ecological niche, occurring in the South arbour where the salinity (normally $9-12^{\circ}/_{00}$) is o low for *Carcinides*, which only penetrates into e Middle Harbour.

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Modified Horizontal Migration Method in Paper Chromatography

Very recently, Matthias[1] has described a modified echnique which may be looked upon as a combination f uni-dimensional and circular paper chromatoraphy. In this case, substances to be chromatoraphed are applied near the edge of a strip of aper, the end of which is made in the form of cone; thus the substances are at first radially istributed, which results in better separation.

We have developed a further odification. Whatman No. 1 lter paper sheet (18·5 cm. × 18·5 m.) or circular paper (18·5 cm. iameter) is cut as shown in Fig. 1. he black rectangles indicate openngs of equal size on paper at equal ntervals; thus, *A*, *B*, etc., may be oked upon as a number of strips ined together. The samples are pplied at *X* and, as in circular aper chromatography, paper wicks f equal size (2·0 cm. × 1·5 cm.) re inserted at *W*, so that one ick develops two samples at a ime. The piece of paper (sheet or ircular) is then placed between wo Petri dishes of the same diaeter (16·0 cm.), inverted one over e other, in which there is another maller Petri dish (10·5 cm. diaeter) containing the developing lvent. Development starts simultaneously through all the wicks and is complete within 30 min. Detection and identification of the samples are as usual. Fig. 2*a* shows the resolution achieved by the modified technique; twenty-two samples of varying concentrations were chromatographed on a sheet of paper 11 cm. × 18·5 cm. The solvent was allowed to travel a distance of 7 cm. The effective travel can be doubled if the wicks are transferred from the centre to the periphery of the paper, as shown earlier[2] for circular paper chromatography; but in this case only half the number of samples can be analysed. The 'cuts' in the paper can be of various shapes and sizes, provided that the solvent front moves radially at first. The poor resolution of the same sample on ordinary strip without 'cuts' is shown in Fig. 2*b* for comparison. Since there is clear separation of the constituents by the modified technique, quantitative analysis by elution can be done very easily in this case.

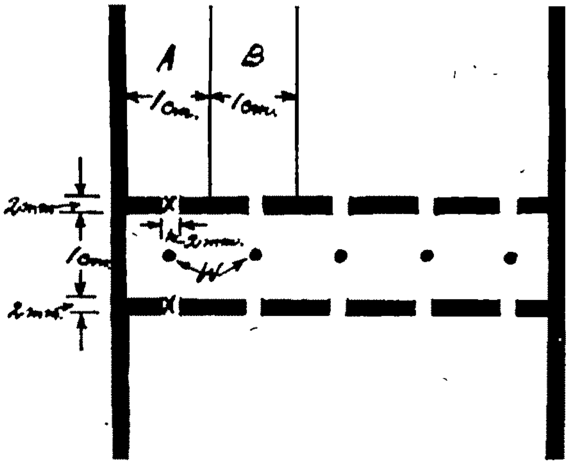

Fig. 1

As was pointed out earlier, all these improved methods depend upon the radial distribution of the chromatographed substances, at least in the beginning of development. In the case of strip chromatography, spots are formed which are generally elongated in the direction of the flow of solvent. This results in the merging of spots of close R_F values. In circular paper

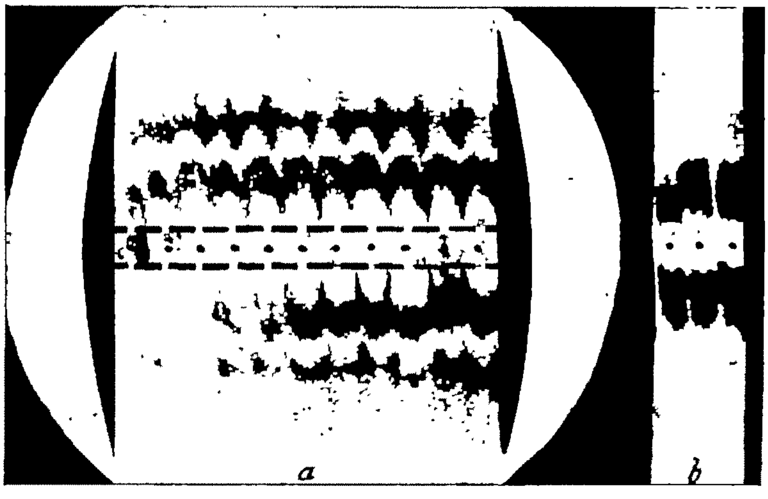

Fig. 2. Samples of amino-acid mixture of varying concentration which have been chromatographed with butanol : acetic acid : water (40 : 10 : 50)

chromatography or in these improved techniques, the substances form either rings or arcs; that is, elongation takes place at right angles to the direction of flow of solvent. This helps to increase the distance of separation between substances of close R_F values and therefore results in improved separations.

I wish to thank Dr. S. C. Roy, of this College, for his interest, and Dr. D. P. Burma, Bose Research Institute, Calcutta, for helpful criticism.

N. C. GANGULI

Department of Applied Chemistry,
University College of Science and Technology,
Calcutta 9. March 18.

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Staining of Bound Lipids

METHODS at present used for staining bound lipids either give an inadequate result histologically or depend on chemical reactions not characteristic of lipids as a class.

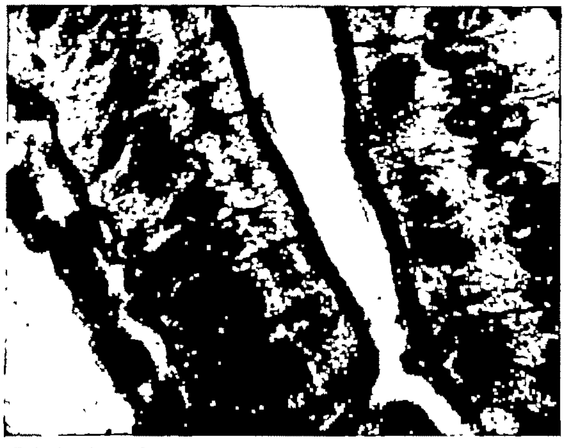
It has been found that if paraffin sections of variously fixed tissues are washed in water for several hours, and then rinsed in alcohol, they are well stained by 2 per cent sudan black *B* in acetone at 37° C. Staining is carried out in an airtight container, is progressive, taking one to twelve hours, and is followed by rinsing in xylol and mounting.

Structures stained include those containing nucleic acids, various cytoplasmic particles, nerve cells and processes, corpora amylacea, lipofuscin, basement membranes, reticulin, collagen, cartilage matrix, mucin, fibrin, amyloid, muscle striations, pituitary and thyroid colloid, bacteria and epithelial brush borders.

Alternatively the sections, washed as above, or exposed to dry heat at 60–65° C. for some hours, may be stained by burning saturated sudan black *B* in 70 per cent alcohol over them[1] six to ten times, washing in alcohol, clearing and mounting.

Here stained structures are those containing nucleic acids, red cells, erythroblast cytoplasm, eosinophil granules, muscle striations, cartilage matrix, mucin, lipofuscin, bacteria and thyroid colloid.

Continuous refluxing of tissues with ethanol–ether, methanol–chloroform and *n*-butanol–petroleum–ether mixtures progressively reduces stainability, litt being left after extraction for two weeks. The difficulty of disrupting some lipoprotein bonds by solven alone is well known[2].



Intestinal epithelium of guinea pig; alcohol-fixed; washed 24 hr.; acetone – sudan black 6 hr. Showing staining of brush border, cytoplasmic granules, nuclei and basement membrane

It is postulated that washing dissociates protei from laminated lipoproteins, allowing access to th stain[3].

This hypothesis is supported by the effect of mil peptic digestion (0·2 per cent pepsin in 0·05 hydrochloric acid for 30 min. at 37° C.) and of soap (1 per cent sodium ricinoleate at *p*H 7 for 1 hr. 37° C.), after either of which procedures sectio stain intensely without further washing.

This evidence suggests that these methods sta lipids bound to protein, and possibly to carbohydra and nucleic acids.

It is hoped to publish a full account of this an related work in due course.

M. C. BERENBAUM

Department of Pathology,
Chase Farm Hospital,
Enfield, Middlesex.
April 12.

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Extension of Range of the Angwantibo

I WISH to correct a pardonable error in the revie of "The Overloaded Ark" published in *Nature* May 15, one in fact which I myself held until ver recently. *Arctocebus calabarensis* is not found onl in the forests of the British and French Cameroon Two specimens of it have, a short time since, bee taken in the Mamu River Forest Reserve, a patch isolated remnant high forest situated some thirt miles east of Onitsha on the left bank of the Nige

This is an interesting if not important discover since it extends the known range of this animal we beyond what is with some justification regarded as faunal frontier precluding several animals of the mai central African forest block from the West Africa block—the Cross River basin. The Angwantib which in its main habitat cannot truly be describe as a "very rare" lemuroid, was certainly regarded one of the chief of these; so, too, was *Hylarnu batesi*, which has likewise been captured well to th west of the Cameroons.

The high forests lying between the Cross Rive and the Niger, that is, in the densely populou Eastern Region of Nigeria, have been very largel destroyed, and it is thus difficult to determin precisely the limits of the central African block. I our present state of knowledge there appear, however, to be indications from plants as well as anima that it is the somewhat insignificant Cross Rive rather than the Niger which forms the dividing lin To a scientific worker interested in animal di tribution, investigation of the few remaining an little-known forest remnants of the Eastern Regio of Nigeria, rather than the over-done Cameroon would be well rewarding.

D. R. ROSEVEAR
(Inspector-General of Forests)

Lagos,
Nigeria.

APPOINTMENTS VACANT

pplications are invited for the following appointments on or ore the dates mentioned:

urator (with a degree in geology) in the Geology Department Head of the Geology Department, Imperial College, South Kensing-, London, S.W.7 (July 28).

ecturer (with special interests in animal husbandry) in Agri-ture—The Registrar, The University, Nottingham (July 28).

emonstrators (with an honours degree in chemistry) in Chem-ry—The Registrar, College of Technology, Manchester (July 29).

cientific Officer or Senior Scientific Officer (with a first-second-class honours degree in physics or chemistry, and with eral years experience in the study of surface chemistry), to work problems associated with the surface chemistry of materials of erest in the nuclear energy field—The Establishment Officer, omic Energy Research Establishment, Harwell, Berks (July 29).

ecturers (with a good honours degree in electrical engineering) Electrical Engineering—Head of the Electrical Engineering partment, City and Guilds College, London, S.W.7 (July 30).

esearch Assistant (with a good degree in botany and high ualifications in chemistry and with physics to at least introductory al) to the Professor of Plant Biophysics in the Department Botany, to study problems in growth and senescence of apple cell lls using electron microscopy and other physical methods—The gistrar, The University, Leeds 2 (July 30).

enior Lecturer (with high academic and research qualifications) Organic Chemistry—The Clerk to the Governors, Woolwich lytechnic, London, S.E.18 (July 30).

ssistant in Mathematics, and an Assistant in Statistics—e Secretary, The University, Aberdeen (July 31).

hair of Chemistry—The Secretary, The University, Aberdeen ly 31).

Lecturer (preferably with an interest in low-temperature physics in the theory of the solid state) in Physics, at St. Salvator's College The Secretary, University of St. Andrews, College Gate, St. Andrews ly 31).

emonstrator (with a good honours degree in chemistry or bio-mistry, and prepared to engage in research in biochemistry with a w to obtaining a higher degree in this subject) in the Department Chemistry and Biochemistry—The Dean, St. Thomas's Hospital dical School, London, S.E.1 (August 3).

cientific Assistant (with a knowledge of systematic zoology l/or foreign languages), for duties which will include abstracting, lexing and proof reading—Commonwealth Bureau of Agricultural rasitology (Helminthology), Winches Farm Drive, Hatfield Road, Albans, Herts (August 4).

Principal Scientific Officer (with an honours degree in civil gineering or Corporate Membership of the Institute of Civil gineers) at the Road Research Laboratory, Harmondsworth, iddlesex, to take charge of full-scale experiments in bituminous road struction and occupy a senior position in the section dealing with earch on bituminous materials—The Civil Service Commission, entific Branch, 30 Old Burlington Street, London, W.1, quoting 356/54 (August 12).

ssistant in Research in Animal Physiology; an Assistant Research in Soil Chemistry, and an Assistant in Research Agricultural Engineering—The Secretary, School of Agri-ture, Downing Street, Cambridge (August 13).

Lecturer or Assistant Lecturer (preferably with experience of iversity teaching and with special qualifications in petrology or physics) in the Department of Geology—The Secretary and gistrar, The University, Southampton (August 13).

enior Lecturer in Education at the University of Sydney, stralia—The Secretary, Association of Universities of the British mmonwealth, 5 Gordon Square, London, W.C.1 (Australia, August

ollege Lecturer in Electrical Engineering, and a College cturer in Mechanical Engineering—The Secretary, University lege, Cork, Ireland (August 16).

ecturer (with a good honours degree in mechanical engineering l practical experience in industry and teaching) in Mechanical gineering—The Principal, Wigan and District Mining and Tech-al College, Wigan (August 16).

ssistant Lecturer or Demonstrator (with a good honours gree in chemistry or biochemistry) in Chemical Pathology—e Registrar, The University, Manchester 13 (August 25).

ecturer (preferably with qualifications in the fields of human l regional geography, and a special knowledge of the regional graphy of Monsoon Asia and/or the South-West Pacific) in Geo-aphy, at Victoria University College, Wellington, New Zealand—e Secretary, Association of Universities of the British Common-alth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

ecturers (2) (with a special interest in one or more of the following ds: clinical psychology (with therapeutic experience), experimental l statistical, physiological, social, industrial) in Psychology, at University of Natal—The Secretary, Association of Universities the British Commonwealth, 5 Gordon Square, London, W.C.1 uth Africa, August 31).

rofessor of Philosophy at the University of Otago, Dunedin, w Zealand—The Secretary, Association of Universities of the tish Commonwealth, 5 Gordon Square, London, W.C.1 (New land, August 31).

enior Lecturer in Pure Mathematics at the University of Witwatersrand, Johannesburg, South Africa—The Secretary sociation of Universities of the British Commonwealth, 5 Gordon uare, London, W.C.1 (Johannesburg, August 31).

lant Pathologist (with a good degree in botany, including cology, and preferably with postgraduate research experience or ivalent training in plant pathology or mycology) for research on fungal diseases of hops and fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (September 1).

Lecturer in Applied Pharmacology and Therapeutics—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (September 6).

Lecturer (well qualified in organic chemistry, and preferably with experience of the chemistry of vegetable tannins or synthetic dyestuffs) in the Department of Leather Industries—The Registrar, The University, Leeds 2 (September 13).

W. J. Rees Research Fellowship, tenable in the Department of Refractory Metals in the Faculty of Metallurgy—The Registrar, The University, Sheffield (September 15).

Senior Technician (with some training in zoology and experience in laboratory work, and preferably with a practical knowledge of taxidermy and modelling) in Zoology, at Auckland University College, Auckland, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, September 30).

Agronomist/Plant Breeder (with a degree in agriculture or botany, and preferably with some postgraduate experience) on the Research Staff of the Empire Cotton Growing Corporation, Aden, to work on general problems of agronomy and plant breeding, and selection work on the irrigated cotton crop, and to some extent on food crops; and a Soil Chemist or Physicist, to study the soils in Aden Protectorate and possibly Somaliland—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

Assistant Experimental Officer (with at least H.S.C. in science or mathematics) in the Department of Atomic Energy, Risley, for technical information duties, which include preparation of bibliographies, bulletin of journal references, and maintenance of indexes—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 638.

Assistant Experimental Officers (with at least H.S.C. in mathematics or science subjects, or equivalent) in the Department of Atomic Energy, Capenhurst, near Chester, for (*a*) work in a small computing section (after a period of training); (*b*) theoretical investigations, under supervision, of problems arising in the development of power producing reactors and diffusion plant; (*c*) assisting in research concerned with development in fields such as fluid dynamics, mass spectrometry, heat transfer and general physics—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 637.

Assistant Lecturer in the Department of Pure Mathematics—The Registrar, University College of Wales, Aberystwyth.

Chemical Engineer (with an honours degree, A.R.I.C., A.M.I.Chem.E., or equivalent qualifications, and at least three years experience in an industrial research organization) in the Department of Atomic Energy, Sellafield, Cumberland, to lead a team working on chemical engineering problems connected with the development of new processes—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 632.

Chemist, to work in the United Birmingham Hospitals Department of Clinical Endocrinology, on an investigation of protein hormones—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Birmingham 11.

Electronics Technician, to work on the 8 MeV. Linear Accelerator—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

Lecturer, Grade IIa (with an honours degree or equivalent qualification, and preferably industrial and/or research experience) in Physics—The Principal, Paisley Technical College, Paisley.

Lecturer in Market Garden and Glasshouse Crops—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

Lecturer (with special qualifications in pure mathematics) in Mathematics—Head of the Mathematics Department, Imperial College, London, S.W.7.

Master to teach Physics to Scholarship level—The Warden, The College, Llandovery, Carmarthenshire.

Physicist (preferably experienced in instrumentation, with particular reference to the inspection and testing of metallic materials)—The British Non-Ferrous Metals Research Association, 81 Euston Street, London, N.W.1.

Physicist, to continue fundamental research on surface electrification of polymers—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

Physicist (with a good honours degree) for technical assessment and development of inventions chiefly in the applied physics and scientific instrument field—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

Physicist or Electrical Engineer (with an honours degree in physics or electrical engineering), for work with a 1-million-volt cascade generator—Dr. J. F. Loutit, Medical Research Council Radio Biological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Research Assistants in Chemistry, Physics and Mathematics—The Northern Polytechnic, Holloway, London, N.7.

Research Officer (with a first-class honours degree in a natural science and at least two years postgraduate research experience, preferably of freshwater fish and fisheries) with the East African Fisheries Research Organization, to carry out research into the ecology and/or physiology of fish—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.195/194/02.

Scientific Assistant (with a degree in agriculture or natural science, and a knowledge of French and German and ability to write clear concise abstracts in English), for duties which will include examining and abstracting world scientific literature on grassland and field-crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks.

Technician or Senior Technician (with some experience of electronic equipment) in the Londonderry Laboratory for Radiochemistry—The Secretary, Science Laboratories, University of Durham, South Road, Durham.

REPORTS and other PUBLICATIONS

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COASTAL FLOODING IN BRITAIN

THE recently published report* of the Departmental Committee on Coastal Flooding is of considerable interest to a wide variety of authorities and individuals. The Committee was appointed in April of 1953 and was charged with the task of examining the causes of the floods on the east coast of Britain which had occurred in the previous January, and with estimating the possibilities of their recurrence. The Committee was also asked to consider what margin of safety for sea defences would be reasonable having regard to the estimated risks and the cost of protective measures, and whether any system of warning was desirable to lessen the risk of loss of life and damage to property. Finally, the existing administrative and financial structure for the maintenance and replacement of sea defences was to be reviewed.

With commendable speed and efficiency the Committee has studied the problem and made its report and recommendations in a little more than twelve months. Indeed, it had already distinguished itself by the early publication of an interim report on a warning system which appeared in July 1953. Priority was given to this aspect of the terms of reference in view of the public anxiety which had been created by the tragic events of January 1953, when more than three hundred people lost their lives, some 24,000 houses and more than 200 large industrial premises were flooded and damaged, and some 160,000 acres of land inundated.

The Committee proposed in this interim report that a winter warning system should operate initially on the east coast of Britain between September 15 and April 30 each year. It was suggested that water-level reports should be sent in to the Central Forecasting Office at Dunstable, where a seconded officer of the Hydrographic Department of the Admiralty would interpret them in the light of predicted tidal levels and the possibility of surges. If dangerous levels were likely to be exceeded, then the river boards and county police were to be informed immediately, and were locally to be charged with the responsibility of giving adequate warning. This system was put into operation and has apparently stood the test of a trial winter season quite satisfactorily.

As is now well known, the severe coastal flooding of January 1953 was caused by the combination of a fairly high tide with a very high surge, and the effect was increased by severe wave action. Tidal oscillations are well-known phenomena and can be predicted with reasonable accuracy, but the surge has only been recognized and studied in the past thirty years. A surge is mainly due to strong winds blowing forward the surface waters of the sea ; this in certain circumstances may lead to an accumulation of water in a particular locality and hence to a rise in sea-level. Smaller differences in level may also be produced by changes in atmospheric pressure from one part of the sea to another. The surge is therefore clearly a meteorological phenomenon, although once the accumulation (or deficit) of water has been formed in any region it will tend to move away from that region according to the laws of mechanics. Forecasting the incidence and periodicity of a surge is difficult, although once established a fairly reasonable estimate of the dispersal behaviour can be made. Here the Committee is strongly in favour of more fundamental research being carried out in order that the warning system can be further improved.

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* Report of the Departmental Committee on Coastal Flooding. (Cmd. 9165.) Pp. 48. (London : H.M.S.O., 1954.) 2s. 6d. net.

The primary causes of tides and surges are completely unrelated, so that it might seem a maximum in both could coincide. Their combination is not, however, a simple superposition. In steady conditions the slope on the surface produced by a given wind varies inversely with the total depth of water under the wind, so that when the tide is high the slope of the sea surface is somewhat less than when the tide is low. The highest surges have, in fact, reached their greatest heights when the tides have been nearer low water than high water. The flood of January 1953 did not occur at high tide, nor did it occur with the highest spring tides; and the surge, although 9 ft. in height and exceptional, was not the greatest on record. A moderate surge coming near high water on a high spring tide is thus likely to prove even more disastrous. Here again, further information is needed before the precise nature of the interaction between the tide and surge can be understood.

Another somewhat disturbing factor which the investigation has brought to light is the progressive increase over the past hundred years in the highest levels reached in exceptional storms and in the frequencies with which such levels occur on the east coast of Britain. This is largely attributed to the steady rise of mean sea-level relative to the land which appears to be taking place at the rate of one foot per century along the coasts of south-eastern England. Attention is further directed to the effect of large waves upon the coastal defences, since the meteorological conditions favourable to surges will also produce exceptional waves. It also becomes necessary to bear in mind the possibility of upland river flood water adding to tidal and surge waters in constricted estuaries—an important point in the problem of the Thames estuary.

Having established the causes of the severe flooding and shown where additional information is desirable, the report then considers the practical problems of coastal defence which arise on the east coast. Here there are long stretches of natural defences such as dunes and shingle ridges, to which has been added some 1,270 miles of man-made earthen and other types of banks: the whole protecting considerable areas of land now lying well below high-tide level. To reinforce all these defences to meet the maximum water-level that is theoretically possible in the light of present knowledge would of course be financially out of the question. The Committee recommends that the level of January 1953 should be taken as a reasonable working basis for areas of high propert value; elsewhere defences should be at a standar which would have been thought reasonable prior t January 1953. But preparations should be mad where desirable to deal with a limited amount overspill for occasional exceptional water-levels (th statistical chance of the January 1953 level is onc in every two hundred years). Where possible, secon line defences should be strengthened or constructe to create a cell or honeycomb structure which woul contain any overspill flood waters during an eme gency. Where the risk of overtopping is accepte earthen banks should be waterproofed with a carp of material such as asphalt/concrete to preve erosion on the back slopes and the conseque collapses which were so common in 1953. Th sealing of minor tidal creeks is recommended, an the possibility of deliberately spilling water on th seaward side of vulnerable areas is also considered.

The importance of maintaining the natural defenc of dunes and shingle ridges is stressed, together wit the advisability of pressing ahead with research o the behaviour and suitability of binding and stabi izing vegetation for use on such areas. The Committ might also have mentioned the need for a code public behaviour in such localities—few holiday makers and caravan dwellers realize how deleterio their activities can be to the natural coastal defence Further research is also considered advisable int the movements of beach material and offshore san banks, together with the use of groynes as a contr medium for beach retention; conflicting eviden was deposited with the Committee relative to the problems.

Finally, the field of existing responsibilities for th coast protection and defences of eastern England surveyed. As might be expected, there is here complex situation with duties spread over rive boards, county borough councils, county distri councils and government departments, with here an there a part of the coast completely 'unadopted' After careful consideration, however, the Committ does not recommend any change in the distributio of existing responsibilities, but does advise in som instances closer co-operation between certain autho ities. Financial responsibilities are also considered i the report, and an effort is made to lay down som working principles on the problem of who shoul pay for construction and maintenance of th defences.

The special problem of flooding in the Tham receives separate consideration. A surprising amou of the City of London is built on former marsh la and is now below high-tide level; substantial are would be flooded if the embankments were ove topped or gave way. The 1953 flood water general reached the top of the city defences, and low downstream some 30,000 acres were inundated. was fortunate that the down-river inflow was low or much greater damage would have resulted.

Experiments have since been made on the Port London Authority's tidal model of the Thames study the interaction of river flow, tidal changes an surge effects. A complicated picture emerges, as solution in one locality may intensify the problem lsewhere. Thus the raising of the downstream defences in Kent and Essex by 3–4 ft. which followed immediately upon the flood of 1953 will appreciably aise the Thames level in central London should such an incident be repeated; further, any greater surge height at Southend means a progressively greater increase in height upstream towards London Bridge. Relief by means of controlled spill is now almost mpossible, and similarly the raising of the defences of inner London would be extremely difficult and costly because of the associated ancillary work. Two other possibilities were therefore considered: one method would be to erect a barrier across the estuary, leaving gaps through which shipping could pass; but this carries the disadvantage that it would cause deterioration of the estuary. An alternative suggestion which was tried out on the model, and which the Committee recommends for serious consideration, was he construction of a suitable structure across the Long Reach (between Purfleet and Greenhithe) provided with 'gates' which could be closed on occasions of impending high flood.

The report also directs attention to certain unsatisfactory aspects of the present financial and administrative arrangements in the existing Thames flood defence scheme, and to the fact that little positive action followed upon the report of the Hart Departmental Committee of 1931–33, which was set up to consider floods in the tidal portion of the Thames. The present Committee urges that the special problem of the Thames should be resolutely tackled without further loss of time.

This report on coastal flooding is a model of its kind, and one could only wish that the associated, but even more serious and more frequent, problem of river flooding (see *Nature*, 172, 263 and 823; 1953) was also in receipt of equally careful attention and consideration.

ORIGINAL PAPERS OF WILBUR AND ORVILLE WRIGHT

The Papers of Wilbur and Orville Wright

Including the Chanute–Wright Letters and other Papers of Octave Chanute. Edited by Marvin W. McFarland. (Sponsored by Oberlin College on the Wilbur Wright Memorial Fund, and prepared for the Press, with Notes, Appendices, and Bibliography, by the Aeronautics Division of the Library of Congress.) Vol. 1: 1899–1905. Pp. lv+676+141 plates. Vol. 2: 1906–1948. Pp. xxvii+677–1278+plates 142–236. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 2 volumes, £10.

THESE two volumes give for the first time a full account by the Wright brothers of the history of the solution of the problem of human flight. In the ntroduction it is explained that they fully intended to write up the results of their work for publication, but that they became so preoccupied with their experiments and later with the marketing of their machines that they never did so. After Wilbur's death in 1912, Orville had the same good intention, but never carried it out. After his death in 1948, the voluminous correspondence of the brothers and their note-books eventually came into the possession of the United States Library of Congress, and it is from this material that the present volumes have been compiled. The story is told almost entirely by the reproduction of the correspondence in full, so far as it affects the progress of the aeronautical work, with an occasional letter that sheds light on the character and personality of the Wrights. By far the greater part of the letters passed between the Wrights and Octave Chanute, with whom they formed a close friendship in the early days and with whom they discussed, usually by writing, the results of their experiments. It is most fortunate that these letters have been preserved.

The books are by no means easy reading, partly because of the great amount of material in them and partly because the Wrights invented their own terminology, and one must translate it into modern aeronautical nomenclature in order to see precisely what they were thinking. There is, however, a very clear picture of the whole process through which they went, from the first desire to explore the possibility of flight to the successful achievement of powered flight for the first time in history and on again to the development of their machines into forms suitable for practical use in peace and war. The first volume carries the reader from 1899 to 1905 and contains chiefly an account of aerodynamic experiments made to determine the basis on which flight depends. This is unfolded almost entirely by the letters to Chanute and his replies, but in appendixes there is an account of the Wright brothers' nomenclature, of their wind-tunnel experiments and results, and of their study of the problem of the propeller. There are also extracts from Chanute's diary which shed further light on the subject.

The second volume contains later experimental work; but is largely taken up with the efforts made by the brothers, sometimes separately and sometimes together, to obtain some reasonable financial recompense for all their work by selling their invention to governments or private companies, a matter in which they met with no small difficulty. There is also an account, amplified by footnotes, of the various controversies which arose concerning the Wrights' claim to have been the first to fly, and, in particular, of the lengthy battle which raged over the claims of Langley, in which the Smithsonian Institution took, at the time, a rather inglorious part, but later fully recanted.

The broad outline of the Wrights' pioneering work is now fairly well known through details which have been given in Wilbur Wright Lectures and in the publications of the Royal Aeronautical Society and other bodies; but it may be well to direct attention here to salient points. The Wright brothers were no theorists, but practical engineers whose life had started in the cycle trade. They realized, from the start, the extreme importance of obtaining numerical data on the performance of their machines as a basis for future progress. They followed, in fact, the road that has been followed ever since in aeronautical research, combining measurements in flight with experiments on models and endeavouring to correlate the two to form a practical basis for design. In the earliest days they used gliders, which they sometimes flew as kites, and by observations of angles of glide and incidence in the former case, and of tension in the cable in the latter, they were able to get a fairly good quantitative idea of the forces acting on the wings. They soon realized that the existing tables of aerodynamic data, chiefly Lilienthal's, were far from satisfactory, and it was this that led them to devise a wind tunnel in which they could make tests of lift and drag on a whole series of wings of various sections. On these data they based the design of all their subsequent machines, with conspicuous success. They showed the greatest wisdom in their flying, never rising more than a few feet above the ground until they had fully solved the problem of control and had learned how to use that control in all circumstances. They state repeatedly in their letters that the real problem of flight is one of control, rather than the mere provision of wings that can sustain the weight and power to pull them through the air. They did their best to follow the work of others in the field; but it seems fair to say that they owed very little to such work and that from their own resources and tests they evolved the machine, its engine and its propeller, all of which they made with their own hands. This is surely one of the most notable achievements in the history of man. They seem to have been unaware, however, of the writings of Lanchester, and of the theoretical and experimental work of Eiffel and Prandtl; at least, there is no mention of these investigators until almost the last letters of Orville Wright.

It is perhaps surprising that it should be so late before a full account of the Wrights' work has become available. The main reasons are that they themselves did not write out their results, and that they were always careful not to discuss their work, except to close friends, lest they should lose to others some of the credit that they felt was their own. We can now be thankful that the story has at last been told and that the magnificent achievement of the Wright brothers can be appreciated to the full extent it deserves in this air age which they did so much to inaugurate. ERNEST F. RELF

UNIVERSITY OF LEEDS: JUBILEE VOLUME

The University of Leeds

The First Half-Century. By Prof. A. N. Shimmin. Pp. xv+230+8 plates. (Cambridge: At the University Press, 1954. Published for the University of Leeds.) 21s. net.

THIS is a remarkable book about a remarkable institution, and a more fitting foreword than that of its Royal Chancellor can scarcely be imagined. The Princess Royal says: "The making of a University calls for inspiration and enterprise. Although the University of Leeds is still young, the men and women who have created and cherished it have displayed the same devotion to truth in the service of their generation as their forbears in the older Universities. This book is the story of a triumph over many obstacles and over the ill effects of two world wars. So much strength and vigour, gained in so short a time, is good testimony to the loyalty and robust energy of the members of the University themselves. But as the record shows, they have not done what they have done in isolation. Through all the years, while steadily building up its esteem in the world of learning, the University has felt a characteristic impulse from the Yorkshire people whom it serves. In a Jubilee celebration it is most fitting t honour those who have laid the foundations and commend this history to all who care for our University of Leeds. MARY".

In these words Her Royal Highness has mos aptly summarized the intention of the jubilee an the purpose of the commemorative volume which th University authorities so wisely entrusted to the car of Arnold Shimmin, professor of social science.

The volume presents a broad, general, historica sketch of the antecedents of the University and make a most successful effort to indicate the vicissitude and successes from the days of the Medical Schoo (1831); the Yorkshire College of Science (1874) the amalgamation of these two (1884); the federatio of the Yorkshire College in the Victoria Universit (1887); and lastly the granting of a charter t the infant University of Leeds (1904) and so t 1954.

The first pre-natal stirrings are touched on, with reference to an account in the *Leeds Mercury* (1826 of a proposal by the president of the Philosophica and Literary Society of Leeds to establish a universit in Leeds. The scheme was still-born—but was a any rate a stirring of thought. Who knows bu that the processes so started led to the foundatio of a School of Medicine in 1831, for was not the firs president of its Council one Dr. James Williamson who had been the first secretary of the Leed Philosophical and Literary Society?

Prof. Shimmin gives such matters the fulles possible attention in the first of six chapters whic make up Part 1 of the book, entitled "The Makin of the University". In this part, additional to th historical background, are included also such topic as "The Years of Expansion (1925–53)"; "Studen Welfare"; and a revealing section under the title o "Town and Gown".

This Part 1 is the more impersonal of the two mai parts into which the book divides itself. Nevertheless, even the casual reader will realize, as has bee the treasured realization of all members of th University, that distinguished and well-remembere names were foremost among the original teachers i 1874: Arthur Rucker was professor of physics A. H. Green was professor of geology; Edwar Thorpe was professor of chemistry; and these wer soon to be joined by Louis Miall, professor of biology The Yorkshire College of Science had stepped off o the right foot on its path towards university statu and was thus destined, from the start, to be no entirely vocational. Indeed, from one of th appendixes (No. 3) which illumine the historica details, this breadth of vision and balance of stud was (as it still is) well maintained, since, at the tim of the charter in 1904, there were eleven arts departments, six of science, seven of technology and ten o medicine.

During this fifty years, Prof. Shimmin points out many distinguished names have helped in th building up of the external prestige of the Universit and have added to its growing lustre. Such men a George Gordon, Lascelles Abercrombie, Paul Barbier A. Hamilton Thompson, John Clapham, William H Bragg, Arthur Smithells, Arthur G. Perkin, Henry Procter, Henry Raper and Berkeley Moynihan al won in their time high international reputations fo themselves and for the University. Others are to near the present day to be mentioned in this review but in Part 2 of his work, entitled "Et Augebitu Scientia"—the University motto—Prof. Shimmin has, with full justice to all, sung the praise of the present and the immediate past.

But praise for achievement is due not only to the distinguished vice-chancellors and their academic colleagues, but also to those high-minded and far-seeing laymen who have given such ungrudging and helpful service in high administrative and advisory capacity; the functions and purpose, therefore, of all in the hierarchy, from chancellor, through pro-chancellor to members of council and their committees, are set out and particular personalities singled out for special mention. The reader will note with interest, perhaps, that even in the short space of fifty years the outlook and methods of these public-spirited men—often the sons of fathers who have similarly served—have changed in evolutionary manner from the firm, though kindly, autocracy of the past to the gentler advisory guidance of the present.

Many of the illustrations have been charmingly executed by Maurice de Sausmarez, head of one of the youngest University Departments, that of Fine Art; the printing, photographic reproductions and binding are quite impeccable, and the whole effect is most pleasing.

In short, this is a most interesting book, full of information about the University, historically, geographically, architecturally, numerically and financially, but nevertheless it is full also of the human and personal side of a great and continuing endeavour; it will stand as a lasting and authoritative summary of the early life of the rapidly evolving University of Leeds.

R. WHIDDINGTON

FLOWERS AND FUNGI

Wild Flowers

Botanising in Britain. By Dr. John Gilmour and Dr. Max Walters. (The New Naturalist: a Survey of British Natural History.) Pp. xiv+242+56 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 25s. net.

Mushrooms and Toadstools

A Study of the Activities of Fungi. By Dr. John Ramsbottom. (The New Naturalist: a Survey of British Natural History.) Pp. xiv+306+71 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 30s. net.

IT is said that every age has its book, and the book of the present age would almost seem to be a natural history book, so many are these and so insatiable the demand for them. Why this should be opens up a most interesting field for speculation, and many explanations are offered. Some think that it merely expresses the swing of the pendulum in the fashion in books; but it seems unlikely that this can be the whole story, and many prefer to think that it betokens something more than this and, especially, a growing realization that we have wandered too far from the simple and beautiful, and are now seeking, with no little nostalgia, to recapture something that is escaping us.

Whatever the truth may be, there is now an immense array of books dealing with nature study in Great Britain. They are of all sorts and sizes; but their general level is high, and in none of them more so than in the volumes of Collins's "New Naturalist Series". The list of titles here is now impressive; but that there are springs still unexhausted is well shown by two recent (though long adumbrated) additions to it, "Wild Flowers" by John Gilmour and Max Walters (No. 5) and "Mushrooms and Toadstools" by John Ramsbottom (No. 7), both of which fully maintain the standard set by their predecessors. The former is, essentially, a rather new treatment of a theme which never seems to tire, and perhaps the best compliment that can be paid to its authors, who write most pleasantly, is to say that they have succeeded in making something of their own that is distinctive. Incidentally, it should be noted with reference to p. 29 that ancient *Nelumbo* fruits from Manchuria were germinated in Britain almost thirty years ago (see *J. Bot.*, 1926). The latter book is, as essentially, a rich mine of information, both scientific and curious, about a narrower field, which, like some of the plants it contains, is something of an acquired taste, and here again the author has succeeded admirably in his task.

Indeed, if criticism is called for at all it is to be directed, in both cases, at matters of policy rather than content. "Wild Flowers" makes necessary, yet again, the strictures which have so often been passed on the inappropriate use of colour photographs in books of this kind. Surely so reputable a book should not suggest to the botanical tyro that birds-foot trefoil (Plate 12*b*) has large entire leaves, or that betony (Plate 2*b*), which is one of the strongest-hued plants in the flora, is one of the least convincing. All this, moreover, amid some very lovely black-and-white pictures. In "Mushrooms and Toadstools", where the subject eminently suits them, colour photographs are a success, and indeed may steal more of the author's thunder than they warrant; but here an unnecessary weakness is the inclusion of a chapter on penicillin, which, though vastly interesting, does not fall within the title of the book, and seems to have been put in more to tickle the public fancy than for any better reason. Nevertheless, both these books are notable additions to the literature of our countryside and remind us, once again, of the real truth in Stephen Leacock's words:

> "Surely no nobler theme the poet chants
> Than the soft science of the blooming plants".

RONALD GOOD

CHEMICAL ANALYSIS OF INDUSTRIAL SOLVENTS

Chemical Analysis of Industrial Solvents

By Dr. Morris B. Jacobs and Dr. Leopold Scheflan. (Chemical Analysis Series, Vol. 7.) Pp. xxii+501. (New York and London: Interscience Publishers, Inc., 1953.) 10 dollars.

THIS book, the seventh volume in a series on chemical analysis, is a collection of methods used in the examination of solvents. The text can be divided into four sections: sampling and general physical and chemical methods; physiological effects of solvents and vapours; methods for the analysis of solvent mixtures; and the testing and determination of solvents in specific groups.

The general methods are comprehensive and include details of the determinations of specific gravity, viscosity, flash point, boiling range, acidity and iodine value, to name a few at random. The authors have drawn the description of the testing equipment and many details of experimental methods from current American specifications, and not all the tests described can be applied to meet specifications accepted in Great Britain. The section dealing with the determination of pH is perhaps unnecessarily sketchy and curtailed, and this criticism can be applied to most of the physico-chemical methods described in later chapters—polarographic methods, for example, being dismissed in one page.

The chapters dealing with the analysis of solvent mixtures cover both the chemical examination of the liquid solvents and the absorption and examination of solvent vapours. Several schemes are given for chemical identification, and a section on the determination of functional groups is included. One feels that ultra-violet and infra-red spectroscopic methods should merit inclusion in this section, since both can be very useful tools in the analysis of mixtures.

The remaining two-thirds of the book is occupied by detailed analytical procedures for specific groups of solvents. Included are aliphatic, aromatic and cyclic hydrocarbons, alcohols and polyhydroxy compounds, esters, acids, aldehydes and ketones, and solvents containing nitrogen and sulphur. Methods suitable to the general group of solvents, again mainly drawn from specifications, and detailed procedures for the determination of individual solvents are described. The use of trade names for reagents is sometimes confusing, and a mistake appears in the tests for acetic anhydride and formic acid. The general layout and binding are excellent, and the contents list and index satisfactory. References in the text are numerous, and an additional list of selected references is to be found at the end of each chapter.

The book is a most valuable addition to the library of all analytical chemists, and all concerned with the varnish and lacquer industries will find it particularly useful as a book of reference.

C. Whalley

WHAT IS KNOWN ABOUT SLEEP

Sleep

How to Get More of It. By Chapman Pincher. Pp. 120. (London: "Daily Express", 1954.) 5s.

THIS little volume will probably be added to the 3,500 titles currently listed in "How-to-Do-It Books: A Selected Guide"—books that are intended to instruct the reader in "how to do, be, become, make, or cope with something". However, in this sense, the title of Mr. Pincher's book is misleading, as it contains nothing to suggest that *more* sleep is desirable, or how to get it. Quite to the contrary, there is a chapter on "How to Stay Awake".

The eighty-odd pages of text, divided into seventeen chapters, each preceded by an appropriate humorous drawing, represent a fairly accurate digest of findings in research laboratories and hospitals, culled from "day-to-day study of technical reports from many countries". Interspersed historical and contemporary anecdotes pertaining to sleep, as well as accounts of the author's own varied experiences, in war and peace, serve to enliven an otherwise dry recital of scientific and medical discoveries. Mr. Pincher's interpretations of the latter are, unfortunately, not altogether free from contradiction an one-sidedness. Thus, in Chap. 1 ("Settling Down t Sleep"), he chooses to "plump for the side-lyin posture put forward recently as most satisfactory b Dr. James McDonnell, a London physician", usin three drawings to illustrate the one proper and tw faulty positions. Nevertheless, he admits, in the sam chapter, that "no matter what posture you adop for going to sleep however you are certain t change your position many times during the night' Evidently it makes little difference whether on goes to sleep in one position or another. Yet M Pincher states that when he directed attention t Dr. McDonnell's recommendation in a newspape several readers wrote to him "gratefully because th information had brought them more restful slee than they had enjoyed for years".

The author rightly rejects the old 'anæmia theory of sleep; but, on the basis of a reported lowerin of the degree of oxygen saturation of hæmoglobi surmises that "the brain as well as the rest of th body is subjected to some degree of oxygen starvatio during sleep" (p. 25). He further declares that "ther is no doubt that the blood-supply to the brain considerably reduced during sleep" (p. 41). As matter of fact, the brain consumes just as muc oxygen during sleep as in wakefulness (about 3·5 ml 100 gm./min.), and, as to blood flow, it is actuall *increased* some 10 per cent (from 59 to 65 ml./10 gm./min.) in sleep, due to the dilatation of th cerebral blood-vessels.

Mr. Pincher abandons his role of mere interpret of technical reports when, in Chap. 11, he propound a theory of antidromic conduction from the visu area of the cerebral cortex back to the retina as a explanation of hallucinations. That a *psychologic* projection from the brain to the visual field is involve in normal vision of real objects was convincingl demonstrated by Christoph Scheiner in 1614. hallucination, therefore, or seeing things that are n actually there, can result from cortical stimulatio (chemical, electrical, or other) that originates locall instead of in the outside world, via a retinal imag It should be admitted, however, that the gener reader will not comprehend, and so will not b harmed by, the author's excursions into the realm oxygen starvation or theory of hallucinations.

The book also deals with the physiology of wakefu ness and the diurnal variation in alertness. Many reader will rid himself of a guilt complex on learnin that Mr. Pincher found what he "had been seekin for thirty years—a medical reason for getting up lat in the morning and going to bed late at night" (p. 32 Other topics touched upon are: dreaming, snorin insomnia, sleep in animals and babies. Concernin the latter, it is not true that new-born babies slee "most of the twenty-four hours", and that sleep reduced to eighteen hours at three months and seventeen hours at six months (p. 101). Recentl published figures show that the average baby slee only about fifteen hours at birth and less than fou teen hours at the age of six months.

Summing up: when he is not venturing beyon his eruditional depth, Mr. Pincher does an excelle job of popularizing science. Disregarding th 'howtoism' of its title, and considering the univers interest in the subject-matter, the book will be foun both instructive and entertaining. It can be recon mended to the non-scientific reader as one of th better written accounts of the nature of sleep ar wakefulness.

N. Kleitman

RICE SUBSTITUTES

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DURING the past few decades, there has been a steady deterioration in the overall food position f many of the east and south-east Asian countries. The total production, chiefly of food-grains, has undoubtedly increased; but the demand from the apidly growing population has increased to a greater xtent. As the result of this, countries like India have steadily changed from the position of exporters o that of importers of food-grains. The population of India has been increasing at an average of 1·35 per cent[1] a year and that corresponds to about 4·5 million a year, at the present time, with the prospect f increasing to a higher figure in the years to come. A large section of the population are rice-eaters, and s this grain is in great demand, the prices have been steadily rising, though, during 1953, owing to an xceptionally favourable season throughout the region, the export price from surplus countries like Burma came down from about £80 to about £60 per on. It may be reasonably expected that the price will tend to rise again. Unless the consumers change to other types of food-grains, there may even be a ice famine in the years to come.

As a bulk food material, rice has certain unique properties, which are not shared by other food-grains. It has a neutral taste and flavour and can be consumed as a savoury or a sweet dish. It is easily cooked and digested. Having become accusomed to such a soft and almost fibreless grain, the average rice-eater will not readily change over to any other food material which does not possess imilar properties. In fact, attempts made in India to popularize wheat, jowar or maize among rice-eaters have not been successful. Provision of a substitute for rice has therefore become one of the major food problems not only for India but also for he whole Asian rice region, which holds more than half the population of the world.

Processing of Grains and Tubers

One of the earlier attempts in the field was that of Bhatnagar, who carried out investigations on the reconstitution of broken rice, as obtained during milling, into whole rice. During recent years, attempts have been made to process other grains so as to give them the shape and cooking quality of rice. Thus, wheat, barley and maize have been processed, and some brands like 'Ryoena', 'Barley-rice' and Nor-ice' are already on the market. During the war years, wheat semolina was processed to produce different brands of 'mock rice'. Potato rice is still being produced in Holland. Such rice substitutes require the appropriate starting materials, which are not themselves being produced in sufficient quantities n the south-east Asian countries. If the deficit countries are to meet their own requirements, alternative sources, which can be plentifully and cheaply produced in the same region, will have to be found.

Processing of Blends

Since 1949, the Central Food Technological Research Institute, Mysore, has been engaged on the study of the possible utilization of cheap and abundant food materials which are naturally rich in starch and protein, so as to obtain, by suitable blending, a composition and nutritive value approximating to that of rice. After trying hundreds of such blends, it was found that a combination of tapioca (*Manihot utilissima*) and groundnut flours would make a cheap and satisfactory blend. *Manihot* grows well on even comparatively poor soils, and the yield of root, on a dry basis, is at least 3–4 times as much per acre as in the form of any food-grain. When both the outer skin and the inner rind are removed, the residue, on drying, yields an attractive white flour which, though mostly starchy, still contains useful quantities of minerals, especially calcium. Goundnuts can be skinned after gentle roasting or other treatment. The oil can be mostly removed by the expeller or solvent extraction. The residue yields a pale yellow, attractive flour containing about eight times as much protein as milled rice. If the groundnut kernels are carefully selected, the flour keeps well for several months. Both tapioca and groundnut flours, between them, contain more of the essential minerals and vitamins than natural rice. By combining tapioca and groundnut flours in the proportion 85 : 15, a product with an overall nutritive value which was somewhat higher than that of rice was obtained.

The technological aspects of converting such a blend into a grain like rice offered the maximum difficulty. Like other root starches, tapioca starch tends to cook to a translucent and sticky mass. Groundnut protein, especially as present in the flour, has no binding power. It was found, however, that on treatment with 40–50 per cent by weight of boiling water, the starch in the mixture (chiefly that of tapioca) becomes sufficiently gelatinized to yield a satisfactory dough. The dough could be extruded under pressure; but as the resulting product did not possess good cooking properties, further improvements in the composition had to be made. It was found that the addition of 1·5 per cent of karaya gum (*Sterculia urens* Roxb.) improved the quality of the dough and generally the body of the cooked product. Further improvement was introduced by the addition of 1 per cent alkali-digested corn cob. This material tended to harden the grain. Addition of 0·3 per cent of stearic acid made the grain somewhat opalescent and improved its individuality. The colour of the finished product was distinctly improved by the incorporation of 0·04 per cent alkali bisulphite. All the above-mentioned products may be added together as a mixture at the time of the preparation of the dough. The resulting grain, as obtained through an extruding press fitted with the rice die, was quite attractive and comparable in appearance with that of certain brands of natural rice. The product required, however, certain further improvements so as to make it acceptable to the consumers.

In India, as also in most other parts of Asia, the average housewife washes the rice before cooking because the usual bazaar product contains much dust and dirt. Like the usual macaroni products, the extruded grain as prepared above tended to break

Table 1. COMPARATIVE CHEMICAL COMPOSITION (PER CENT) OF SOME OF THE RICE SUBSTITUTES AS COMPARED WITH THAT OF NATURAL RIC

	Natural rice[a]	'Ryoena'[b]	Mock rice[c]	Pearled barley[b] (barley rice)	Japanese 'synthetic rice'[d]		Mysore (Indian) 'synthetic rice'
					A	*B*	
Moisture	13·0	8·2	14·0	10·08	14·0	14·0	9·5
Protein (N × 6·25)	6·0	10·7	10·7	9·85	3·7	7·0	14·2
Fat	0·4	1·6	1·8	1·88	0·3	0·5	1·9
Carbohydrates	79·2*	69·3†	77·5	69·0†	81·1*	77·4*	71·7
Fibre	—	—	—	—	0·3	0·4	0·7
Ash	0·5	1·22	—	1·35	0·6	0·7	2·0
Calcium (as Ca)	0·01	0·05	0·018	0·036	—	—	0·19
Phosphorus (as P)	0·11	0·24	0·114	0·20	—	—	0·15
Thiamine (mgm.)	0·06	0·19	—	0·02	—	—	0·22
Calorific value per 100 gm.	348	343	352	340	344	343	361

[a] Health Bulletin No. 23 (Govt. of India, 1951).
[b] From pamphlet issued by Ryoena Food Products Pty., Ltd., Melbourne.
[c] Same as semolina (M.R.C. Report, Series No. 235, 1946), "Chemical Composition of Foods" (H.M.S.O., London).
[d] *Rice Journal*, 57, 20–22 (February 1954) (synthetic rice *A* is made up of potato starch 50%, wheat flour 40%, rice flour 10%; and syntheti rice *B* of potato starch 20%, wheat flour 70% and rice flour 10%).

* Calculated by difference. † As starch. — Indicates figures not available.

up on being washed and rubbed with cold water. On cooking, it was found that there was heavy gruel loss which, again, would not be acceptable to consumers. The cooked grain was also a little too soft to the bite. It was necessary, therefore, to introduce further improvements in the processing. It was found that, on heating to a temperature of 110–120° C. for even a few minutes, the starch of the blend, and particularly that of tapioca, changed in character and that the individuality of the cooked grains was fairly well preserved. Gruel loss was also reduced to a minimum. Further improvement was effected by spraying a thin coat of calcium caseinate (calcium oxide : casein = 1 : 20) on the finished grain. Even a thin coat corresponding to 3–4 per cent by weight made the grains fairly resistant to water. They could be washed and rubbed under water for 4–5 min. without any appreciable loss. The coat also improved the cooking quality, and the cooked grain had a feel and taste corresponding to that of slightly parboiled rice. It was also found that incorporation of wheat flour to the extent of 20 per cent greatly improved the quality of the dough and the finished grain. In fact, the use of chemical improvers can be largely dispensed with if some wheat flour can be incorporated in the mixture.

Factory Trials

With the above as the background, factory trials were carried out in the United Kingdom and later in Switzerland. Messrs. Buhler Brothers, of Uzwil, took a keen interest in the effort, and fabricated the necessary additional equipment for large-scale processing. The procedure which was finally followed consisted in feeding the flour blend through the conveyor and then running boiling water in a steady stream into the mixing and kneading tank. The resulting dough was then drawn into the extruding press, where it was forced under pressure through a rice die provided with the usual mechanical cutter. The grain which came out, in a steady stream, was then subjected to a preliminary, and then a final, drying. As the grain does not crack on heating, it was found that the temperature could be readily raised to about 120° C., so that the drying could be speeded up. The same heating chamber also served to condition the grain so that both the operations were combined in one. In semi-large-scale operation, heating for about 2 hr. at 120° C., combined with air circulation, serve to dry the grain and at the same time to condition it. The finished grain thus obtained was subjected to spraying with a thin suspension of calcium caseinate, steamed and the dried in a blast of hot air. This helped to dry off th coat almost as quickly as it was formed and thu discouraged the tendency to form lumps. Mechanica agitation during spraying was necessary.

Properties and Nutritive Value

The finished grain, thus obtained, has the appearance of slightly undermilled rice. It is best cooke by being dropped into boiling water, and the cookin time is 5–6 min. as compared with about 20 min required by raw, milled rice. The cooked produc has the taste corresponding to that of certain brand of rice, as sold in the Indian market. Consume trials have shown that the product is acceptable t rice-eaters.

Animal experiments with the product showed tha the overall growth-promoting value is more tha twice that of a good variety of rice. The produc has been given the name 'synthetic rice', in keepin with the name 'synthetic diet' which is used b nutrition workers for blended diets composed of th various food ingredients.

The raw materials, including all the accessorie would cost the equivalent of about Rs. 350 per ton The entire processing cost, including labour, supervision and depreciation, would amount to Rs. 50–6 per ton. In the early stages, the cost would naturall be high; but with the continued working and on big scale, it would eventually come down. Allowin for incidentals, the product can be marketed at abou Rs. 500 (less than £40 or 100 dollars) per ton. Eve at this price, it would be distinctly cheaper tha rice. With further experience, and on continue large-scale production, the cost can be furthe reduced.

The potentialities of such a product can be easil envisaged. With a given area of land, and wit much less attention, we can obtain 3–4 times a much of the starting materials as can be obtained i the form of any food-grain. This will be of grea advantage to the densely peopled countries, wit heavy pressure on land. The second, and a mor important, feature is the nutritive value. The product as prepared by the Mysore workers, has about twic the nutritive value of rice; but it can be stepped u to a still higher level if so desired. Considering th low level of nutrition in most of the tropical countrie and especially in the rice-eating region, there is very strong case for using synthetic rice either b itself or as a supplement in the dietary of th people.

Japanese Production

The researches conducted at Mysore have been published[1-10] in the form of short notes and papers which have appeared during the past three years. Numerous popular articles and pamphlets have also been published. During 1952, the Japanese manufacturers, who have also been keen on the search for rice substitutes, started production, using blends of potato starch, wheat flour and rice flour for their composition. The underlying principles are practically the same as those of the process adopted by the Mysore workers. The Japanese have also adopted the same English name, 'synthetic rice', for their product, and the Japanese name is 'zin-zomai'. It should be said to the credit of the Japanese that they were quick in taking up the manufacture. During 1952–53, the reported production is stated to have been about 100,000 tons. The price of the Japanese product appears to be fairly high; but there is no doubt that it will eventually be reduced. Further improvement in nutritive value is needed, and this can be achieved by adding a concentrated proteinaceous material along the lines indicated by the Mysore workers.

The relative chemical compositions of some of the rice substitutes as compared with natural rice is given in Table 1.

Outlook for the Future

Judging from the present trends, there is every indication that the rice production in the east and south-east Asian countries will not be able to cope with the increasing demands of the fast-growing population. A product like synthetic rice is bound to find a growing demand, and in the course of the next few years we may reasonably expect to see the production rise to a few million tons per annum. With further improvements in the composition and the technology of processing, better and cheaper grains could be produced. The nutritive values of the products can also be maintained at a distinctly higher level than that of natural rice.

There are already a number of rice substitutes on the world's market. They are made from different raw materials and they have varied compositions. Most of them are being marketed under proprietary names and selling on their own merits. It is expected that, in course of time, several more such products will be marketed. It will soon be necessary to discuss the composition of such products and to lay down specifications on an international basis; the Food and Agriculture Organization can usefully take the initiative in this direction.

There are three broad lines of food production. The first one is that of increasing the production from land, water and other sources. Improved methods can easily raise the world's production by 25 or even 50 per cent, though it will be extremely difficult to ensure a uniform application of such methods all over the world. The second method is that of converting the vast and abundant sources of second-grade food materials, by suitable blending, into first-class articles of food. Production of synthetic rice will come in this category. Products like sugar from cellulose, food yeast, food-stuffs from seaweeds and other algae will also come in the same category. The possibilities in this direction are very considerable. The third method, which is still a dream of chemists, is that of synthesis from elementary materials. Unlike the fixation of nitrogen, the fixation of atmospheric carbon dioxide is going to be rather difficult because of the low concentration of this gas in the atmosphere. For a long time to come, the world may have to depend on the processing of coarse and low-grade food materials, which are fortunately still abundant, and their conversion into first-grade articles of food. Production of synthetic rice is a beginning in this direction; but bigger and more important developments are bound to follow in the years to come.

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[10] Subrahmanyan, V., Kuppuswamy, S., Rama Rao, G., Swaminathan, M., and Bhatia, D. S., *ibid.* (in the press).

RHEOLOGY IN MECHANICAL ENGINEERING

RHEOLOGY is regarded by some as a specialized activity concerned with the description of the response to mechanical stress of those categories of matter the behaviour of which cannot, even approximately, be described as Newtonian flow or Hookean deformation. Others view the subject more broadly as that branch of the science of applied mechanics which is concerned with the deformation and flow of matter generally. The membership of the British Society of Rheology embraces both those who specialize in the subject and those chemists, physicists and engineers, mainly engaged in applied science, whose work involves a knowledge of deformation or flow of matter and who find in the Society common ground for the development of this interest. It is to these latter that the recent conference of the Society held at the Mechanical Engineering Research Laboratory (Department of Scientific and Industrial Research), East Kilbride, during June 10–12 will have had the most appeal.

This Laboratory, which has assumed responsibility for a large part of the research formerly pursued in the Engineering Division of the National Physical Laboratory, is organized in seven divisions as follows: properties and strength of materials; mechanics of solids, stress analysis and vibration; mechanics of fluids, including hydraulic machinery; lubrication, wear and corrosion; mechanisms and engineering metrology; mechanics of formation and machine shaping of materials; heat transfer and applied thermodynamics. It will be apparent from this list of activities that the deformation and flow of matter enters very much into the work of the Laboratory, and the opportunity afforded to participants to inspect work in progress was a valuable feature of the conference.

In view of the importance of metals as materials of construction for machinery, it is not surprising that the predominant interest in the conference was the flow of metals. Thus the first paper, by Dr. J. F. W. Bishop (East Kilbride), was on the relationship of certain properties of metals to their crystal structure. Phenomena associated with metals were divided into three classes—macroscopic, microscopic and atomic—and the relevance of investigations at one of these levels to phenomena associated with a different level was discussed. Dr. Bishop summarized the salient features of three types of lattice structure commonly occurring in metal crystals and described their mechanism of deformation, stressing those structures which are able to accommodate an arbitrary strain by relative sliding of atomic planes. Applications of the Bishop–Hill theory of crystal distortion as generalized for aggregates were described and discussed in relation to experimental evidence.

Mr. H. Ll. D. Pugh (East Kilbride), in his paper on current problems and experiments on time-independent plastic deformation, dealt with the fundamental plastic properties of materials, such as yielding under combined stress, hardening and the effects of hydrostatic pressure. In the absence of a general solution of the equations governing plastic flow, their simplification for the special cases of plane stress and plane strain is necessary to enable certain engineering problems to be attacked. Strip drawing, extrusion and certain machining operations resolve themselves into steady-state problems, while indentation becomes a yield stress problem. Theoretical and experimental results were compared for extrusion and for indentation with flat smooth rigid dies.

Mr. F. Ellis and Prof. H. Ford (Imperial College of Science and Technology, London) discussed strip rolling as a steady-state process. An approximate theory was outlined by Prof. Ford, who described subsidiary experiments to determine the yield stress–strain characteristics of the strip material. Coefficient of friction between roll and work was estimated from rolling experiments in which varying amounts of back tension had been applied. Mr. Ellis described experiments wherein the data required to plot the slip-line field were obtained from the measured distortion of a network of lines engraved on a surface lying in the plane of flow. This technique was complicated in its application to rolling by forces in the plane of the sheet which would cause two unattached sheets placed side by side to separate. The difficulty was overcome by a specially developed method whereby the edges of two sheets could be welded together after the reference lines had been engraved on them.

In contradistinction to the two previous contributions, which were directed towards the elucidation of situations wherein it was desired to cause flow as part of a manufacturing process, that by Dr. A. E. Johnson (East Kilbride) on the behaviour of metals under complex stress at high temperatures was concerned with the small unintentional flow or creep of metals used for the construction of boilers, turbines, etc., that are required to operate at high temperatures. Where such parts are subject to combined stresses, designers have previously been obliged to rely on experimental data obtained from simple stress tests and adjusted by doubtfully valid theory. Dr. Johnson described a comprehensive research into the complex stress, creep, plastic strain and relaxation properties of some typical technical materials. At lower stresses the materials were shown to follow the St. Venant–Von Mises creep-rate relations and to remain isotropic; but at higher stresses the strained material becomes anisotropic, which necessitates modification of the equations.

Fatigue failure of metals may be regarded as rupture rather than a flow phenomenon, but some work sponsored by the Mechanical Engineering Research Laboratory and described by Mr. N. Wadsworth (University of Bristol), in a paper on observations of energy dissipation during high-speed fatigue tests revealed the occurrence of an increasing number of slip bands during the progress of a fatigue test During the early stages of a test, the rate of energy dissipation in the material fell to a low value and then increased until failure occurred. This increase was dependent on stress, and a strong correlation between this rate and fatigue life was revealed. Annealing at intervals during the test appeared to remove the effect of previous stressing on energy dissipation, but did not affect life. This threw doubt on the significance of the observed correlation, and Mr. Wadsworth concluded with the suggestion that the first irreversible change leading to the formation of cracks must have occurred very early in the fatigue test.

A more general approach to rheological problem was represented by a contribution from Dr. P Feltham (Standard Telecommunication Laboratories on the laws of stress relaxation and creep in solids Remarking on the qualitative similarity in the response of solids of widely different structures to applied stresses, particularly in creep and relaxation, Dr Feltham sought an explanation in the nature of flow itself rather than in the study of detailed atomic o molecular structure. A given solid can be assumed to possess 'relaxation centres' having approximately the same heat of activation but, on account of variations such as shape and size, having different configurational entropies of activation. Assuming norma distribution of relaxation times it is possible to derive a relaxation curve common to many solids. Experimental data selected from published work relating to aluminium, rubber, plastics and ceramics were shown to be in good agreement with the theory. Dr. Feltham regards Nutting's Law as approximating to more general laws over sufficiently wide ranges of the variables to be of practical use in the presentation o experimental data.

The fact that mechanical engineering science is by no means confined to the behaviour of solids was exemplified by a paper by Mr. E. J. Le Fevre (East Kilbride) which dealt with some developments in the theory of viscosity. The importance of the viscosity of gases in the study of the transfer of heat by convection is obvious; but availability of experimenta data covering this quantity over the range required is restricted, and discrimination is necessary in assessing its accuracy. Mr. Le Fevre showed how viscosity data relating to those fluids which satisfy the principle of corresponding states can be correlated in terms of reduced variables. It was shown that, with few exceptions, the viscosity of gases can be predicted within about 5 per cent from knowledge of the three critical constants. This result was considered relative to the kinetic theory and was shown to be deducible from combination of the Lennard-Jones and Devonshire theory of the critical state with the calculations of Kihara and Kotini. The Sutherland model was shown to be inconsistent with experiment

Many problems of fluid motion in the mechanical and chemical engineering industries are amenable to solution by models, and Mr. W. J. Robinson (East Kilbride), in his paper on some fluid-motion problems, exemplified useful applications of this technique at the Mechanical Engineering Research Laboratory. Advantages are offered by substitution in a model of gases for liquids or vice versa. The conflicting requirements of the laws of similitude complicate the design of experiments, and a plea was made for the publication of more experimental data to provide a basis for evolution of rules to govern the 'scaling-up' of model performance. Increases in the duty required to be undertaken by modern hydraulic machinery have caused a marked increase in the incidence of cavitation, and Mr. Robinson discussed the influence of the properties of the liquid itself and the presence of nuclei on cavity collapse and noise. Methods for estimating flow losses with non-Newtonian liquids require development. The pumping of raw peat and measurement of the flow of blood to and from the human heart provoked a lively discussion.

Lubrication has been defined as the reduction of friction and wear between rubbing surfaces by interpolation of substances which offer resistance to the normal forces pressing the surfaces into contact and yet are capable of being deformed easily in a tangential direction. It is obvious that the rheological properties of lubricants are of interest to engineers concerned with running machinery, and Dr. F. T. Barwell (East Kilbride), in a contribution on lubrication from the rheological point of view, outlined some of the considerations governing boundary and hydrodynamic lubrication. Further understanding of the mechanism of wear is dependent, among other things, on an understanding of the rheological behaviour of material in the surface regions of components suffering damage. Examples were given of those forms of wear known as abrasion, scuffing and pitting, and the potentialities of radioactive tracer methods for the study of wear were discussed.

THE ROYAL NETHERLANDS METEOROLOGICAL INSTITUTE (1854–1954)

THIS decade is one of centenaries in the meteorological world, for official meteorological activities started in many countries around 1850. The Royal Netherlands Meteorological Institute, now at De Bilt near the town of Utrecht, was established in 1854 and celebrated its centenary this year on January 31. As part of the celebrations, a substantial memorial volume has been prepared*, in which the history of the Institute is portrayed in word and image.

Meteorology in the Netherlands did not start in 1854; there are many signs of earlier activity in the form of long series of observations, admirably compiled by Labrijn. As everywhere else in the world, these observations were made at universities, or by organizations and persons especially interested in meteorology; and looking at the state of affairs in 1854, one should realize that the famous American naval officer, Maury, prior to that year, had already collected many meteorological observations from oceanic areas.

In the Netherlands it was important for the development of the subject that Buys Ballot, chemist, mineralogist, mathematician and physicist, became fascinated by meteorological problems, and that he, in his position as university professor, created an observatory in Utrecht. Late in 1853 Buys Ballot convinced the Government that "there was a future in the establishment of a Meteorological Institute" and early in 1854 his observatory was converted into the Koninklijk Nederlands Meteorologisch Instituut. Buys Ballot was the first director of the Institute and aimed very high. Translated freely, his programme was formulated by the words: "As a result of the methods we have adopted—namely, to collect observations from some well-selected points abroad and to study the deviations from the normals at these points—the Institute pursues a higher object than any other existing institute. Day after day it deals with the most important questions in meteorology, the solution of which was already some years ago vaguely indicated by Dove for monthly periods. Utrecht will become the central observatory for Europe. Already nowadays the weather and its changes over the greater part of Western Europe are being closely followed and studied".

The early period of Buys Ballot's directorship was one of great activity. It was the time of Dove in Germany, Espy in the United States, FitzRoy in Britain and LeVerrier in France. It was also the time in which meteorologists suddenly became aware that weather forecasting might develop into a reality as a result of the invention of the electric telegraph. Great discoveries were made: Buys Ballot announced one of them in the form of four propositions during a meeting of the Netherlands Academy of Sciences (October 3, 1857), and it was on the basis of these four propositions that later on the famous wind law of Buys Ballot was formulated. Weather maps, though rather primitive, were drawn by Buys Ballot on a routine basis, and a gale warning service was established in 1864. Internationally minded as he was, Buys Ballot copied the system of signals already in use in Britain; but when the British service was discontinued in 1866, he felt free to develop the 'aëroclinoscope', a new design to indicate forthcoming gales to sailors. The aëroclinoscope was a signal post, which showed the direction and value of the pressure gradient over the Netherlands. Its indications had therefore to be interpreted by the users, who had to have a thorough idea of Buys Ballot's law. This might be one of the reasons why the Dutch merchant marine became so early thoroughly interested in meteorology and assisted the Institute in building up an enormous amount of material, gathered from almost every ocean.

It is worth noting that Buys Ballot needed continuous registration of the pressure values at several stations in order to be able to follow the gradients closely. The first electric telerecorders, precursors of our radiosondes, were then developed and for some time serious efforts were made to record at Utrecht the pressure values at Flushing during the night hours. The technical difficulties appeared to be very great, and finally the efforts were given up. It is still, however, customary in the Dutch synoptic service to compute the pressure gradient in various triangles over the Netherlands on an hourly routine basis.

Buys Ballot needed uniform observations for the successful realization of his programme. The well-known international congress in Brussels (1853), which was initiated by Maury, created a certain uniformity in maritime meteorology; over land, however, observations were made at different times, with different instruments in varying exposure. The difficulties resulting from the lack of generally accepted rules inspired Buys Ballot to write a treatise entitled "Prière à tous ceux qui veulent bien de la météorologie" (1856). But it was only sixteen years later that Buys Ballot opened the first international meteorological congress at Leipzig and became the first president of the International Meteorological Committee and the real father of international meteorology. Dutch meteorologists continued to play important parts in the international meteorological world; Van Everdingen guided the International Meteorological Organization during 1923–35, and Cannegieter was the first chief of the permanent secretariat of that Organization.

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* Koninklijk Nederlands Meteorologisch Instituut 1854–1954. Pp 460+74 figs.+4 coloured plates. ('s-Gravenhage: Staatsdrukkerij en Uitgeversbedrijf, 1954.)

The Institute lost its great leader in 1890, and with his decease an era of steady development came to an end. Meteorology entered, not only in the Netherlands but also elsewhere, a rather dull period which started with "the disappointment of the nineties". New horizons were opened around 1910, with the beginning of upper-air observations. Van Everdingen, director since 1905, started his activities as extra-ordinary professor at the University of Utrecht with a lecture entitled "The Third Dimension in Meteorology". A theodolite for recording the projections of pilot balloon-tracks was developed, kite ascents were made, and many Dutch meteorologists had licences as free-balloon pilots. Cannegieter was the first who experimented with aeroplanes as meteorograph-carriers, and the regularity of the Netherlands upper-air ascents became known all over the world. When a new field was opened with the introduction of the radiosonde, Cannegieter used the instrument on an expedition to the Azores, from where no upper-air information had previously been obtained, and also in Iceland during the second Polar Year.

When Van Everdingen took the reins, the Institute, which had moved from Utrecht to De Bilt in 1897, consisted already of five divisions. It was then, and still is, really a geophysical institute, the activities of which are not limited solely to meteorology. With the development of the geophysical sciences during the course of the past half-century, the divisions slightly changed their names, but there are still those of forecasting (now combined with aeronautical meteorology), climatology (now combined with agricultural meteorology), maritime meteorology (now combined with oceanography), seismology and magnetism (now also deeply involved in ionospheric research) and finally a general service division (administration, library, workshop and instrument development). Each division is headed by a director (a specialist in his own field), and in Van Everdingen's time the director in chief was still an all-round meteorologist.

Cannegieter guided the Institute through the unhappy period of the Second World War, when forecasting for the general public and for aeronautics was curtailed, and synoptic and aerological observations were totally stopped. In spite of all material and other difficulties, the war period provided some dividends, as the synoptic staff took part in an extensive magnetic survey of the Netherlands, thorough plans could be made for future development and serious scientific investigations improved the knowledge of the forecasters who were perforce idle during this period.

Thus came the post-war period, with its stormy development in the Institute's activities and the enlargement of its field of action. Cannegieter, who had already passed the retiring age, was succeeded by Vening Meinesz, a geophysicist of renown who had already long relations with the Institute, where, among others, his apparatus for gravity measurements at sea had been built. From 89 men (24 scientists) in 1945 the personnel jumped to 345 (73 scientists) in 1954. The greatest growth took place between 1945 and 1950. It was no longer feasible to house all the workers stationed at De Bilt in the old building. Offices were spread all over the village. The disadvantages of this involuntary decentralization were felt almost daily. Vening Meinesz's ambitions to bring the Institute again under one roof were, in spite of all difficulties, realized in 1953, when new wings to the old building came into use. The floor space of approximately 1,000 m.^{2} was increased to 3,500 m.^{2}, and, in addition, a plot of 2 hectares was joined to the gardens, sufficiently large for investigations in the field of agricultural meteorology and for the launching of radiosondes in spite of the fact that the aerologists are close neighbours of the ionospheric transmitter with its high antennæ.

Vening Meinesz found himself too much absorbed in administrative duties and returned to science again in 1951, at the moment when, according to his views, the staff was sufficiently large to deal with its practical and scientific tasks, and when his plans for the extension of the premises were accepted by the Government. He was succeeded by the present director, C. J. Warners, a former Secretary of State in the Netherlands East Indies.

The Royal Netherlands Meteorological Institute is an entity in the economic life of the Netherlands, not only because of its forecasts for the general public, agriculture and horticulture, fisheries, shipping and aviation, but also because of its activities in so many other fields. It has relations with agricultural research, through an active group of agricultural meteorologists. With those interested in the water balance of earth and atmosphere, it studies evaporation and related processes. A group of statistical workers has already solved many practical problems. The maritime meteorologists, up to now engaged in the construction of the atlases for mariners, have diverted their interests in a scientific direction. Oceanographers pay much attention to high tides and storm surges in the North Sea, but do not neglect other problems of a local nature. New ideas about microseisms have developed in the seismology division, and the telegraph authorities keep close contact with the workers in the fields of magnetism and ionospheric research. These are but a selection of the many topics in which the Institute is interested, all of which are faithfully recorded in the recent centenary volume.

W. Bleeker

OBITUARY

Mr. F. Morley Colebrook, O.B.E.

During his thirty-three years service on the scientific staff of the National Physical Laboratory, Mr. F. M. Colebrook, who died on June 21, played a major part in the development of the Radio Division from its birth as a section of the Electricity Division, and more recently became the head of the newly formed Electronics Section.

Colebrook was born in March 1893 and studied science at Birkbeck College, University of London. After service in the First World War, he continued his studies at the City and Guilds Engineering College, obtaining his A.C.G.I. and B.Sc.(London) and, after some research on high-frequency resistance, his diploma of the Imperial College (D.I.C.).

He joined the National Physical Laboratory in 1921 and soon demonstrated his flair for carrying out a combined theoretical and experimental investigation of various fundamental problems in the radio field. He soon made distinctive, and very practical, contributions to our knowledge of the characteristics of transmitting and receiving aerials, to the development of radio-frequency valve amplifiers, the technique of the precise measurement of current and field-strength at high frequencies and the definition and measurement of interference. He was responsible for the publication of several special reports of the Radio Research Board, outstanding among which is the one entitled "A Theoretical and Experimental Investigation of High Selectivity Tone-Corrected Receiving Circuits". This work, published in 1932, did much to clear the minds of those responsible for the allocation of frequencies for broadcasting and communication services, at a time when confusion of thought made the 'physical reality of sidebands' a subject of serious discussion among certain authorities. Many other papers were contributed to the *Journal of the Institution of Electrical Engineers*, and to the *Wireless Engineer*, of which periodical he later became a member of the editorial advisory board. He was the author of two books on "Alternating Currents and Transients" and "Basic Mathematics for Radio Students".

On technical committees, as in his laboratory work, Colebrook displayed that outstanding characteristic for starting a penetrating inquiry into matters which had often already been accepted by others, and so bringing to light sometimes a fallacy, and at other times a new and refreshing point of view. As a colleague, he was delightful to work with, and he could be relied upon to produce a novel, if sometimes idealistic, point of view on any new problem; he was always ready to be consulted. I was indeed sorry when, with the formation of the Radio Research Organization, Colebrook was destined to sever his formal association with radio matters and become the leader of the separate team formed at the National Physical Laboratory to develop, into a practical working machine, the mathematician's conception of an automatic electronic computor.

Apart from his work, Colebrook was a man of many tastes. He read voraciously and widely, he had a keen ear for music, and with the aid of a high-fidelity receiver of his own design and construction, he seemed to listen to and enjoy every worthwhile musical broadcasting programme. He had a lively interest in amateur dramatics; he was a keen gardener, and, under the necessities of wartime, took a practical and utilitarian interest in the breeding of rabbits.

It is to be regretted that he was not spared to develop and enjoy these personal and unofficial activities, or even to be invested with the O.B.E., to which he was appointed in June last.

R. L. SMITH-ROSE

NEWS and VIEWS

Chemistry at the Imperial College of Science and Technology: Prof. H. V. A. Briscoe

AFTER an association with the Imperial College of Science and Technology extending, with one intermission, over a period of forty-eight years, Prof. H. V. A. Briscoe now relinquishes the directorship of the laboratories for inorganic and physical chemistry at the College, and retires from his chair of inorganic chemistry in the University of London. Entering the College as a student in 1906, he served after graduation as research assistant to the late Sir Edward Thorpe and afterwards was a member of the teaching staff of the Chemistry Department. In 1921 he was appointed to the chair of inorganic and physical chemistry in Armstrong College (now King's College) at Newcastle upon Tyne, in the University of Durham, succeeding the late Sir Norman Haworth four years later as head of the Chemistry Department. In 1932, however, he returned to the Imperial College to follow Prof. H. B. Baker in the chair of inorganic chemistry, and on the retirement, four years later, of Prof. J. C. Philip, assumed the direction of the laboratories for inorganic and physical chemistry.

Throughout an active academic career Prof. Briscoe has also devoted much attention to researches of industrial importance; he was one of the founders of the Northern Coke Research Committee and has served as president of the Research Association of British Paint, Colour and Varnish Manufacturers. He has also participated in a study of the part played by dangerous dusts in the causation of silicosis and similar maladies. In recent years, Prof. Briscoe has taken much interest in the organization of training for laboratory service, and is now chairman of the National Joint Committee on Recruitment and Training of Science Laboratory Technicians.

Prof. R. M. Barrer

THE chair of physical chemistry at the Imperial College of Science and Technology in the University of London, formerly occupied by the late Prof. J. C. Philip, has now been filled by the appointment of Prof. R. M. Barrer. A graduate of Canterbury University College, Christchurch, New Zealand, Prof. Barrer held an 1851 Exhibition Scholarship at Clare College, Cambridge, afterwards being appointed to a research fellowship. During 1939–46 he was head of the Chemistry Department at Bradford Technical College. In 1946 he left Bradford to take up an appointment as reader at Bedford College, University of London. Since 1949 he has occupied the chair of chemistry in the University of Aberdeen, where he has gathered around him an active school of research in physical chemistry, particularly in those branches of the subject concerned with adsorption, diffusion, and the physicochemical properties generally of permeable materials, especially zeolites.

Physiology at Queen Elizabeth College: Prof. J. A. C. Knox

DR. JOSEPH ALAN CRUDEN KNOX has been appointed to the chair of physiology tenable at Queen Elizabeth College (University of London) in succession to Prof. J. Yudkin, who has become professor of nutrition in the College. Prof. Knox was born in 1911 and was educated at Aberdeen Grammar School and Glasgow

High School. He studied medicine in the University of Glasgow and graduated M.B., Ch.B., in 1935 and M.D., with honours, in 1948. In 1936 he was appointed demonstrator in histology in the Department of Physiology at Glasgow; and in the same year became assistant to the professor of physiology, the late Prof. E. P. Cathcart. He became lecturer in physiology in 1940, and four years later was appointed to a similar post at King's College, University of London, where he became senior lecturer in 1948 and adviser of studies to the Medical Faculty in 1953. Prof. Knox has published work on the effect of exercise upon the heart-rate, based upon very accurate methods of counting. During the Second World War he worked with Dr. D. P. Cuthbertson on the effect of analeptics on fatigue. More recently, he has been interested in the electro-physiology of isolated muscle and its response to denervation. He has had very wide teaching experience both in Glasgow and in London.

Philosophy at the University College of North Staffordshire: Prof. A. G. N. Flew

Mr. Antony Garrard Newton Flew, lecturer in philosophy in King's College, University of Aberdeen, has been appointed to the chair of philosophy in the University College of North Staffordshire in succession to Prof. W. B. Gallie. Prof. Flew was educated at Kingswood School, Bath, and was State Scholar in Japanese at the School of Oriental and African Studies in 1942, afterwards being attached to the Air Ministry in the Intelligence Section. He went to Oxford in 1946, taking a first in Greats in 1947, and was awarded the John Locke Scholarship in Mental Philosophy in 1948. He was then appointed lecturer in Christ Church, Oxford, before going to King's College, Aberdeen, in 1950. Prof. Flew has a considerable interest in adult education and has conducted many courses for the Workers' Educational Association and Service groups as well as broadcasting. His main studies lie in the notions of personal identity, survival and immortality, which have led him to a philosophical consideration of psycho-analysis and psychic phenomena. An enthusiastic mountaineer, Prof. Flew takes to his new post at North Staffordshire an energy and zeal which augur well for the rapidly developing school of philosophy in the College.

Development of Canada during the Past Few Decades

Addressing the Parliamentary and Scientific Committee on June 3, Dr. C. J. Mackenzie, president of the Atomic Energy Control Board, Canada, reviewed the fundamental political and economic changes which science and technology have made in Canada since 1918. He thinks that there is a substantial basis for Canada's prospects and prosperity. Since 1939, the population of Canada has increased from eleven to fifteen million, while the net income has doubled and government expenditure and foreign trade increased four-fold. Only 14 per cent of Canada's capital now comes from outside. Referring to the development of the National Research Council, formed in 1916, Dr. Mackenzie said that in 1939 it employed three hundred people, and there was a large reserve of well-trained research scientists. After the Second World War the Council undertook military and atomic energy research and now has six thousand employees. In agricultural research Canada spends 25–30 million dollars a year, or more per capita than any country in the world; Canada is now, and will remain, an industrial nation of the first rank. In reply to a question, Dr. Mackenzie said that since 1939 the National Research Council has lost only one senior man, and he knows of none who has left to go to the United States since 1946. In general, Canada has a surplus of research scientists; but more people are going from Britain to Canada than are going from Canada to the United States. Attention may also be directed to the article on the conference on "Canada's To-morrow" on p. 212 of this issue.

Commonwealth Conference on Human Problems in Industry

At a recent meeting, at which H.R.H. The Duke of Edinburgh, patron of the Industrial Welfare Society, presided, it was decided that a Commonwealth and Empire Conference should be held in Britain (probably at Oxford) during July 1956. The purpose of the Conference will be to bring together representatives from the Commonwealth and Empire who would pool their knowledge and experience of the human problems of industry in their own countries. It is intended that the age of the delegates should normally be between twenty-five and forty. The Conference will deal with the human factors in industrialization as a whole: on one hand the personal factors of the health, satisfaction, effectiveness and well-being of those working in industry; on the other, the social problems arising from the effects of industrialization on the lives of individuals, their families and communities. There is no suggestion that there should be consideration and discussion of the formal relationships between employers and trade unions, covering wages, conciliation and arbitration machinery, etc. Committees are to be set up to explore various aspects of the Conference, and a small steering committee, under the chairmanship of Sir Harold Hartley, was appointed to co-ordinate the work of the other committees. Further particulars can be obtained from the Industrial Welfare Society, 48 Bryanston Square, London, W.1.

Division of Man-made Fibres, University of Leeds

From October 1955 the Department of Textile Industries of the University of Leeds will consist of two Divisions—the present Wool Division and a new Man-made Fibres Division. Good progress is being made with the new building for the Man-made Fibres Division, which is situated in University Road, opposite the present Department. The building will cost £267,000, towards which a donation of £60,000 has been made by Courtaulds, Ltd., and £40,000 by an anonymous donor. It consists of four floors, the first floor being the most important as this will contain the pilot plant for the production of all present-day types of man-made fibres, machines for processing various fibres, looms and knitting machinery. The ground floor will contain the dyeing, printing and finishing sections and also two humidity rooms. The second floor will consist mainly of two large teaching laboratories, and on the third floor will be two lecture rooms, capable of housing 84 and 150 people, respectively, as well as a well-lighted design studio. On each of the four floors there will also be a number of research laboratories. It is estimated that the equipment for the Division will cost about £100,000, part of which is being contributed by private industry. The donations include £5,000 from the Tootal Broadhurst Lee Company, Ltd., of Manchester, and £25,000 from the Man-made Fibres Producers' Committee, acting on behalf of the following producers: British Celanese, Ltd.; British Enka, Ltd.; British Nylon Spinners, Ltd.; Courtaulds, Ltd.; Harbens, Ltd.; Kirklees, Ltd.; Lansil, Ltd.; Lustrafil, Ltd.; Nelsons Silk, Ltd.; and North British Rayon, Ltd.

Very-high-frequency Broadcasting in Great Britain

THE first stage of the scheme by the B.B.C. to introduce sound broadcasting on very high frequencies, as envisaged in the second report of the Television Advisory Committee (see *Nature*, February 13, p. 297), has now received government approval, and work is proceeding in setting up the nine stations that will each send out the home, light and third programmes on frequencies in the range 88–95 Mc./s., using frequency-modulation. The stations will be in Wrotham (Kent), Pontop Pike (near Newcastle), Divis (Northern Ireland), Meldrum (near Aberdeen), Norwich, South Devon, Sutton Coldfield (near Birmingham), West Wales and Holme Moss (near Huddersfield), and will radiate 60 kW., except Wrotham, Norwich, Sutton Coldfield and Holme Moss, which will radiate 120 kW. The network is intended primarily to reinforce, and not supplant, the long-wave and medium-wave services already in existence and should make it possible to receive the three programmes free from interference in many areas where reception on medium wave-lengths is spoiled by interference and fading, especially after dark during the winter months. At Wrotham there are already two transmitters, which have been carrying an experimental service since 1950; a third transmitter will be installed, and the station will be brought into regular service in May next year. The other eight stations will be completed during the following eighteen months; they will be at the same sites as television stations, and the same masts will be used as for the television transmissions. The site for West Wales has not yet been settled. The radio industry in Britain is ready to produce receivers designed for very-high-frequency reception and adaptors for use with existing receivers, and these will become available in the various areas in time for the opening of the respective stations.

Scenes of Red Indian Life in the 1830's

DURING the 1830's, George Catlin, a self-trained artist, painted more than five hundred pictures of Red Indians and Western scenes in the United States, and the majority of these are now lodged in the Smithsonian Institution, Washington, D.C. Through the Information Section of the American Embassy in London, a selection of twenty-seven paintings are being shown in the Whitechapel Art Gallery, London, and this exhibition will continue until August 8 (admission free; daily 11 a.m.–6 p.m.; Sundays, 2–4 p.m.; closed Mondays). In conjunction with the Catlin paintings, there is also the Combined Societies Exhibition of International Photography, 1954. Catlin took great trouble over his work and was well aware of the importance of accuracy, so that his paintings are authoritative records of the life and appearance of Red Indians a hundred and twenty years ago. The paintings at the Whitechapel Art Gallery cover mainly his journeys in the Santa Fe–Fort Gibson area (lying within New Mexico, Texas and Oklahoma) during 1834 and in the Fort Clark–Fort Pierre area (lying within North and South Dakota) during 1832, and depict respectively Mandans and Sioux. Though perhaps the art is not of a first-rate order, the paintings (which are in oil on canvas) are nevertheless very pleasing by the great dignity of the sitters conveyed in the posed portraits, and by the free, lively, almost Impressionist, style of some of the landscapes and broad scenes of village life; the colours are agreeably subdued. It is interesting to note that, after touring the United States in 1838–39, the majority of Catlin's paintings were housed during the 1840's in London at his gallery in 6 Waterloo Place, and his account of his exploits were published in England in a two-volume work entitled "Letters and Notes on the Manners, Customs, and Conditions of the North American Indians" by Geo. Catlin, "Written during Eight Years' Travel amongst the Wildest Tribes of Indians in North America, in 1832, 33, 34, 35, 36, 37, 38, and 39"; a copy of the third edition of this work, dated 1842 and published by Tilt and Bogue, of Fleet Street, London, is on show at Whitechapel and contains four hundred line engravings which Catlin prepared from his original paintings.

Thirty-five Catlin paintings have been acquired by the Chicago Natural History Museum, and these are reproduced in a little book by George I. Quimby, curator at the Museum, entitled "Indians of the Western Frontier: Paintings of George Catlin". Red Indians in various kinds of costumes are depicted, and there is also an interior, a hunting scene and two or three drawings of bison.

Scientia Electrica: New Swiss Journal of Applied Electricity

IN the past thirty years the scientific principles used in electrical engineering have become more complicated and recondite, and the volume of scientific papers has correspondingly grown. In Great Britain the Institution of Electrical Engineers has found a place for all types of papers concerned with electrical science, except for a small number published by the Royal Society, Physical Society, Institute of Physics and elsewhere. The position is not so satisfactory abroad, and a new journal, *Scientia Electrica: Moderne Probleme der theoretischen und angewandten Elektrotechnik* (Band 1, Heft 1, October 1953, pp. 40, 4 Fr.; Heft 2, January 1954, pp. 42, 4 Fr.; Heft 3, June 1954, pp. 46, 4.80 Fr. Zurich: S. Hirzel Verlag), edited by Prof. Max Strutt, has been started in Switzerland to cover current advances and problems in the scientific aspects of the theory and practice of electric technology; the contents of the first three numbers are contributed from colloquia given at the Technical High School, Zurich, by leading experts. It is intended to publish submitted articles of suitable merit within the given terms of reference. The articles so far published contain reviews of recent progress together with some original work of the authors. The subjects chosen are both interesting and important, such as transistor amplifiers, fine transfer in contacts, corona loss in high-voltage transmission, absolute voltage measurement, new insulating materials, and backfires in mercury arc rectifiers. Presumably, submitted articles will often be of narrower scope and confined to original work. If so, those concerned in electrical science will certainly have to take note of this new journal. Even should the articles remain somewhat of a review type, the important work on applied electricity in Switzerland and the standing of the journal's sponsors are such as to ensure the standard and usefulness of its contents.

Staffing of Grammar Schools

In July 1953, a sub-committee of the North-West Division of the Incorporated Association of Headmasters instituted an inquiry into the qualifications, length of service, age distribution and extra remuneration of the teaching staff in the boys' and mixed grammar schools in the area covered by the counties of Lancashire and Cheshire. The inquiry was also concerned with the size of schools, the strength of sixth forms, and at a later stage the academic qualifications and ages of headmasters. The main intention of the survey was to throw light upon the known shortage of teachers in some subjects taught in grammar schools, to view the deployment of specialist and other teachers, and to study the way in which special responsibility allowances which supplement the basic Burnham Salary scales had been awarded. The survey was conducted by W. E. Egner of the Grammar School, Ormskirk, and A. Young of the University of Liverpool. Their report (pp. 20; from the University of Liverpool; 1954; 2*s*.) presents summarized details of the more interesting information elicited by the inquiry, special attention being paid to teachers of science and mathematics; the information analysed has been obtained from sixty-six grammar schools.

National Institute for Research in Dairying, Shinfield: Report for 1953

In the annual report of the National Institute for Research in Dairying of the University of Reading for 1953 (pp. 138 + 1 plate; from the Institute, Shinfield; 1954; 3*s*.) the policy of 1952 has again been adopted of presenting in outline a selection of the advances that have been accomplished during the year under review, particularly some of those with a more practical and obvious interest. This is a very useful measure and serves also to pin-point some of the highlights of research of this team of distinguished scientists. There is still the customary series of extended summaries of researches in progress (or recently completed), and these, together with notes on staff and their publications, constitute a closely packed volume of 138 pages. The director of the Institute, Prof. H. D. Kay, points out that in the selection of advances which have been summarized in brief the choice is of necessity arbitrary and omits reference to much of the work in progress. The product of a collaboration with Sir Charles Dodds and members of his staff at the Courtauld Institute of Biochemistry, London, has been the finding of two *iso*flavones with œstrogenic properties (but far less active, weight for weight, than the naturally occurring œstrogens synthesized by the animal), biochanin A and formononetin, which have been isolated in a pure form from red clover. They have approximately the same œstrogenic activity as the closely related genistein, which is believed to be responsible for much of the œstrogenic activity of subterranean clover. Many of the other advances are of very great interest and importance to the industry, and Prof. Kay and his colleagues are to be congratulated on this outstanding record of achievement.

Enzymic Decarboxylation of γ-Methyleneglutamic Acid by Plant Extracts

The enzymic decarboxylation of γ-methyleneglutamic acid by various plant extracts has been demonstrated by L. Fowden (*J. Exp. Bot.*, 5, 28; 1954). He has shown that γ-methyleneglutamic acid, an acidic amino-acid isolated from groundnut plants, was decarboxylated by enzymes present in extracts of *Capsicum* fruits, barley roots and tulip leaves, and also by intact cells of *Clostridium welchii* S.R. 12. The amino-acid was attacked in a similar manner to, but in all cases at a slower rate than, *l*-glutamic acid. The nature of the enzyme responsible for the decarboxylation of γ-methyleneglutamic acid was further investigated, using preparations from barley roots (which do not contain the amino-acid) and from tulip leaves (in which the amino-acid is normally present, together with larger amounts of its amide form, γ-methyleneglutamine). The effects of *p*H, inhibitors and partial heat denaturation upon the enzyme systems present in the barley and tulip extracts indicated that a single enzyme was responsible for the decarboxylation of both *l*-glutamic acid and γ-methyleneglutamic acid. Although the *Cl. welchii* rapidly deamidated and then decarboxylated *l*-glutamine, γ-methyleneglutamine was not attacked by the organism.

Bowen Prizes for Papers on Scientific Instrumentation

The Institute of Physics has awarded Bowen Prizes of fifteen guineas to the following for papers published in the *Journal of Scientific Instruments* during 1953: A. G. Milnes and T. V. Vernon (jointly), Royal Aircraft Establishment, Farnborough (saturable-core reference source for use with magnetic amplifiers); G. D. Dew, National Physical Laboratory, Teddington (preparation of plane diffraction grating replicas for helical rulings); and G. D. Archard, Research Laboratory, Associated Electrical Industries, Ltd., Aldermaston (magnetic electron lens aberrations due to mechanical defects). The Prizes are awarded to persons less than thirty-five years of age for papers of originality, scientific value and practical utility to instrument makers and users. The money is provided by the Scientific Instrument Manufacturers' Association of Great Britain, Ltd., from the Bowen Trust Fund established by the late Mr. William Bowen.

University Teachers: Conference in Vienna

The eighth Conference of University Teachers, organized by the International Association of University Professors and Lecturers, will be held in Vienna during September 9–14 at the University of Vienna and at the Vienna Hochschule für Welthandel, under the chairmanship of Prof. Francesco Vito, of Italy. The Conference will be open to all members of the Association and of its affiliated national associations of university teachers, to university administrative staff, and to others directly interested in matters of university education; university institutions in which there are, as yet, no sections of the Association are invited to send representatives of their teaching staff. The topics to be considered include the following: relations between scientific research in the universities and in industry; selection of students for university entrance (in particular, the systems and the extent of their assistance from public funds, bursaries, scholarships, etc.); conditions of employment of university teachers abroad, and the contractual obligations involved; main obstacles to the international exchange of university teachers; and methods of international co-operation in the university and scientific spheres. A registration fee of £1 will be charged. Further details can be obtained from the Secretary, IAUPL, 19 Dunraven Street, London, W.1.

Utilization of Fish and Agricultural Food Products

A CONFERENCE on new developments in the utilization as food of fish and agricultural products will be held in Aberdeen during September 30–October 2, under the auspices of the Society of Chemical Industry (Aberdeen Section and the Food and Agriculture Groups) and the Institute of Biology (Scottish Branch). The conference will be opened by Dr. F. N. Woodward, director of the Institute of Seaweed Research, and Dr. Norman Wright, scientific adviser to the Minister of Food, will give the closing address. Topics to be discussed are: the feeding values of oats, straw and oat-milling products; the vacuum dehydration of foodstuffs; freezing at sea; quality of sea-frozen cod; recent developments in fish by-products; supplements in the rations of livestock; distillery by-products, and their recovery and use as animal feeds; seaweeds and their constituents as foodstuffs; large-scale culture of microscopic algæ as food. There will be visits to the Ministry of Food Experimental Factory, the Torry Research Station and the Rowett Research Institute. A detailed programme and registration form will be available early in August from the Honorary Secretary (F. T. Walker), Institute of Biology, Scottish Branch, 25 Inverleith Gardens, Edinburgh 4.

University of London

THE title of professor emeritus in the University of London has been conferred upon the following on retiring from their respective chairs: Prof. H. V. A. Briscoe, inorganic chemistry at the Imperial College of Science and Technology; Prof. H. Munro Fox, zoology at Bedford College; Prof. Morris Ginsberg, sociology at the London School of Economics and Political Science; and Prof. Hyman Levy, mathematics at the Imperial College of Science and Technology. The following have been appointed to University readerships, tenable at the institutions indicated: Mr. D. G. MacRae, sociology at the London School of Economics and Political Science; Dr. R. G. White, bacteriology at the London Hospital Medical College; and Dr. J. H. Wilkinson, chemical pathology at Westminster Medical School.

The Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: L. W. Harwood and N. Lamont (agricultural officers, Fiji), senior agricultural officers, Fiji; R. J. M. Swynnerton (assistant director of agriculture (field services), Kenya), deputy director of agriculture, Kenya; R. P. St. John Watkin (chemist, Tanganyika), assistant government chemist, Nigeria; G. S. Brown (senior assistant conservator of forests, North Borneo), senior assistant conservator of forests, Federation of Malaya; W. B. Tevendale (geologist, Geological Survey Department, Gold Coast), senior geologist, Geological Survey Department, Gold Coast; D. A. R. Campbell, V. T. Domville and B. F. Topper (agricultural officers, Jamaica), senior agricultural officers, Jamaica; A. S. Martin (medical officer, Jamaica), assistant bacteriologist, Jamaica; R. Foster, scientific officer, Tanganyika; R. N. Gourlay, veterinary officer, Uganda; J. M. Ross, veterinary officer, Northern Rhodesia; R. N. Chrystal, forest entomologist, Cyprus; C. D. Cooke, veterinary officer, Nigeria; J. V. Thirgood, sylviculturist, Forestry Department, Cyprus.

The Night Sky in August

FULL moon occurs on August 14d. 11h. 03m., U.T., and new moon on August 28d. 10h. 21m. The following conjunctions with the moon take place: Aug. 2d. 18h., Venus 6° N.; Aug. 6d. 03h., Saturn 8° N.; Aug. 10d. 08h., Mars 3° S.; Aug. 25d. 01h., Jupiter 1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Pollux on Aug. 3d. 23h., Mercury 7° S., and also in conjunction with Uranus on Aug. 4d. 12h., being 0·6° S. of Uranus. On Aug. 31d. 01h., Venus is in conjunction with Spica and is 0·1° N. of the star. During the first part of the month Mercury is visible as a morning star, rising at 2h. 50m. and 4h. on August 1 and 15, respectively, and is in superior conjunction on August 21. Venus, an evening star, sets at 21h. 10m., 20h. 35m. and 19h. 50m. at the beginning, middle and end of the month, respectively; the visible portion of the illuminated disk varies from 0·655 to 0·523, and the stellar magnitude from −3·6 to −3·9. Mars sets very soon after midnight on August 1, and at 23h. 25m. and 22h. 45m. on August 15 and 31, respectively; but as its declination is about 28° S., it is not very favourably placed for observation in the British Isles. Jupiter is a morning star, rising at 2h. 25m., 1h. 45m. and 1h. on August 1, 15 and 31, respectively. It is easily identified (stellar magnitude −1·5), and its motion from west to east of δ Geminorum during the month is obvious. Saturn, an evening star, sets at 22h. 35m., 21h. 40m. and 20h. 40m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·9. Its slow easterly motion from κ Virginis is easily detected. The Perseid meteors attain a maximum about August 10–12, but bright moonlight will interfere with their observation. No occultations of stars brighter than magnitude 6 occur during August.

Announcements

THE University of Leeds has conferred the title of reader in physics on Dr. F. E. Hoare, senior lecturer in the Department of Physics; Mr. E. W. Bennett has been appointed lecturer in the Department of Civil Engineering of the University.

THE University of Cape Town is offering a scholarship of £200 a year tenable for three (or possibly four) years to a student from Great Britain proposing to take a degree course at the University, beginning in March 1955. Applications should be forwarded not later than August 15 to the Secretary of the Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

THE Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 a year is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted to the General Secretary, Chemical Society, Burlington House, Piccadilly, London, W.1, on the appropriate form not later than November 5.

THE third conference of the British Occupational Hygiene Society will be held at the London School of Hygiene and Tropical Medicine on November 1; it will be devoted to a discussion of radiation hazards in industry. Application forms for the conference can be obtained from the Hon. Secretary of the Society, Mr. P. C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne.

TECHNICAL COLLEGES AND INDUSTRY IN BRITAIN

THE papers presented at the Conference on Technical Colleges and Industry arranged by the Education Committee of the Federation of British Industries at Ashorne Hill on May 5–7 covered a wide field. They attempted to formulate industry's ideas as to what it expects of the technical colleges in Britain, and, on the part of the technical colleges, to present the perspective in which the colleges work and their relations to the universities and the schools as well as to industry itself. Such discussions flowed naturally on to the broadening of the technical college and its place and function in training for management.

So far as the Conference leaves any dominant impression, it is one of the complexity of the whole problem of technical education in Britain, and the futility of any attempt to improve its standard or expand the provision for technical education without taking full account of the educational system of the country as a whole from university-level downwards, and in co-operation with industry. The inadequacy of such piecemeal tactics as the Ministry of Education has hitherto followed was clearly displayed, by implication rather than by explicit condemnation. There was no attempt to formulate a definite policy at the Conference; but essential features of any effective policy were indicated, though at the same time the need for flexibility and variety was equally stressed. It was certainly made clear that many sections of industry are already fully prepared to co-operate and that there should be a generous and prompt response to a clear and bold lead.

Sir Arthur Smout (Murex, Ltd., and Murex Welding Processes, Ltd.), in some outspoken comments on the present position, urged afresh the establishment of a Technical College Grants Committee on a par with the University Grants Committee, which would enable the administration and finance of at least the major technical colleges to be taken out of local and party politics. He insisted, too, that we cannot expect to have an educational system worthy of a great nation on the cheap, and while it was evident that industry as represented at the Conference is likely to support generously a policy of expansion for technical education, such support presupposes a policy and a recognition by the Government that technical education is a sound investment. Moreover, while it seemed to be generally admitted that only a relatively few technical colleges could be expanded into major institutions under such a policy, the importance of the contribution to be made to technical education by the rest was equally recognized. Dr. P. F. R. Venables (principal, Royal Technical College, Salford) suggested that the term 'higher technological education' should be restricted to postgraduate education; and this suggestion might well help not only to remove confusion but also to eliminate the difficulty, real or imaginary, which is sometimes caused by status. Dr. Willis Jackson, indeed, expressed the opinion that the weakness of Great Britain relative to the United States is at the level of technique and not at the professional level, and that post-war discussions here have concentrated too much on the professional grade rather than on the technician.

Much that was said at the Conference served to clarify these interrelationships. Sir Arthur Smout, for example, pointed out that we must get away from the idea that all higher education must be of the university type, and he visualized the technical colleges as the appropriate means for training for industry young men who are ill-suited and ill-equipped for university life. Further, he believes that a main purpose of the 'sandwich system' is to encourage a good type of recruit to join smaller firms direct from a grammar or secondary school and obtain the appropriate technical training in a technical college while based on the works. Apart from thus integrating practical training in the factory with technological studies in the college, Sir Arthur sees great advantages in bringing the smaller firms into relationship with technical colleges in this way.

The importance of maintaining a variety of channels for technological training was emphasized by other speakers. Dr. Venables pointed out that the fulcrum of the definition of technology is in the scientific study, while with a craft it is in the exercise of a skill or technique. Fundamentally, a technology requires the student to undergo an exacting scientific discipline which confers mastery of the theoretical concepts required for widely differing ends. In his view the difference between technological education in the universities and in the technical colleges is simply one of the timing or phasing of the two main elements—the science and the art of the technology. In the universities, the phasing is preponderantly scientific, with the art phase introduced mainly as a pre-undergraduate year, as brief intermittent phases of vocational experience in industry, and a thorough postgraduate phase; but for most technical college students the phases are more interpenetrating or even concurrent or alternate as in 'sandwich courses'. While he believes there is an ample reserve of ability in Britain for training in technical colleges, it is on condition that such expansion of the technical colleges does not contemplate the raising of more than the minority of such colleges to provide largely technological, as distinct from technician or craft, education. We should preserve flexibility and also encourage transfer between courses and occupations, so that the best ability when found can be moved forward and upward.

Dr. Venables suggested that the main elements in our policy should be the development of 'sandwich courses' on a recognized national basis, a national standard of intake and a national length of courses. This would remove much of the present confusion and though he believes it is also desirable that more research should be carried out in the technical colleges, that depends on the recruitment of the appropriate staff and the establishment of conditions of service which will attract competent men. Dr. Willis Jackson (Metropolitan-Vickers Electrical Co., Ltd.) supported Dr. Venables in his general view as to the relative functions of the universities and the technical colleges; the latter, he suggested, should provide courses which are more technical and more related to industrial practice. Some university courses are already technical enough, and he would like to see the universities rather ensure a sounder foundation in pure science. Moreover, in view of the increasing interrelation of different branches of technology and their increasing mutual dependence on pure science, he believes they should be drawn together at a comparable level and in intimate association with pure science departments of high standing.

Dr. Jackson did not minimize the difficulty of any such attempt; but he also urged that the technical colleges rather than the universities should encourage the development of short-term specialist courses, whether full-time or evening, and the universities should concern themselves only with the scientific and analytical foundations of prospective technological development—with what industrial practice should be five or more years ahead rather than with what it is to-day. The technical colleges, moreover, can only make their full contribution in the teaching of current industrial practice if industry is willing to co-operate to the extent of making available the services of the appropriate senior members of its staff.

In opening the discussion on the broadening of technical education, Sir Reginald Vernon Smith (Bristol Aeroplane Co., Ltd.) pointed out that the responsibility once again rests with the schools and industry as well as with the technical colleges. So far as industry is concerned, the standard of selection adopted by industry for its recruits is an important factor, as is the pattern of training afterwards given. Technical education, moreover, is a continuing process and much can be done by the intelligent and liberal use of postgraduate courses, residential courses, interchange schemes, overseas travel fellowships and the like. On the part of the technical colleges, he suggested, like Dr. Venables, that emphasis should be placed more on the fundamentals or intellectual discipline of a technology than on the applications, and that technical subjects should be presented against a stimulating background of historical development and in relation to allied subjects. The latter suggestion found confirmation in Prof. Rex Knight's observations on the probable reaction of technical college students to the widening of their programme of studies. Prof. Knight (professor of psychology, University of Aberdeen) believes that any new subjects must be linked to subjects of which the vocational significance is clear; they must be seen by the student to be an integral part of the preparation for the job he is to do in industry. They must also, he thought, form part of the target the student has to hit, though not necessarily as subjects of examination. Prof. Knight also remarked that much of the widening of curriculum would have to be done in industry, and while he believes that in the technical colleges, even more than in the universities, there is great need for grading students according to their ability and educational achievements, to facilitate both the prosecution of their individual studies and the removal of specific defects in their educational equipment, he stressed finally that all such further education is dependent on effective co-operation between all concerned. He also endorsed Dr. Venables's remark as to the importance of social facilities, and the suggestion that the Federation of British Industries might press for greater proportionate facilities for technical college students.

Mr. H. A. Warren (principal, South-East London Technical College), who followed Sir Reginald Verdon Smith, from the point of view of the technical colleges went rather deeper into the implications of the broadening of technical education. It should be remembered, he pointed out, that this age is extremely preoccupied with technics, and we have above all to present technics or technology as a means to an end in terms of human values, not as an end in itself. If we fail to put power into the hands of the coming generation with a sense of purpose and of responsibility, we are in danger of being overwhelmed by an environment of our own making. Technical education, moreover, is wholly secular, and more regard should be paid to those fundamentals of the human spirit which limit and constrain technical education. With much of what Prof. Knight said he agreed; but he emphasized that the decisive factor is the outlook and capacity of the teacher, and here, he said, the Federation of British Industries can be of great assistance. The Federation can also make it widely known that industry desires and values this broadening of technical education.

Dealing specifically with management studies in the technical colleges, Mr. Bertram White (formerly technical director of the Federation of British Industries) said that the technical colleges have here a valuable but limited contribution to make. He too stressed the importance of the quality of the teaching and suggested that the Urwick Committee was over-optimistic in its estimate of the potential supply of men and women with appropriate experience willing to devote part of their time to the teaching of management. He believes that lectures on management are often delivered by teachers with no practical industrial experience; indeed, generally the business community lacks the faculty of coherent and articulated expression of its ideas. While much closer association with the professional associations is required, any further development of management studies should proceed by way of agreement. Much closer association between the technical colleges and local industry is required, particularly in teaching the various techniques through which management achieves its purposes. Besides this, technical colleges in their management studies should endeavour to teach background subjects: those aspects which are usually termed 'general management' subjects are best learned on the job under good supervision. Industry must train its own managers; the role of the technical colleges is supplementary. He advocated the abandonment of courses that are ineffective and cannot be improved and also, for the next decade, disregard of certificates and diplomas in management studies. The Federation of British Industries and the British Institute of Management should confer with the associations of technical institutes to ascertain those areas of the country in which more co-operation between industry and the technical colleges and greater awareness of the value of management training are required.

Mr. J. Wilson (principal, Birmingham College of Technology), who followed, agreed that most of the difficulties in education for management arise from over-enthusiasm and pressure for development started up by the Urwick Report. There has been some lack of consultation with industry; but the staffing position is the critical factor and limits the rate of progress. He also agreed that it is desirable to concentrate highly qualified staff in a few centres providing facilities for all levels of interest in industrial administration. The urgent need in the training of men for management is to bring into partnership all those bodies already concerned with it separately, from universities to trade unions, from technical colleges to professional associations, and from public to private enterprises.

CANADA'S TO-MORROW

THE Canadian Westinghouse Co., Ltd., believes that "business and industry can flourish only as the whole nation advances in the direction of the good life", and a few months ago expressed its appreciation of fifty years spent in Canada in a rather unusual way—by the sponsoring of a conference at Quebec for the study of the country's future. The papers read at the conference provided an excellent picture of Canada's past and present, and also gave some glimpse of the future. "A sober, calm, highly critical assessment" was the description of one of the guests, who remarked on the lack of that complacency which might so easily have resulted from the sudden up-surge in the country's fortunes. Canadians of the calibre of the eight conference speakers clearly have a very realistic grasp both of Canada's internal situation and of the part that her people must play in the troubled world of to-day.

Canada's resources are both human and natural. B. K. Sandwell discussed the people, whose numbers, he is convinced, could be greatly increased without adversely affecting the present high standard of living, so great are the country's resources and so vast the potential market for primary and secondary products, both within Canada and in the United States and elsewhere. The natural resources were discussed in a comprehensive stocktaking by Maxwell W. Mackenzie. He stressed in particular the suitability of the timber of the Canadian Shield for newsprint, the value of the mineral resources of the Shield and other areas, and the significance of the fact that hydro-electricity can easily be transmitted to the points where energy is required. He believes that the time has come for electricity, gas and oil to be distributed through a national network, since their part in Canada's future must be at least as great as has been the contribution of rail, road and water transport in the past. He also emphasized the importance of conservation practices and research programmes, especially for timber and cereals, which together accounted for 45 per cent of the value of Canada's exports in 1951. Food production, apart from wheat, should, he suggested, be based on probable domestic demand. The United States and other countries should still be permitted to purchase primary products such as timber, though at the same time Canada must press for the reduction of trade barriers, especially those which prevent the export of processed products such as plywood and composition boards. She must also be courageous in her attitude towards, and exploitation of, her extensive resources. He sees no justification for the hoarding of the nation's very considerable wealth of copper, lead, zinc, nickel, cobalt, tungsten, iron ore, titanium and other lesser known but important alloy metals, or for placing restrictions upon the export of primary products. The mining of the iron ore of Labrador and of lead and zinc at Pine Point on Great Slave Lake, for example, would undoubtedly result in the opening-up of vast new stretches of country.

These great resources, while providing Canadians with considerable material comfort and higher standards of living, also help to give rise to what R. K. Stratford, scientific adviser of Imperial Oil, Ltd., called "the greatest social challenge in history". Several of the papers dealt with the impact of economic development upon the social and political life of the community, through education, industry and government. It was recognized that "we refuse to give to our hearts and minds the thought and care that we lavish on our physical needs", and that far more attention is commonly directed to the problems of industry and resources than to the study of urban and rural social problems. One speaker pleaded for the expansion of university departments, whence might come "long, systematic studies of the human being under different environmental conditions". Another deplored the gap between the two main cultures, the French and the English, and advocated the erection of bridges across the cultural gulf: this, she believed, might be achieved by an increasing sense of the need, "not for a superficial and chatty bilingualism, but for a genuine mastery of the two languages". Realistic recognition was also given to the third great cultural force, that of Canada's neighbour, the United States. Faced with these various influences and traditions, there should be encouraged in Canadian schools "individual self-reliance in opinion, critical dissidence, intelligent non-conformity, the ability at least occasionally to stand aside and stand up for one's own individual beliefs".

The role of government, in economic and social affairs, has changed considerably during recent years. Government encouragement of economic activity, as in the building of communications and the fostering of settlement, has given way to private enterprise, and public authorities are now increasingly concerned with social security and short-term economic stability. Prof. Maurice Lamontagne, of Laval University, claimed that the Canada of the future needs neither capitalism nor socialism but a complementary relationship between private initiative and government action, with the Federal Government playing a dominant part in the collective effort to maintain economic equilibrium.

Prof. D. G. Creighton, professor of history in the University of Toronto, turned the thoughts of the conference to Canada's place in the world. The country has already established her independence within North America and a prominent place in the Commonwealth, and is rapidly securing for herself an acknowledged position in international affairs. She has, in his view, to accept a world in which Communism dominates the larger part of Asia, and must be prepared to abandon what he called "our complacent, parochial North Americanism". It is essential that Canada should give to the United Nations its steady support.

At the close of the conference Prof. D. W. Brogan, as "an outsider looking in", surveyed the wide range of papers and subjects discussed. He said he was impressed by the wealth of Canada's resources, but he saw "the basic source of Canadian prosperity in the character of the Canadians and of their civilization". Canada has shown the world that the highest potentialities of modern technology are attainable without violence, disorder, or cultural savagery. As population increases—as it should—by natural increase and by immigration, the specifically Canadian aspects of North American culture must be fostered and the double culture of Canada steadily fused. Each group must express its own vision of Canadian life, at the same time sharing that vision with its neighbour. Canada, Prof. Brogan reminded his listeners, "is the heir of the two great formative traditions of western Europe: it is her pride and opportunity to develop both".

Canada's to-morrow is bright and promising because Canadians are proud of her past and conscious of the opportunities of the present. Through the public spirit of a great concern—typical of many of the corporations of North America—and because of its confidence in the nation's future, more than three hundred representatives of Canada's commercial, industrial and cultural life were able to share in the thoughts and concerns of a few of their fellow-countrymen through this conference.

The papers form an invaluable commentary on Canadian thinking to-day, and on Canada's prospects to-morrow. Fortunately, the Canadian Westinghouse Co. has now published the papers in book form*, thus making available for a much wider audience the deliberations of this very balanced and comprehensive conference.

ROBERT W. STEEL

* Published by the Macmillan Co. of Canada, Ltd., 70 Bond Street' Toronto. 3.50 dollars.

THE SPORTS TURF RESEARCH INSTITUTE

SILVER JUBILEE

TO mark the silver jubilee of the Sports Turf Research Institute, a conference and open day were held at its headquarters, St. Ives Research Station, Bingley, Yorkshire, on July 1. A most satisfactory attendance, including representatives from sports clubs, sports associations, education authorities and municipalities throughout the British Isles, was presented with a very full day's programme in which major items were experiment plot demonstrations, educational exhibits, displays of modern machinery and the presentation of various papers on turf topics at intervals during the day.

The director of the Institute, Mr. R. B. Dawson, spoke about the developments of scientific turf management during the past twenty-five years, stressing particularly the big improvements in design and range of equipment that have taken place. He referred also to the growth of the experimental and other work of the Research Station. Mr. J. R. Escritt (soil chemist) discussed the relative importance of physical and chemical properties of soils for turf production, and Mr. J. Drew Smith (plant pathologist) dealt with turf diseases and his own work on fungicides. The fourth paper, given by Mr. G. Wright, a member of the Board of Management, described turf research work in progress at several research centres in the United States, emphasizing the big problems created in some parts by climatic factors adverse to good turf production.

The Institute (formerly known as the Board of Greenkeeping Research) has the stated aim of raising the general standard of sports turf. It is supported by subscriptions from numerous interested bodies, including sports clubs, golf clubs, industrial welfare clubs, sports associations, public authorities and education committees. Management of the Institute is in the hands of a Board of Management which includes representatives of the main sports controlling bodies, namely, the English Golf Union, Scottish Golf Union, Golfing Union of Ireland, Welsh Golfing Union, Football Association, Football League, Ltd., Lawn Tennis Association, Rugby Football Union, Rugby Football League and the English Bowling Association. The Board has available both scientific and practical advisory committees for consultation. In pursuance of its object, the Institute has a comprehensive research programme for investigating problems of general turf management, problems of individual management of turf for particular purposes and, of course, the control of weeds, pests and diseases. Extensive field trials running to many hundreds of plots are backed by useful laboratory facilities.

Field work at present in progress at the Research Station (and demonstrated on the open day) includes trials on height of cut, top-dressing materials, long-term fertilizer treatment, weed control, disease control, grass growth stunting and seeds mixtures. Although the main experimental ground bears a considerable number of trials, many experiments can only be carried out satisfactorily at outside centres; for example, at present a new series of simple trials on seeds mixtures for renovating football grounds is in progress. Turf diseases and their control are receiving particular attention at the moment, with attempts to produce cheaper and more efficient materials for controlling known turf diseases. It is interesting to note that this concentration on disease problems has revealed that one or two new diseases previously unrecognized occur quite frequently, and work is proceeding on methods of control.

Knowledge gained from the various trials is passed on through the advisory work of the Institute, through instructional courses for groundsmen, greenkeepers and other interested persons and also through lectures given by members of the staff at various centres throughout Great Britain. In addition, an annual *Journal* is produced and also brief quarterly *Bulletins*, both these publications being circulated to all affiliated members. The advisory services are being increasingly called upon, and more and more is being demanded of the staff concerned in this work.

The Institute was founded in 1929 by the golf clubs through the four national Unions; but the great expansion of activities, particularly since the Second World War, in various other directions, led to a reorganization and the formation of the Sports Turf Research Institute. The status of the organization as an independent non-profit-making scientific body was recognized by the granting of a licence from the Board of Trade in August 1951, thus permitting the Institute to be registered and to operate without the use of the word 'Limited' in its title. The former Board of Greenkeeping Research ceased to exist on September 3, 1951. It has become increasingly obvious that the Institute has an important part to play in the future as in the past. More and more its advice is called upon in the construction of new playing fields for all kinds of bodies. In particular, the educational programme of producing more new school playing fields demands a great deal of attention from the Research Station in order to enable the education authorities to produce fields of sufficient quality without unnecessary expenditure of public funds.

DEVELOPMENT AND UTILIZATION OF WATER RESOURCES

THE eighteenth session of the United Nations Economic and Social Council, which opened in Geneva on June 29, discussed among other items a report on the Development and Utilization of Water Resources*. This report was prepared as a result of earlier resolutions calling for information on the work being done by the specialized agencies and

* United Nations: Economic and Social Council. Report on the Development and Utilization of Water Resources. Pp. 20. (London United Nations—London Information Centre, 1954.)

other international organizations engaged in the broad field of water control and utilization.

The complex nature of the inter-relationship between the various factors which have an influence upon, or are in turn affected by, the availability of water is first stressed—the needs of agriculture, inland navigation, industrial and domestic demands, electric power and the like are considered in relation to techniques of conservation to prevent excessive run-off, soil erosion and flood damage. The report then directs particular attention to three aspects: the first need in any activities on water control is the organization of a continuous collection of hydrological data which must be available for a considerable stretch of years to be of any value; in this connexion the suspension of the United Kingdom Inland Water Survey (referred to in *Nature* of November 7, 1953, p. 823) is again seen to be a retrograde step.

Secondly, attention is directed to the topic of watershed management, as this is regarded as an important but neglected aspect of water conservation. It is claimed that effective control in these initial stages reduces the need for river-training works and downstream flow-control measures. It is suggested that there is a regrettable lack of understanding of watershed management, not only on the part of the general public but also among those who are responsible for the political and economic decisions which are often made on water supply. The need exists to build up a body of information on this subject and also to arrange for its dissemination, perhaps through Unesco. The third aspect selected for special attention is the use of water for industrial purposes. This is considered to be the largest single factor making for the increased demand for water which is being experienced in most countries of the world to-day. Some dramatic illustrations of the growth of this demand are given: in 1950 the industrial use of water in the United States was higher than the agricultural use, and the Paley Commission estimates that by 1975 industries will use two-thirds of all sweet water and that availability of water will be the main determining factor for industrial location. To produce a ton of steel now requires 65,000 gallons of water, and to refine a barrel of crude oil requires 18½ barrels of water; a ton of sulphate paper needs 64,000 gallons, while almost astronomical figures are required for thermal generating stations and atomic power stations.

To meet these and related problems of water pollution, the report considers the possibility of a more effective integration and co-ordination at various levels of the interested agencies and organizations. A strong case is made for the creation at national level in each country of a 'water board' representing all the interested government departments and local government bodies concerned with any of the numerous aspects of water conservation and utilization. This is a recommendation that might well receive careful consideration in the United Kingdom, although we are not alone in this lack of one central body: few countries have so far succeeded in co-ordinating their local activities on water development. Until this has been done, however, there seems little hope of efficient and successful co-ordination and co-operation at the regional and international level. Meanwhile, it is recommended that the United Nations Organization should encourage the holding of technical conferences and meetings of existing hydrological agencies. The United Nations Organization should also serve as a clearing house on water matters and perform such other functions as it may appropriately undertake in implementation of the Economic and Social Council's resolution on water control (Resolution 417, XIV).

W. G. V. BALCHIN

NETWORK ANALYSER OF THE ELECTRICAL RESEARCH ASSOCIATION

THE alternating current network analyser has now become established as an essential tool for the design, operation and study of electrical power systems. The direct representation of the electrical characteristics of the network components by variable calibrated elements with suitable sources of alternating current, flexible means of interconnexion and sensitive measuring equipment readily applied to any point on the network makes possible examination of a complicated network for power flow, transmission efficiency, stability and fault conditions with an ease and accuracy quite beyond the range of human computation, while permitting an experimental approach as yet impracticable with a digital computer. The same equipment can in principle be used in the study of any systems capable of representation by linear differential equations and certain non-linear problems within a range dependent on the versatility of the components and measuring equipment.

The network analyser constructed by the Electrical Research Association, the first completed section of which was exhibited to the technical and scientific press on April 28, has been designed for application to the widest possible range of problems. To this end the equipment can operate at any frequency from 160 c./s. to 16 kc./s., so that frequency can be a variable or one of the unknowns in a problem. The maximum accuracy is at the 'base' frequency of 1,592 c./s. ($\omega = 10^4$). This versatility is accompanied by the possibility of extension to a size not less than that of any existing analyser. The equipment is believed to be unique in providing steady-state, transient and harmonic solutions on the same installation.

The impedance elements, mounted in racks, are connected by twin cables to terminals on a 'plug board' and thence by pairs of flexible cords to plugs which can be inserted into sockets in an interconnecting board to form the nodes of a network. The potential drop across a 20 milliohm shunt in series with one of the flexible cords associated with each element, and the potential difference between any two nodes of the network may be connected by a selection system to the terminals of the central measuring equipment which indicates simultaneously current, voltage, load and reactive load at the selected points. Two independent selection systems, which can be cross-connected, make this measuring equipment extremely versatile. Monitoring and fault-finding indications are provided.

Physically small components used in the network elements yield an inexpensive and compact design with short interconnecting leads and thus increased frequency-range. Small components require a low power-level, to avoid thermal effects in resistors and non-linearity in inductors. The level adopted is 2·5 mW., 500 mV. and 5 mA. for the base (that is, 100 per cent) values, with a range up to 400 per cent n voltage and current. This means that only 100 μV. s available across a shunt for the measurement of current at 100 per cent level. At the same time a resolution and repeatability of 0·1 per cent of amplitude (and 0·1° of phase angle at amplitude levels greater than 10 per cent) has been aimed at, with an absolute accuracy of 1 per cent and 1° at the base frequency. Such stringent requirements call for a bridge method of measurement.

For voltage measurement a voltage derived from the network is compared in a transformer with an nternal reference signal. The latter is derived from a hree-phase master oscillator through a magslip phase hifter and a potentiometer amplitude adjustor. The same oscillator energizes the network through phase shifters and potentiometers in active units representing generators. The difference of the two signals is derived from the transformer and provides the input to a servo-system which adjusts the shafts of the eference phase shifter and potentiometer until the reference signal becomes equal in phase and magnitude to the unknown voltage and the error signal disappears. The phase and magnitude of the network voltage (referred to a phase of the master oscillator) are then indicated on dials ganged with the shafts of he reference phase shifter and potentiometer. The current bridge is identical except for a difference in the operating level.

The shafts of both bridges drive the elements of a small analogue computer, also servo-operated, which indicates the products $P = VI \cos \varphi$ and $Q = VI \sin \varphi$. Here φ is the direct phase angle between the voltage V and current I measured, and hence P and Q represent the active and reactive volt-amperes.

Although the equipment is for use primarily in the service of the electrical industry, it is intended that so ar as possible its versatility and flexibility shall be made available for the solution of problems within its range irrespective of their origin.

FAMILY PLANNING

IN an article on family planning*, Dr. Philip M. Bloom discusses the principles of family spacing which have been commonly accepted by most civilized communities. Besides accounts of the 'safe' period and the more usual methods of contraception like the condom and cervical cap, Bloom discusses investigations now being made into the development of oral contraceptives. At present, research is along four lines. In the first place an anti-fertility substance, phosphorylated hesperidin, is being investigated. It is thought that the sperm liberates an enzyme, hyaluronidase, which acts on the capsule of the newly-discharged ovum in such a way as to allow penetration and fertilization by the sperm. Phosphorylated hesperidin is a non-toxic inhibitor of hyaluronidase; an American worker has administered it orally to three hundred couples in an attempt to control fertility. He claims much success but corroboration is needed.

Secondly, an anti-fertility factor of an entirely different nature is that contained in the plant, *Lithospermum ruderale*. It is likely that it either inhibits the secretion of the pituitary gonadotrophic hormone or neutralizes it. Dried extracts of *Lithospermum* used on laboratory animals of both sexes have reduced fertility; nothing is really known of its effects on human beings. In England, a gromwell (*Lithospermum officinale*) has been found to contain this anti-fertility factor, and properly prepared extracts are non-toxic. They permit the possibility of trials in human volunteers. A third line of research is that of finding substances such as anti-vitamins or anti-hormones which will prevent development of the ovum or curtail its ability to embed itself in the endometrial lining of the uterus. Fourthly, there is the possibility of active immunization. An antigen which would produce immune bodies in the female capable of preventing either fertilization or nidation offers interesting speculation. Langer in New York has used such an antigen in female mice. With extracts of human umbilical cord given in three weekly injections, he found that female mice brought into contact with fertile males following a wait of three weeks showed delays in producing young in about 80 per cent of cases. Further, some of these substances may act as early abortifacients and would not be readily accepted by large sections of society. Others, by interfering with ovulation, would produce irregularities in menstrual cycles which may cause considerable emotional upsets in women. A great deal of further research work has to be done before an easy oral contraceptive is discovered and accepted; but it is probable that at some future time such a substance will be found.

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* *Health Education Journal*, 12, No. 2; April 1954.

SALMON MIGRATION AND THE ENVIRONMENT

By Prof. A. G. HUNTSMAN

Fisheries Research Board of Canada and University of Toronto

WHAT fish do of themselves is simple enough; but where they go is greatly complicated by environment and weather. This is a general conclusion from twenty years investigation of salmon and other fishes with the view of their management. Where they go is basically important in management and needs to be predicted.

Where salmon go may, as is most natural for us, be considered psychologically in the belief that they go where they will, and they are free to go anywhere in the water. Or it may be considered physiologically in the belief that their internal processes determine where they go, and physiology has now the highest repute among zoologists. But, to follow either of these courses is to reckon without one's host. The host in this case is the environment. Claude Bernard concluded that living is the continuous adjustment of internal conditions to external: "Ce n'est point par une lutte contre les conditions cosmiques que l'organisme se developpe et se maintient; c'est, tout au contraire, par une adaptation, un accord avec celles-ci"[1]. This means that the environment sets the pace, that it determines living.

If we can rid ourselves of preconceived ideas, there is no mystery in salmon migration. It is easy to see that the anadromous salmon is carried downstream and swims back up, and that the katadromous eel swims upstream and is carried back down. It is also easy to see that fish are carried downstream when they wander and do not resist the current sufficiently by heading and swimming upstream, and also that, when wandering vigorously, they head and swim upstream under the stimulus of being carried over the bottom by a current. Closeness of their relations with the bottom, which provides the stimulus, determines whether they go upstream or downstream. That the fish may keep down from too much light near the surface of the water, and up from close contact with the bottom, means variety in the stimulus for ascent. Heading upcurrent, avoidance of strong light and avoidance of solid or hard boundaries can be observed generally in animals that move about in water or in air, and these behaviours may be considered as simple and basic, no matter how complicated may be their psychology or their physiology.

The following account briefly summarizes what has just been worked out for our best example of fish migration. The details will be given in a bulletin on fish and fishery management that is in preparation for the Fisheries Research Board of Canada.

The Margaree River of Cape Breton Island happens to have particularly good conditions for developing a rather complete picture of the migration of the local salmon, even for the sea portion when they are for the most part deep in the water and out of sight. When small salmon or parr that live for several years in the river are swept into the sea by heavy floods, they reach the Margaree estuary. They survive where the water is not so salt as to kill parr. Thereupon they ascend small streams tributary to the estuary[3]. When adult Margaree salmon are tagged after spawning and are liberated in the estuary in the autumn, they may or may not (depending upon floods) ascend the river and be found in it as late as the middle of the next summer. Finally, they are found only in the sea, and, until they have again become fat and vigorous, only along the outflow of the river for ten or twenty miles to the north-east along the coast[3]. Fat salmon that have ceased feeding and are wandering vigorously have been tagged and liberated as caught in traps on the Margaree coast. The individuals go in every direction in the sea, as shown by their recapture wherever there is gear to take them[4,5]. As a whole, however, they are shifted by the water movements. They may be concentrated near the shore by near-surface currents from onshore winds, or concentrated near the mouth of the estuary by the return subsurface current that replaces the sea water entrained in the outflow. They are shifted both offshore and onshore as well as to and fro along the coast by wind currents. Native Margaree salmon are thus bandied about by the weather, and in this way, as well as by wandering, become widely dispersed, as was shown by recaptures of individuals from a lot of more than 30,000 that were marked by fin-clipping when they were descending as smolts in 1938. Some of these were tagged as fat 3-sea-year fish in 1941 from various nets along the coast. Recaptures made in the sea showed movement only away from the river as it happened, and the only recaptures in the river were of fish that had been in the concentration close to the mouth of the estuary[4]. It must be understood that salmon do not readily enter the Margaree estuary, few of the fish that begin to wander vigorously in June being taken in the river before August or September in most years. There is nothing to prevent them entering, and they might let themselves be carried in with flooding tide and remain.

The young Margaree salmon become smolts in the spring and descend to the sea after two years in the lower warmer parts of the river system and after three years in the upper cooler parts. They descen when it becomes warm enough for them to be quit active and when light and low water do not kee them so close to the bottom that they are stimulate to head and swim upstream. Their behaviour i tidal waters with plenty of room can be observe when they are in the broad and shallow estuar before being carried out in the stronger currents an deeper water of spring tides. They are to be see dispersed over the bottom, each one occupying station and feeding on passing plankton while stem ming the tidal currents that fluctuate in strengt and change in direction every six hours or so. I may safely be presumed that they do this where the are carried by the estuarial outflow to deep wate in which they descend out of sight.

Knowledge of where they settle when carried se ward in the outflow and dispersed is necessarily ver limited. Fishermen occasionally catch salmon o their baited hooks when fishing in the outflow an at depths as great as thirty fathoms or more. Onl when the salmon cease feeding and, on wanderin become concentrated near shore or in the outflow i it profitable to fish for them. Few of them do th as grilse after a year in the sea. Most of them do after two years, and a considerable number afte three years. The nets used have a mesh size suitabl for capture of these larger fish. When those marke as smolts in 1938 appeared as 2-sea-year fish in 194 they were at first found only in the outflow and fro six to twenty miles along the coast from the estuar mouth. They were more abundant near the inn than near the outer end of this zone, which evidently where they had settled as smolts. Th river had, as usual, declined in flow during June 1938 when they descended, which meant that th 3-year-old smolts from upper cooler waters woul not on the whole be carried as far seaward as th 2-year-old smolts. Correspondingly, as study of th scales of the fish showed, the former dominate among the salmon taken at the inner end of th zone of their primary distribution in the sea an the latter dominated at the outer end. As the fishin season progressed, this difference decreased as result of mixing from wandering of individuals t and fro in every direction. A similar situatio existed in 1941, when these marked native Margare salmon appeared as 3-sea-year fish. However, the appeared later in the season than the 2-sea-year fis had done and along a greater part of the outflov These facts indicated that the 3-sea-year fish ha settled farther offshore in deeper and cooler wate where they would mature more slowly and be expose later in the season to vernal warming. Where the settled had determined their remaining a longer tim in the sea and reaching a greater size. On the whol this was farther from the estuary mouth, so th the 3-sea-year fish had a smaller percentage th had been 3-year-old smolts than had the 2-sea-ye fish. The relative distribution of 3-year-old an 2-year-old smolts along the outflow as shown by th adults varies with the river discharge during th period of their descent. In 1933, the dischar fluctuated greatly and did not decline very markedl It has been found that, as a result of this, 3-year-ol smolts were not dominant among the salmon fro the smolts of that year that were taken near th estuary mouth in 1935 as 2-sea-year fish and in 19 as 3-sea-year fish. Ordinarily they would be domina among salmon taken near the estuary mouth, as w true for the 3-sea-year salmon of 1935 and for th

-sea-year salmon of 1936, which were from smolts descending in 1932 and 1934, respectively, when the river discharge declined steadily and markedly. With marked decline, the 3-year-old smolts in rriving late would not find where they settled near he estuary mouth the ground already occupied by so many younger, but not smaller, fish.

In conclusion, it may be stated that, while individual fish may quickly reach and enter the iver (one even returning from Newfoundland), ntrance of the adult stock into the estuary depends on the whole upon the fish being carried into the stuary or close to its mouth. Also, ascent of he river from the estuary depends, as is well known, upon freshets, which stimulate the fish to greater activity.

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PAPER CHROMATOGRAPHY AS A TOOL FOR MOSQUITO TAXONOMY: THE *CULEX PIPIENS* COMPLEX

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THE taxonomy of mosquitoes is well advanced by comparison with that of most groups of insects, and yet there remains a number of problems which cannot be solved by ordinary taxonomic methods. This is particularly true of the *Culex pipiens* and *Anopheles maculipennis* complexes, where recognition characters are insufficient to distinguish between the various members of the group. Recently, the *Culex pipiens* complex has been the object of intensified and concerted efforts on the part of taxonomists, geneticists and others, in order to establish the exact relationship of the mosquito populations which comprise this group[1]. It is apparent, however, that neither taxonomic nor biological differences have been sufficiently significant to provide an accurate basis for distinguishing between members of the complex. Without adequate morphological discontinuities, it is obvious that the problem must be approached with additional methods.

To provide a more discriminating tool for mosquito taxonomists and to learn more about mosquito–parasite relationships, we initiated the biochemical approach to the problem with the application of paper chromatography to the study of mosquito extracts[2]. It was possible to demonstrate that different genera of mosquitoes exhibit markedly different patterns of free amino-acids. The purpose of the present communication is to show that, with a revised and simplified technique, it is possible to demonstrate consistent biochemical differences between members of the *pipiens* complex used in this study.

American *Culex pipiens* (Illinois), *C. fatigans* (California) and *C. molestus* (Germany) were maintained as laboratory colonies, whereas European *C. pipiens* were collected as adults in Pavia, Italy. The adults of all species except the latter were used at two to three days of age, unfed. For some experiments, mosquito extracts were prepared according to previously described methods[2] for obtaining free amino-acids. When whole mosquitoes were used, the wings and legs were removed and the bodies boiled for two minutes in distilled water to coagulate the protein. Excess water was removed and the bodies mashed on the chromatographic paper with a glass rod. Four adult female mosquitoes were always used to make one preparation. The spot produced by each specimen was allowed to dry before adding the next in order to keep the material confined to a small area. Propanol and 1 per cent ammonia (2 : 1) was the solvent used for all one-dimensional chromatograms, and the different strains were always run in duplicate. Two-dimensional chromatograms were run with phenol as the first solvent and butanol – acetic acid and water (4 : 1 : 1) as the second. Whatman No. 1 filter paper was used for all chromatograms. All sheets were allowed to remain in the solvent for 16 hr. at 22–25° C. Those run in phenol were dried in the oven at 80° C., whereas all other chromatograms were allowed to dry at room temperature. All were sprayed with 0·2 per cent ninhydrin in water-saturated butanol.

Chromatograms of four extracts of each member of the *pipiens* complex used, as well as those of whole boiled mosquitoes, revealed consistent differences in their ninhydrin-positive patterns. One-dimensional chromatograms in propanol – ammonia showed eleven ninhydrin-positive spots for all species. As can be seen in Fig. 1, the patterns representing each of the forms studied are similar except for spots 6, 7, 8 and 9, where there are striking differences in the density of colour. Spot 6, which does not photograph well due to its yellow colour, is always more intense in *fatigans* than *pipiens*. On the other hand, spots 7, 8 and 9 are consistently darker in the latter species. The pattern of *molestus* is similar to that of *fatigans*, except the latter exhibits less intense spots, 7, 8 and 9.

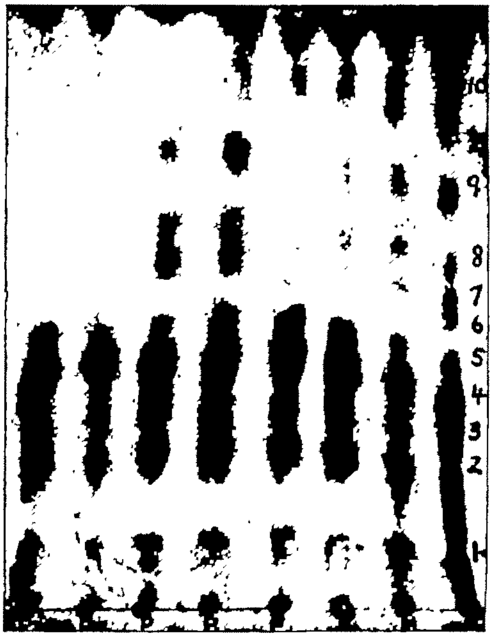

Fig. 1. One-dimensional chromatogram of specimens of European *C. pipiens*, PW; American *C. pipiens*, P; *C. fatigans*, F, and *C. molestus*, M, run in duplicate

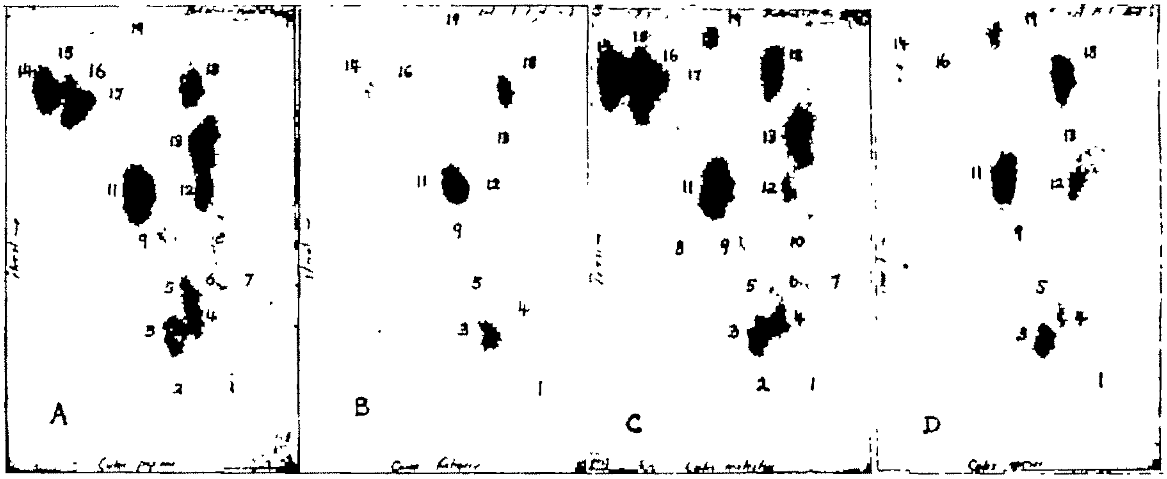

Fig. 2. Two-dimensional chromatograms of extracts. (*A*) *C. pipiens* (American); (*B*), *C. fatigans*; (*C*), *C. molestus*; and (*D*), *C. pipiens* (European)

The European *pipiens* present an interesting pattern inasmuch as they show the greatest amount of proline (spot 6) of all the forms studied, and yet spots 7, 8 and 9 are practically absent. The extracts presented essentially the same pattern.

For better and more accurate comparison of certain ninhydrin-positive substances, two-dimensional chromatograms were run with extracts. Fig. 2 compares chromatograms of the different members of the *pipiens* complex studied. At the level of concentration used, sixteen to nineteen spots representing free amino-acids appeared on chromatograms of extracts of the four different forms. Actually, fewer ninhydrin-positive areas than this are seen in Fig. 2, since some spots developed after the photographs were made. Although in general the patterns are similar, striking differences in amino-acid concentration are seen in certain areas as judged by the density of colour. For example, spots 2 and 7 do not appear on the chromatogram of European *pipiens*, and the latter spot is also absent in *fatigans*. One of the most significant differences may be seen in spot 19, which is markedly more dense in European *pipiens* in spite of the relatively low concentration of other amino-acids.

It appears from the results thus far obtained that paper chromatography may be an extremely useful taxonomic tool, particularly when there are no good morphological recognition characters for the species involved. In fact, it may well be that such biochemical methods as chromatography and infra-red spectrophotometry[3] present the most consistently accurate means of distinguishing between populations of mosquitoes within a complex.

Whole mosquitoes provided material equally as good as extracts for one-dimensional chromatography and without the time-consuming methods and special equipment required for the latter. This method is thereby a simplification of that previously used[2]. Far less material is required than for extracts, since a chromatogram can be run with as few as four specimens. Furthermore, the propanol–ammonia solvent does not have the objectionable characteristics of phenol and the chromatograms dry rapidly.

It is not yet known how the ninhydrin-positive patterns vary with the age of the specimens used. On a few occasions adults of two weeks of age have been used with no apparent alteration in the characteristic pattern. The European *pipiens*, however, which have all been collected from the basement of a building during the winter, were probably one to two months old. The relatively small quantity of ninhydrin-positive substances seen in the chromatograms of these specimens, therefore, may reflect a lowered metabolic rate or a partial depletion of certain amino-acids. Although all the forms used in the present study contain the same amino-acids (including glutamine) as previously determined with other strains[2], no attempt has yet been made to identify the substances which appear on the one-dimensional chromatograms.

This work on members of the *Culex pipiens* complex is being continued and extended to the *Anopheles maculipennis* complex.

The work described in this communication was carried out under a Fulbright Research Grant. I am indebted to the Istituto di Zoologia, Università di Pavia, for the use of facilities and equipment. Thanks are due to Dr. J. B. Kitzmiller, of the University of Illinois, for kindly supplying three strains of *Culex* used in this work.

[April 11.

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NEW TYPES OF INTERFERENCE FILTERS OF GREATER AREAS AND HIGHER CONTRAST

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IN a previous communication[1] the principles were outlined for the production of interference filters $ML_{2m}M$ of the Fabry–Perot type with transmission bands at definite wave-lengths (M means silver layers and L_{2m} means a layer of a dielectric with low index of refraction and with an optical thickness of $2m. \frac{\lambda}{4}$). Briefly, the method consists in measuring the thickness of the dielectric layer during evaporation by measuring in reflexion polarimetrically the phase difference $\Delta = \delta_p - \delta_s$ of the components of the electrical vector parallel (E_p) and perpendicular (E_s) to the plane of incidence at a definite angle of incidence of 75°.

During the past three years, this method has been further developed both theoretically and experimentally, and has been used to control the production of new types of interference filters, especially compound interference filters $M'L_{2m}M''L_{2m}M''L_{2m}M'$ with four silver layers and three dielectric layers.

A new evaporation plant was built in 1951 for the purpose of production of filters with a diameter up to 25 cm. to be used for astrophysical purposes. The diameter and height of the steel bell jar were 60 cm. and 80 cm., respectively. The evacuation of the container was carried out by a 9-in. silicone oil diffusion pump. The filter blank (glass plate) was rotated during evaporation by a small motor placed outside the container, by means of magnetic coupling acting through a brass plate. The distance between the evaporation source of the dielectric and the centre of the filter blank was 68 cm. By this arrangement it has been possible for a filter up to 25 cm. in diameter to obtain a constant thickness of the dielectric layer with an accuracy better than 0·5 per cent.

On the steel bell jar were welded side tubes carrying plane windows at such angles that a perpendicular transmission of the polarized light beam was secured. By this arrangement the polarimetrical quantities $\Delta = \delta_p - \delta_s$ and $\tan \Psi = \rho_p/\rho_s$ resulting from reflexion at the filter layers can be measured directly during the evaporation and employed for control of the thickness of the dielectric layers[1]. In the green–yellow spectral region these polarimetric measurements can be carried out visually by means of a $\lambda/4$-mica plate (Senarmont compensator) combined with a half-shade arrangement. Recently, however, a photoelectric method due to Clegg, Archard and Taylor[2] has been adopted. By this method, using a rotating analyser and a Wollaston prism, it is possible to read Δ and Ψ directly without use of either compensator or half-shade arrangement and to measure in the infra-red as well as in the visible.

For most of the filters cryolite was chosen as a dielectric, because of the experimental difficulties of using magnesium fluoride, due to its higher melting point. However, the optical properties of cryolite depend greatly upon the conditions of evaporation, especially the index of refraction, which depends upon the speed of evaporation (rate of growth of the layer). With a rapid evaporation, a value of n as low as 1·27 will result. With a very slow evaporation (more than 1–2 hr.) n turns out to be as high as 1·34. The index of refraction is determined by measurements of $\Delta_{\text{min.}}$ and $\Delta_{\text{max.}}$ during evaporation.

Only with very slow evaporation can a stable interference filter be made with cryolite as dielectric material.

Magnesium fluoride is more difficult to evaporate in the rather large quantities required by this apparatus. Again, with rapid evaporation n may be as low as 1·28 (measured in vacuum). However, a few hours after the filter has been removed from the container, n increases to 1·38 and a stable filter results.

Interference filters of the Fabry–Perot type $ML_{2m}M$ have the disadvantage that about 0·5 per cent or more of light with a wave-length far from the transmission band passes through the filter. The contrast is given by

$$\frac{I_{\text{max.}}}{I_{\text{min.}}} = \left(\frac{1+R}{1-R}\right)^2 \text{(at } R = 0{\cdot}85\text{; } \frac{I_{\text{max.}}}{I_{\text{min.}}} = 152\text{)}. \quad (1)$$

Dufour[3] has developed a theory for filters with three silver layers, $M'L_{2m}M''L_{2m}M'$. The contrast factor of such a filter is about 2000 (at 5500 A.). However, for many practical purposes the contrast factor is still not high enough.

For these reasons it was decided to try to construct filters of a still more complicated type $M'L_{2m}M''L_{2m}M''L_{2m}M'$, consisting of four silver layers and three dielectric layers. For such compound filters it is important to know what thicknesses of the silver layers M' and M'' will give optimum conditions. In the theory, the following notations are used: R_2 and T_2 are the reflecting power and the transmitting power of the central silver layers M'', and δ_2 and β_2 the phase shifts at reflexion and transmission, respectively, at normal angle of incidence of silver layers M''. R_1 and T_1 are the reflexion and transmission power of the outer silver layers M'. Introducing the important quantity

$$\sigma \exp i\alpha = 1 - \frac{T_2}{R_2} \exp i2(\beta_2 - \delta_2),$$

it can now be deduced from the fundamental equations for thin films that the transmission as a function of wave-length $I(\lambda)$ is given by:

$$I(\lambda) = \frac{(T_1T_2)^2}{|\{1 - R.\exp(-iy_1)\}^2 - R_2.\exp(-iy_2)\ \{1 - \sigma R.\exp(-i(y_1 - \alpha))\}^2|^2}, \quad (2)$$

$$\text{where } R = \sqrt{R_1R_2}; \quad y_1 = \frac{4\pi d_1 n}{\lambda} - \frac{(\delta_1 + \delta_2)\pi}{180}; \quad y_2 = \frac{4\pi d_2 n}{\lambda} - \frac{2\delta_2.\pi}{180};$$

d_1 is the thickness of the outer dielectric layers and d_2 that of the centre dielectric layer.

If $y_1 = y_2$ and if the approximation $\alpha = 0$ is made, it can be deduced from (2) that $I(\lambda)$ will only have one peak (of a definite order) if the relation

$$2R_1(R_2.\sigma)^2 + \sqrt{R_1R_2}\,(1 + (R_2\sigma)^2 - 6R_2.\sigma^2) + 2\sigma R_2 > 0 \quad (3)$$

is satisfied. If this quantity is negative, as in the case of four silver layers of equal thickness, more peaks (of the same order) will result (Fig. 1, D). If only one peak is present, the peak transmission $I_{\text{max.}}$ and the contrast factor $I_{\text{max.}}/I_{\text{min.}}$ can be deduced from equation (2):

$$I_{\text{max.}} = \frac{(T_1T_2)^2}{((1 - R)^2 - R_2(1 - \sigma R)^2)^2} \quad (4)$$

$$\frac{I_{\text{max}}}{I_{\text{min.}}} = \left(\frac{(1 + R)^2 + R_2(1 + \sigma R)^2}{(1 - R)^2 - R_2(1 - \sigma R)^2}\right)^2 \quad (5)$$

To compare the applicability of such compound filters $M'L_{2m}M''L_{2m}M''L_{2m}M'$ with filters of the usual type $ML_{2m}M$, some results from numerical calculations will be given. All the quantities occurring in equations (2–5) can be calculated when the index of refraction of the silver layers and of the dielectric

Table 1

λ / $\nu - i\kappa$	t'' / t'	R_4 / $R_1(3)$	$I_{\max}$ (4)	$\frac{I_{\max}}{I_{\min}}$ (5)	σ / a
6560 A. 0 13 − i 4 27	500 A. 205 A.	0 940 0·685	0 41	5·3 × 10^4	1 0225 −0 228°
5500 A. 0 15 − i 3 36	500 A. 225 A.	0 895 0·608	0 34	0·8 × 10^4	1·0422 −0 575°
4360 A 0 17 − i 2 33	500 A. 250 A.	0 788 0 474	0 28	0 5 × 10^4	1·1074 −1 874°

layers and the thicknesses t' and t'' of the silver layers M' and M'' are known. The results are given in Table 1 and in Figs. 1–3.

In Table 1, t' is calculated in such a way that only one peak results (equation (3) equal to zero) and it is assumed that $n = 1·35$.

In Fig. 1 and Fig. 2 intensity (calculated directly from equation (2)) is plotted against wave-length for different thicknesses t' and t'' of the silver layers for the red, and in Fig. 3 for the green, spectral regions. The small negative value of α gives rise to a small displacement of the peak towards the violet compared with the peak of the filters $M'L_1M''$ and $M''L_2M''$ and gives rise to an asymmetrical curve. This asymmetrical curve is most pronounced for a filter with four silver layers of equal thickness (Fig. 1, D). Comparison of Fig. 1 and Fig. 2 shows that the thickness of the inner silver layers t'' has to be somewhat greater than for a filter ML_mM to get a reasonable band-width of such a filter. In these numerical calculations, a table for the addition of complex numbers[4] has been of great value.

Some filters of this compound type for different wave-lengths have been produced, the polarimetric method[1] mentioned being well suited to control the thickness of the three dielectric layers on the base of the filter. The thickness of the silver layers M' and M'' is determined by means of transmission measurements with test plates. The filters produced seem to confirm the theory. Filters (20 cm. × 20 cm.) with peak transmission as high as 0·35–0·40 have been produced having a transmission less than 0·001 at a wave-length 500 A. from the peak (second order).

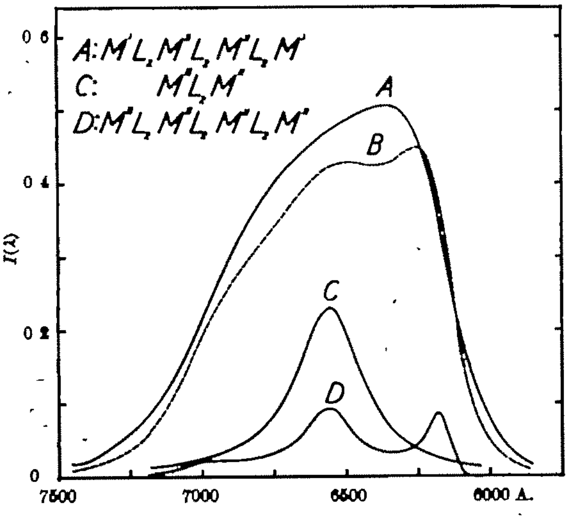

Fig. 1. Calculated curves for compound interference filters $M'L_1M''L_2M''L_1M'$. The thickness of the inner silver layers is $t'' = 400$ A. for all the curves. The thickness of the outer layers t' is: A, 168 A., B, 205 A., and D, 400 A. The thickness of the dielectric layers is chosen in such a way that the filters $M'L_1M''$ and $M''L_2M''$ both have peak transmission at 6560 A. ($R_4 = 0·90$; $T_4 = 0$ 06; $\sigma = 1·0536$; $a = -0·462°$)

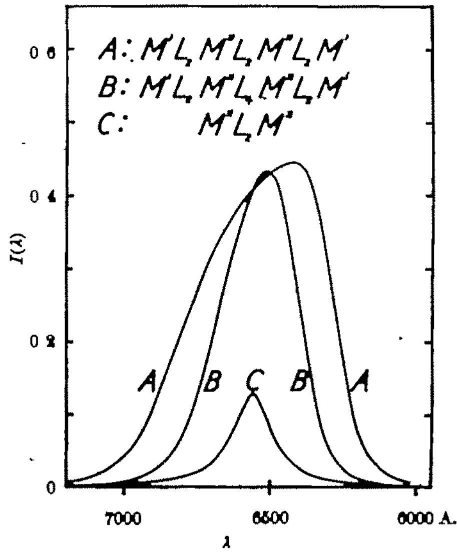

Fig. 2. Calculated curves for two compound interference filters $M'L_1M''L_2M''L_1M'$ and $M'L_2M''L_1M''L_2M'$ compared with the Fabry–Perot filter $M''L_2M''$. $\nu - i\kappa = 0·13 - i\ 4·27$, $n = 1·35$, $t'' = 500$ A. and $t' = 205$ A. The thicknesses of the dielectric layers are chosen in the same way as in Fig. 1

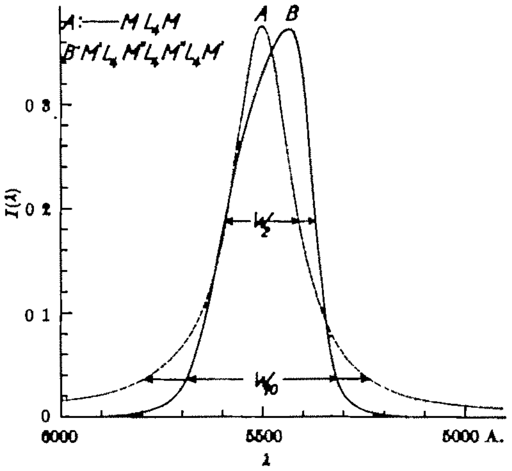

Fig. 3. Calculated curve for a compound interference filter (B) compared with a Fabry–Perot filter (A) with the same peak transmission. $\nu - i\kappa = 0·15 - i\ 3·36$. $t'' = 500$ A., $t' = 225$ A. for the compound filter and $t = 360$ A. for the Fabry–Perot filter. Both filters are of the second order

A more detailed account of this work will be published elsewhere.

I wish to thank Prof. Bengt Strömgren, director at the Royal Astronomical Observatory, Copenhagen, who made the construction of the larger evaporation plant possible. I am also grateful to Prof. Ebbe Rasmussen, the director of this laboratory, for many valuable discussions and for his interest in this investigation; finally, I wish to thank Mr. P. W. Streander for the construction of the apparatus.

[Dec. 28.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Dawn and Dusk Flight of *Drosophila subobscura* Collin

Few records exist of insects with two peaks of activity in 24 hr. Of the many identified species attracted to a light in four years of continuous trapping, only one, a moth *Pterophorus monodactylus*, was caught at two separate times each night[1]. *Aphis fabae* has a double peak of emigrant flight from its secondary host, and this is the result of a complex chain of moulting rhythms, weather influences and flight behaviour[2]. A fall has been observed in the number of *Simulium venustum* in the air when evaporation-rate was high, leaving density maxima at 09.00 and 18.00 hr.[3]. Several species of Drosophilidae have been caught at bait traps with maximum numbers at dusk and dawn both in Europe and America[4-6]; but many factors, including humidity, will affect the area of influence of these traps and hence the number of insects caught and possibly their time of arrival.

Many insects have been caught by suction trap[7] at Rothamsted, but none shows such a striking bi-modal periodicity as the Drosophilidae (several species of *Drosophila* and *Scaptomyza*). Specimen catches for *D. subobscura* on two days of contrasting weather in July and on a dull day in October are recorded in Fig. 1. These density values are absolute and are not artificially stimulated by bait or light; the ordinate is the mean density of insects per *c*. 10,000 cu. ft. of air during the 30 min. abscissa intervals. The depressing effects of adverse weather on aerial density can be seen in the July histograms and the shift in time of flight with a shorter day in the October catch. Despite differences in trapping site, weather, times of year and population density, the two peaks remain quite distinct, with no flight either in complete darkness or bright daylight.

This is curious, because the Schizophora (Diptera), apart from the Drosophilidae, are mainly day-flying insects, and the Drosophilidae have apposition eyes usually associated with good directional vision in daylight; *D. subobscura*, in particular, cannot mate without light, at least in the laboratory[8]. Its crepuscular activity therefore seems anomalous. However, in wild-type *D. melanogaster*—which has a similar periodicity—there is a shift in the spectral sensitivity of the eye to shorter wave-lengths when light intensity is low[9]. This will tend to increase the relative efficiency at dawn and dusk.

Drosophilidae are highly susceptible to desiccation[10], and those that live in humid sub-tropical forests have a more flexible periodicity than species found typically in open country[6].

It is interesting to speculate that *Drosophila* may have become adapted to increasing daytime aridity not by increased resistance to desiccation, as must have happened to most Schizophora, but by increased visual efficiency to low light intensities, together with a shift in flight periodicity to less climatically extreme but darker times of day. In this context the observation on *Simulium venustum* already mentioned is especially interesting.

Further analysis of the observations, now in progress, may reveal how far flight behaviour alone is responsible for the periodicity. Emergence rhythm also may be involved as in *Aphis fabae*, though this seems unlikely as it has a single daily maximum and few virgins were caught; but it may partly explain the difference sometimes found between the morning and evening sex ratios (see Fig. 1).

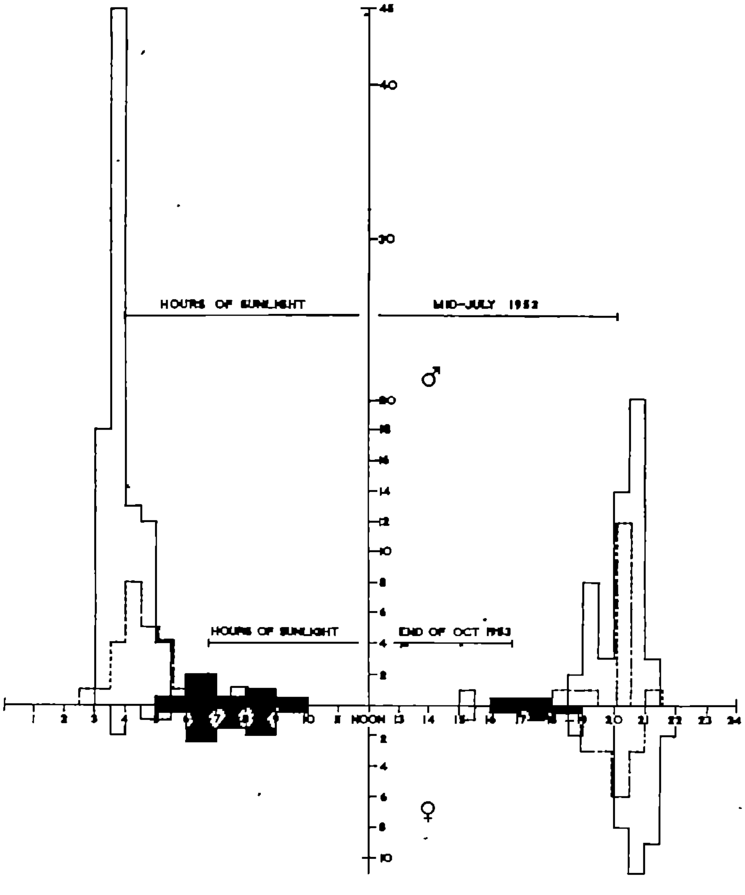

Fig. 1. Numbers of *Drosophila subobscura* caught in a suction trap at Rothamsted, Herts

———: On July 10, 1952, a fine day: the mouth of the trap placed level with the top of a bean crop in a walled garden at Rothamsted Lodge. - - - -: catch of July 23, 1952, a dull day: the trap sited as above. ///////////: catch of October 28, 1953: the trap placed 3 ft. 6 in. above ground-level, in an orchard at Rothamsted Manor House; dull, slight drizzle

We would like to thank Dr. E. B. Basden, of the Institute of Animal Genetics, Edinburgh, for confirming the identification of *D. subobscura*.

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An Epizootic among Laboratory Stocks of the Desert Locust, *Schistocerca gregaria* Forsk

D'HERELLE[1] isolated a small Gram-negative bacillus from dead or dying *Schistocerca pallens* Thunb. in Yucatan, Mexico. He considered this organism, which he named *Coccobacillus acridiorum*, to be the etiological agent of a highly virulent disease which was responsible for widespread destruction of locusts in this region. Although he claimed success in locust control by means of the organism, other workers were less successful and the method was finally abandoned. Later, there was some confusion as to the true identity of *Coccobacillus acridiorum*; but Steinhaus[2] states that it is probably related to *Aerobacter aerogenes*.

The Anti-Locust Research Centre, London, recently reported an epizootic among laboratory stocks of *Schistocerca gregaria*, Forsk, in which mortalities were often as high as 80–90 per cent per cage, although not all cages were affected. Ante-mortem, the condition is difficult to distinguish in a crowded cage until shortly before death, when the insect becomes moribund with spasmodic twitching of the appendages. Post-mortem, the integument darkens and the eyes become a deep red; the abdomen and appendages are extremely flaccid and the viscera a viscous mass.

In our experiments the typical disease was found to be serially transmissible by intrahæmocœlic inoculation of healthy locusts with tissue suspensions prepared from dead insects. No evidence of a virus etiology could be found; Seitz and 'Gradocol' membrane (0·70 μ) filtrates of infective tissue suspensions were innocuous. On the other hand, a bacterial etiology was suggested by the facts that blood cultures taken shortly before death almost invariably yielded pure cultures of a Gram-negative organism, and that after death smears of blood or tissue showed Gram-negative bacilli in very large numbers.

There is strong evidence that a non-lactose-fermenting Gram-negative bacillus is the etiological agent of this epizootic disease. Such an organism has been isolated from every case of the typical disease, but in only one of 150 healthy locusts was it found. Intrahæmocœlic inoculation of less than ten of these organisms invariably produces death. Locusts fed on food sprayed with broth cultures c the bacillus showed mortalities of 70–90 per cen and the cannibalization after death by health locusts of insects inoculated with the organism wa sufficient to start an epizootic disease giving rise t a similar mortality-rate.

The identity of the organism has not yet bee established, though it is probably a paracolon. I seems possible that the organism originally isolate by D'Herelle may resemble the causative agent c the disease briefly reported here, and that D'Herelle' organism was afterwards confused with other strain A second Gram-negative lactose-fermenting bacillu was often isolated from dead locusts; but on only on occasion was it isolated from a sick locust prior t death. Massive doses of this organism are neede to kill, and feeding experiments result in mortalitie similar to those resulting from the feeding of foo sprayed with sterile nutrient broth (namely, 5–20 pe cent). This organism, which is probably *Aerobacte aerogenes*, can regularly be isolated from the gut, an must be regarded as a normal member of the gu flora.

It is hoped to publish detailed results of this wor in the near future.

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Conception in Prepuberal Mice following Artificially Induced Ovulation and Mating

SUPEROVULATION in prepuberal mice is a recommended procedure for obtaining unfertilized mammalian ova[1]. Experimental results[2] have indicate that, after fertilization, these ova approximate to th viability of ova from spontaneous ovulations.

In previous studies, fertilized eggs were not obtainable from prepuberal donors since sexual receptivit did not accompany ovulation. The present repor demonstrates that administration of gonadotropi hormones can be followed by ovulation, mating an conception. Since, however, conception in prepubera mice has seldom led to pregnancy, fertilized egg from these animals have been transplanted int mature recipients. Such eggs have developed int viable young.

Mice approximately 35–40 days old were given priming injection of pregnant mare's serum, 1 I.U 60 hr. before the desired time of ovulation. A ovulatory injection of human chorionic hormone 1 I.U., was given 13 hr. before the desired time o ovulation. Observations upon conceptions in prepuberal mice are given in the following experiments

These injections were administered to 37 femal mice (Table 1, *A*); strain 129; 34–41 days old 12–17 gm. in weight. At the time of the ovulator injection (4.30 p.m.), each female was caged with an adult male. The following morning, 34 of th 37 females (92 per cent), showed evidence of having mated (that is, presence of vaginal plugs). The 3 females were subjected to laparotomy at 32 hr. afte

Table 1. OBSERVATIONS ON MICE FOLLOWING ARTIFICIALLY INDUCED BREEDINGS

Sample	No. ♀♀ injected	No. ♀♀ with plugs	No. ♀♀ with eggs	No. eggs	No. 2-celled eggs
A	37	34	34	188*	130 (69 per cent)
B	10	10	10	63	62 (98 „)
C	10	10	9	60	57 (95 „)
D	10	9	7	53	25 (47 „)
E	14	12	11	73	59 (81 „)
Totals	81	75	71	437	333 (76 „)

* Only right oviducts were examined. Remainder of data includes observations on both right and left oviducts.

ovulation. The right oviducts were excised and all were found to contain eggs. Cleaved eggs were found in 31 of the 34 right oviducts. A total of 188 eggs were isolated, of which 130 (69 per cent) were in the 2-cell stage.

The 31 animals that possessed cleaved eggs in the right oviducts were divided into two groups. One group, 16 animals, was autopsied three and a half days after ovulation and the remainder, 15 animals, were examined eight days after ovulation.

Of the 16 uteri that were excised and irrigated at three and a half days after ovulation 15 yielded 69 eggs. Forty-five eggs (65 per cent) were typical blastocysts. These particular blastocysts were discarded; but we have reported previously[3] that eleven blastocysts similarly produced have been transplanted to a mature recipient. Six of the eleven blastocysts survived through birth and five were raised to maturity. Our experience has indicated that eggs transplanted from prepuberal mice are no less viable than eggs transplanted after spontaneous ovulations.

The 15 animals that were examined at eight days after ovulation showed no indication of uterine implantations. Similar experiments have been repeated many times, and only occasionally (less than 10 per cent of mated animals) has there been evidence of implantation. Although our results demonstrate that induced ovulation and mating is a reliable source of viable, fertilized eggs, these events have not regularly led to implantation in prepuberal mice.

The procedure for obtaining conception in prepuberal mice has been re-tested using mice of strain 129 (Table 1, *B* to *E*). Females in four subsequent samples were managed differently from those in sample *A*, in so far as they were introduced into pens with males 2 hr. before the expected ovulation and allowed to remain for 5 hr. Copulation occurred in 86–100 per cent of the females, and these mated animals were autopsied 24–36 hr. after ovulation. The mean numbers of eggs in four samples (*B–E*) fell between 6·3 and 7·6, and the ratio of eggs that were in the 2-celled stage varied from 47 to 98 per cent. The five samples of prepuberal mice from inbred strain 129 have shown that induced ovulation and mating occurred in 71 out of 81 animals. Recovery of 437 eggs showed that development had been initiated in 76 per cent of the eggs. Conception in prepuberal mice has provided viable fertilized eggs for a variety of experiments.

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Transport of Chloride in the 'Symplasm' of *Vallisneria* Leaves

Vallisneria leaves exposed to light show a fairly constant chloride absorption[1]; by secretion into the vacuole, the osmotic value of the cell sap is enhanced. If a part of the leaf is in contact with a chloride solution, the chloride is introduced into the cytoplasm and is translocated through it to the rest of the leaf. The chloride can be accumulated in the vacuoles in any part of the leaf that is exposed to light. If the absorbing zone is in the light and the rest of the leaf, here called the 'free part', in the dark, there is no noticeable transport and all the chloride absorbed remains in the absorption zone. If this zone is in the dark and the free part exposed to light, accumulation in the absorption zone is smaller and that in the free part much larger. This points to a transport in the cytoplasm and a secretion into the vacuoles under the influence of light[2].

A new experiment for studying the transport in the cytoplasm of the parenchyma cells is described here. In the first phase (16 hr.) of the experiment, chloride ions are accumulated in the first zone (2·5 cm.) of the leaf strips (7·5 cm.). Then the leaf strips are put into water, and a redistribution of the chloride over the other zones can be observed. In this second phase the first zone is in the dark and the free part of the leaf in the light. This difference in the exposure to light is essential to get a redistribution. The amount of chloride present in the different zones 2·5 cm. in length was determined after 8 hr. and 24 hr.

REDISTRIBUTION OF CHLORIDE IN *Vallisneria* LEAVES

First phase, uptake during 16 hr. Second phase, redistribution after 8 hr. and 24 hr. Values in the table give the amount of chloride absorbed by 8 leaf zones of 2 5 cm length and 0·4 cm. width

Uptake	Zone 1	Zone 2	Zone 3	Whole strip
	0 002*M* KCl (+ $CaSO_4$) in the light (γCl)	water in the dark (γCl)	water in the dark (γCl)	(γCl)
16 hr.	208	12	5	225
Redistribution	in the dark in water	in the light in water	in the light in water	
8 hr.	189	26	19	234
24 hr.	172	45	16	233

It is apparent from the table that in the first zone chloride is leaking into the cytoplasm from the vacuoles in which it was accumulated before. As this zone is darkened, there is no further secretion into the vacuoles to restore the chloride content. The chloride is transported in the cytoplasm to the other zones of the leaf which are exposed to light and where secretion brings the chloride from the cytoplasm into the vacuoles. The leakage is continued during the 24 hr. of the experiment. It is remarkable that the chloride contents of the whole leaf strip remain unaltered, no chloride being lost to the outer solution; only the distribution is changed by changing the exposure to light of the different zones. The transport in the cytoplasm from cell to cell over a length of 7·5 cm. without loss to the outer solution indicates that plasma connexions between the cells must exist. The cells behave like a 'symplasm'.

This experiment is in good agreement with former results[3] obtained with inhibitors such as potassium cyanide and 2,4-dinitrophenol, and indicates that three distinct processes have to be taken into consideration: uptake in the cytoplasm, translocation through the cytoplasm and secretion from the cytoplasm into the vacuole. The leakage of the vacuoles is a new factor which, though small, is quite definite.

Full details about these experiments will be given elsewhere.

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Structural Analogies of Pox Viruses and Bacteria

Dawson and McFarlane[1] reported that the pepsin-digested elementary body of vaccinia reveals a nucleus-like central body surrounded by a membrane. This phenomenon was confirmed by subsequent papers for vaccinia[2,3] and other viruses of the pox group—fowl pox[3,4], neurovaccinia[3], ectromelia[5] and myxoma[3,5]. Pepsin digestion does not interfere with the deoxyribonucleic acid content of the virus, as shown by an earlier report[6]. In analogy to cells of higher organisms and bacteria, the structure containing deoxyribonucleic acid had to be looked for in the central body. Therefore, we attempted to diges specifically the central body by pure enzymes, as we did with the nuclei of rod-shaped and coccoid bacteri (*Escherichia coli*[7] and *Neisseria sicca*[8]).

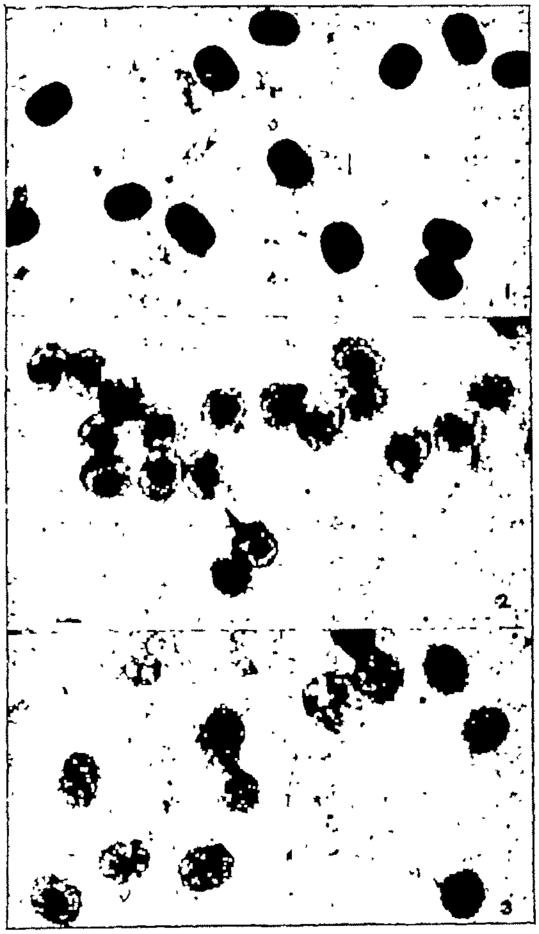

Fig. 1. *Molluscum contagiosum* elementary bodies, untreated. × 25,000

Fig. 2. As Fig. 1, after Chabaud fixation (15 min.) and treatment with crystalline pepsin (0·02 per cent, pH 2·0, 37° C., 2 hr.)

Fig. 3. As Fig. 2 after further treatment with crystalline deoxyribonuclease (0·1 per cent, *M*/15 phosphate buffer pH 6·0, 37° C., 30 min.) followed by a second pepsin treatment as above

Elementary bodies of *Molluscum contagiosum* taken from specific lesions by dabbing[9] (Fig. 1) were fixed in Chabaud solution and treated with crystallized pepsin at pH 2. As in other pox viruses, most of the elementary bodies were degraded and showed a more or less opaque central body of varying size and shape (Fig. 2). Earlier findings[1] that the central bodies of pepsin-treated virus particles become less opaque by treatment with deoxyribonuclease could not be confirmed, because of the variable density of these bodies. But when the deoxyribonuclease treatment was followed by a second pepsin treatment, the mass of the central body was hydrolysed, leaving an almost empty membrane (Fig. 3), thus showing that pepsin will not digest the proteins of the central body unless the protection afforded by deoxyribonucleic acid is rendered ineffective by the depolymerizing action of deoxyribonuclease; this finding was borne out by similar observations on deoxyribonucleoproteins of higher organisms (see ref. 10).

So far as the effect of these enzymes is concerned, there is obviously no dissimilarity between the central body of pox viruses and the nuclear structure of bacteria[7,8]. The virus membrane left after enzyme treatment resembles in many respects the empty wall of a bacterial cell.

A full report of this work will be published elsewhere[11]. Analogous results were obtained with vaccinia virus[12], in which we have studied the morphological variation of the central body (unpublished work). We acknowledge the assistance of the Deutsche Forschungsgemeinschaft.

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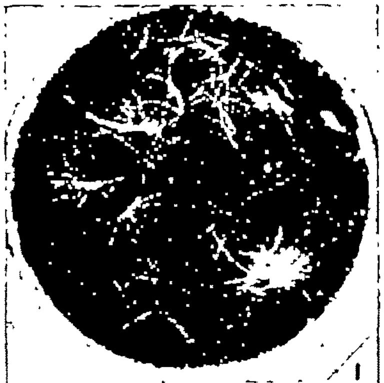
Isolation of *Keratinomyces ajelloi* from Soils in Great Britain

Karling[1] first used keratinaceous materials for the isolation of keratinophilic chytrids from soil and water. Similar techniques for the isolation of other keratinophilic fungi from soil have since been devised by other workers. Thus, Mandels *et al.*[2], Cooke[3] and Ajello[4] have also isolated *Microsporum gypseum* from various soil samples in the United States. Belgian soils examined by Vanbreuseghem[5] yielded no known dermatophytes, but did reveal the presence of a keratinophilic fungus which Vanbreuseghem placed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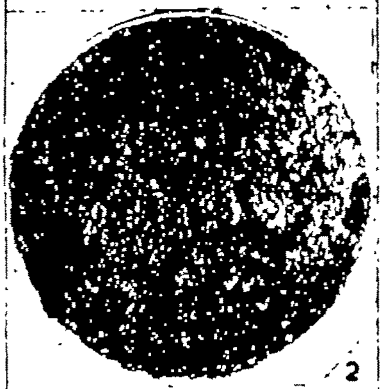
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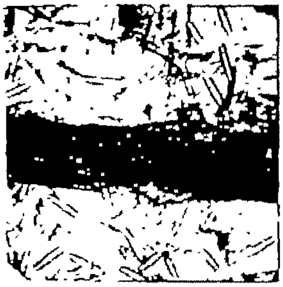
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Fig. 1. Fungal growth on hairs on non-sterile soil after 8 days. (4/7 natural size)
Fig. 2. Unattacked hairs on sterile control plates after 8 days. (4/7 natural size)
Fig. 3. Perforating organ of *K. ajelloi* penetrating hair shaft. Dark background photograph (× *c.* 95)
Fig. 4. Macroconidia produced by *K. ajelloi* growing on hair from soil plate. (× *c.* 190)

ı a new genus, *Keratinomyces*, and gave the specific ame of *K. ajelloi*. This organism was also isolated y Ajello[4] from one sample of soil from Tennessee nd two samples from Georgia, out of a total of 16 soils collected from different localities. In this ommunication *K. ajelloi* is recorded for the first time ı Great Britain, having been isolated from sixteen ut of nineteen soil samples collected in different calities.

Soil samples were collected from the top two inches nd placed in sterile tins. The method used for the olation of *K. ajelloi* was the same in principle as hat described by Vanbreuseghem[5]. For each sample x Petri dishes were half filled with soil; three of hese were autoclaved at 20 lb. per sq. in. for 20 min. nd served as controls. Strands of autoclaved hair ere placed on the surface of the soil, and the latter moistened with sterile distilled water. The cultures were incubated at 20° C. and examined daily. After 7–14 days vinaceous buff-coloured[6] mycelium covered the strands of hair on non-sterile soil (Fig. 1); but no growth was observed on sterile control plates (Fig. 2). Hairs from the experimental plates were removed and mounted in cotton blue-lactophenol. Microscopical examination of the hairs showed various stages in digestion and penetration of the hair shaft by fungal perforating organs of the type described by Vanbreuseghem[7] (Fig. 3). Abundant macroconidia were produced by the fungus growing on the hairs (Fig. 4).

Pure cultures were obtained by transferring spores to Sabouraud's glucose agar slopes. Isolates resembled in every respect those of *K. ajelloi* isolated from Belgian soils and described by Vanbreuseghem. Colonies growing on Sabouraud's glucose agar were pale yellow-orange[6] in colour and lanose in texture and produced a dusky drab-coloured[6] diffusible pigment, although in some strains pigment only developed as the colonies aged. All strains produced abundant, multiseptate, fusiform macroconidia.

Source of soil	Type of soil	Result of examination of soil
1. Longniddry, East Lothian, Scotland		
Beechwood	Soil rich in decaying organic materials	+
Garden plot	Sandy loam	+
Foreshore	Sand	–
2. Manchester Garden plot in the University grounds	Clayey loam	+
3. Failsworth, Manchester Garden plot	Clayey loam	+
4. Worsley, Lancashire Garden plot	Clayey loam	+
5. Oldham, Lancashire Garden plot in Alexander Park	Clayey loam	+
6. Huddersfield, Yorkshire Garden plot	Clayey loam	+
7. Saddleworth, Yorkshire		
Garden plot	Clayey loam	+
Cropped pasture	,, ,,	+
8. Holme Moss, Yorkshire *Eriophorum* moorland	Peat	–
9. Jodrell Bank, Cheshire Garden plot, University of Manchester experimental grounds	Sandy loam	+
10. Alderley Edge, Cheshire Beechwood	Soil rich in decaying organic materials	+
11. Great Budworth, Cheshire		
Garden plot	Sandy loam	+
Cropped pasture	,, ,,	+
12. Wolverhampton, Staffordshire Chicken run	Sandy loam rich in decaying organic materials	+
13. Snake Pass, Derbyshire *Eriophorum* moorland	Peat	–
14. Spalding, Lincolnshire Garden plot	Sandy loam	+
15. Nevin, Caernarvonshire, Wales Garden plot	Sandy loam	+

Key to table: + = *K. ajelloi* isolated; – = *K. ajelloi* not recorded.

The types and origins of the soils from which *K. ajelloi* was recorded are shown in the accompanying table.

I wish to thank Prof. C. W. Wardlaw for his continued interest and valuable advice. Dr. R. Vanbreuseghem, of the Institut de Médecine Tropicale Prince Leopold, Anvers, kindly confirmed my identification of *K. ajelloi*. I am indebted to Mr. E. Ashby for the photographs.

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Effects of Antibiotics on Carbon Dioxide Production in Soil

THE fate of antibiotics in soil is of great interest, partly on account of the possible importance of antibiotic substances in the development of the associations in the natural micropopulations, partly on account of the aspects of using antibiotics in the control of soil-born plant pathogens.

Gottlieb *et al.*[1] have shown that basic antibiotics like streptomycin are rapidly inactivated in soil by adsorption by the clay and the organic matter. They also found that the activity of two amphoteric antibiotics, aureomycin and terramycin, are dependent of the hydrogen ion concentration of the soil; generally they are acting as bases, being adsorbed by the clay. A neutral antibiotic, chloromycetin, was rapidly inactivated, probably by biological agencies. Jefferys[2] found that the rate of inactivation of penicillin and eight other fungal antibiotics varied from soil to soil, and considered this to be mainly an effect of pH on biological activity. Pramer and Starkey[3] found that decomposition of streptomycin occurred in soil and succeeded in isolating a species of *Pseudomonas* capable of decomposing streptomycin.

The effects of high concentrations of antibiotics on the complex micropopulation of the soil has been studied by determination of the evolution of carbon dioxide (by Petersen's method[4]) as a measure of the rate and extent of biological activity in soil. Five antibiotics were used: penicillin, chloromycetin, terramycin, streptomycin and aureomycin. Carbon dioxide from triplicate flasks was determined during a 14-day period at 25° C. In each of the experiments a normal Danish field soil (pH 6·5) was used, air-dry, with addition of 16 per cent water and 0·5–0·7 per cent of each of the five antibiotics mentioned above.

The results are shown in Figs. 1 and 2. Penicillin, chloromycetin and terramycin brought about a slight inhibition in the evolution of carbon dioxide, in the first 24–72 hr., perhaps corresponding to the lag phase. The inhibition was followed by a great rise in the production of carbon dioxide, which during the whole period amounted to approximately twice the production of the control experiments (Table 1). The excess over control corresponds to 10–20 per cent of the carbon in the amounts of the three antibiotics added.

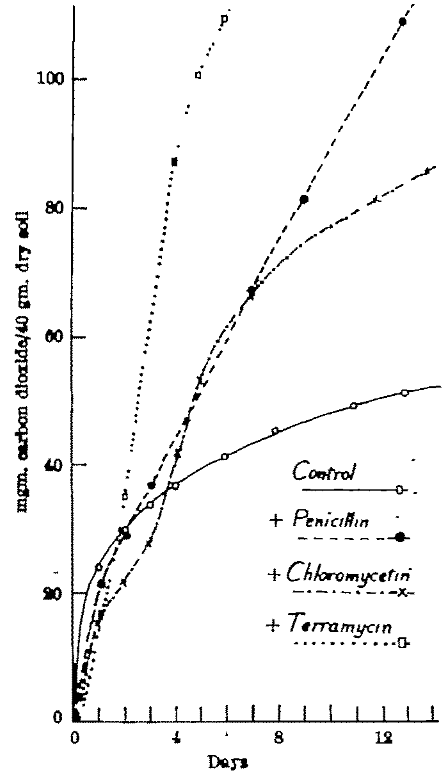

Fig. 1

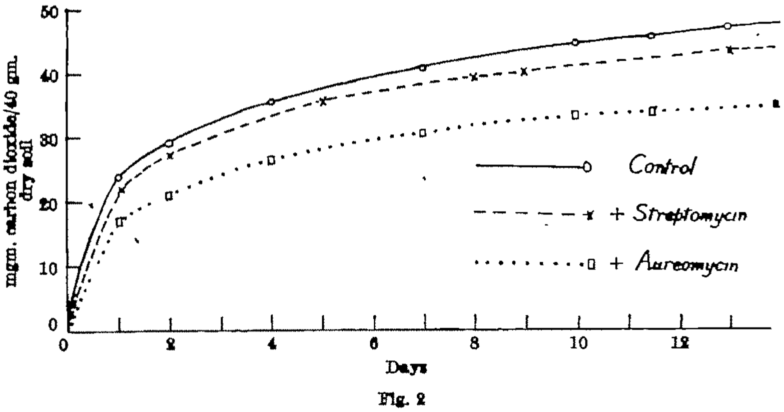

Fig. 2

The experiments with aureomycin and streptomycin showed a slight but persistent inhibition during the 14-day period, perhaps on account of the amounts added, which probably exceeded the adsorption capacity of the soil. These experiments thus indicated that there was no decomposition of these two substances within the experimental period.

Plate cultures from the soil used in the three first experiments were made on a mineral agar plus the corresponding antibiotic as the only source of carbon. In all three cases soil fungi were isolated which were

Table 1. EVOLUTION OF CARBON DIOXIDE FROM THE SOIL
(mgm. carbon dioxide per 40 gm. dry soil)

		Penicillin	Chloromycetin	Terramycin
Control		51·2	47·8	56·8
Antibiotic added		112·6	85·2	148·7
Excess	Carbon dioxide (mgm.)	61·4	37·4	91·9
	Carbon (mgm.)	16·5	10·2	25·1
	Per cent of carbon added in the antibiotic	14	10	20

able to grow in liquid synthetic medium with the corresponding antibiotic as the only source of carbon. The following types were found: Penicillin-exp.—*Penicillium* sp., *Fusarium* sp.; Chloromycetin-exp. —*Penicillium* sp.; Terramycin-exp.—*Penicillium* sp.

This work shows that fungi play an important part in the decomposition of antibiotics in soil.

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Nutritive Value of Lucerne Protein Concentrates, fed with and without Cholesterol

THE possibility of large-scale extraction of protein concentrates from green leaves has been raised by several workers[1]. Machinery for squeezing juice from crushed leaves has been developed, and a protein concentrate is obtained from this juice by precipitation. Little work has, however, been carried out on the nutritive value of these protein concentrates. Carpenter *et al.*[2] have shown a crude preparation from grass to be superior to groundnut meal when fed as a supplement to a low-protein cereal diet for chicks and rats. Davies *et al.*[3] found purified preparations from cocksfoot to have biological values of 46 and 61 when fed as the sole protein to rats.

We have found that lucerne is one of the most promising crops for protein extraction, and the nutritive value of lucerne concentrates has been studied in a number of experiments. Reasonable growth was obtained when a lucerne/grass protein concentrate was fed as the principal protein in a practical chick ration (18·8 per cent crude protein), in which 2·5 per cent of yeast was included[4]. However, lucerne protein concentrate has been found to be inferior to fish meal when added as the sole supplementary protein to rations composed of cereal products, minerals and concentrated vitamin supplements (15·1–16·3 per cent crude protein).

In discussion with Dr. J. Duckworth, it was suggested that the low nutritive value to chicks of lucerne protein concentrates might be due to a factor similar to that found in lucerne meal by Peterson[5], the effect of which was reduced by the addition of cholesterol to the rations. Using the gross protein value technique[6] the nutritive value of lucerne protein has been further studied.

In all trials, each of three replicates of each treatment consisted of twelve Rhode Island Red × Light Sussex pullets. These were reared from day-old on a diet complete in all known nutritional requirements, but deficient in protein. At 14 days old they were put on to the test rations, and live-weight gains and food consumption measured during the following fourteen days. The test rations were based on a mixture of cereal products, yeast, whey, minerals, vitamin concentrates of A, B_2, B_{12}, D and E and penicillin, to which were added either starch to give the 'cereal' control ration, casein and starch to give the 'casein' control ration, or protein concentrates and starch to give the 'lucerne protein' rations. Oatfeed was added to all rations to balance fibre contents, and calcium and phosphorus were also balanced. Cholesterol, when fed, was added to make up 0·3 per cent by weight of the ration. The protein concentrates were prepared by heat precipitation (80° C.) from lucerne juice at normal *p*H, with roller drying at 120° C. of the resulting coagulum.

Table 1

Supplementary protein source	Percentage crude protein	Mean weight gained in 2 weeks (gm.)	Protein utilization*	Gross protein value†
Trial A				
'Cereal' control	8·0	37·4	—	—
'Casein' control	11·2	91·8	6·53	100
Lucerne protein	11·3	63·8	3·69	57
Lucerne/grass protein	11·1	68·0	4·23	67
Lucerne protein + cholesterol	11·3	77·3	4·83	74
Lucerne/grass protein + cholesterol	11·2	72·5	4·58	70
Trial B				
'Cereal' control	9·9	40·2	—	
'Casein' control	13·6	109·0	5·03	
Lucerne protein + cholesterol	13·3	95·8	4·46	
Lucerne/grass protein + cholesterol	13·0	86·1	4·09	
Trial C				
'Cereal' control	8·1	43·2	—	
Lucerne protein + cholesterol	11·2	85·2	4·95	

* Gain in weight over 'cereal' control per gram of supplementary protein consumed.

† Least significant difference (5 per cent level) = 6·2.

In trial *A*, lucerne protein (48·4 per cent crude protein) and lucerne/grass protein (42·8 per cent crude protein), both fed with and without cholesterol, were compared with 'cereal' and 'casein' controls. In trial *B* the same samples of protein concentrates, both fed with cholesterol, were compared with the 'cereal' and 'casein' controls, all at protein-levels approximately 20 per cent higher than those of trial *A*. Trial *C* adds evidence on the nutritive value of the lucerne protein sample fed with cholesterol.

The results (Table 1) show that in trial *A* the gross protein values of lucerne and lucerne/grass protein concentrates were higher than that of groundnut meal with a value[6] of 50. The addition of cholesterol raised the gross protein values to nearly that of soya-bean meal with a value[7] of 76. The amounts of the lucerne protein rations consumed were less than those of the casein rations, possibly due to the lower palatability of the former.

It appears that the nutritive value of the lucerne protein concentrate was depressed by a factor, possibly a saponin[8], which was inhibited by cholesterol. Work is in progress on the removal of this factor from protein concentrates, and on other methods of purification. Herbage species other than lucerne are also being studied.

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Pentoses associated with Jute α-Cellulose

Sarkar and co-workers[1] claimed to have shown that jute α-cellulose does not contain any pentose; we showed[2], however, that xylose and arabinose are present, and this was confirmed by Adams and Bishop[3] by a different method. Recently, Mazumdar and Sarkar[4] have suggested that there is an inherent defect in the formic acid method[5] adopted by us for this purpose. As required by them, the chromatogram of α-cellulose prepared from different jute holocelluloses[6] with 17·5 per cent sodium hydroxide is reproduced in Fig. 1 to show that α-cellulose contains xylose and arabinose.

The finding of Mazumdar and Sarkar[4] that glucose hydrolysed by formic acid gives two spots has already been pointed out by us in the case of glucuronic acid[2]. The extra spots are presumably due to formates[7], which could be easily hydrolyse if the hydrolysate is purified by repeated boilin with water and drying[8] (compare G and G_1 in Fig. 2). We have already stated[2] that the extra spot could b readily differentiated from that given by pentose by colour developed with aniline oxalate reagent nevertheless, they find[4] one extra spot the colou and position of which are different from those o xylose and arabinose, which they attribute to thes sugars although we have repeatedly pointed out that these sugars were chromatographically separate and chemically identified and that the chromatogram was certainly 'over-run' (108 hours)[2]. Recently, b using the published formic acid treatment, Adam and his school[9], of the National Research Council Canada, have found xylose very readily and also trace of arabinose in jute α-cellulose. The formi acid method, therefore, has no inherent defect.

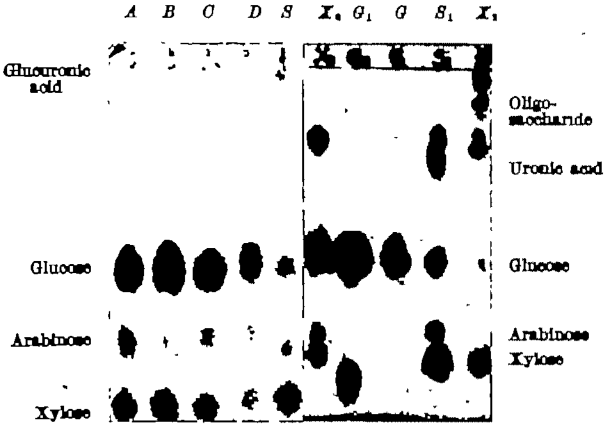

Fig. 1 Fig. 2

Fig. 1. Chromatogram in moist *n*-butanol for 108 hr. on Whatman No. 1 filter paper hydrolysed with formic acid (85 per cent) 3 hr. *A*, Chlorine dioxide α-cellulose; *B*, Cross and Bevan α-cellulose; *C*, Norman and Jenkins α-cellulose; *D*, chlorite α-cellulose; *S*, reference sugars—glucuronic acid, glucose, arabinose and xylose

Fig. 2. Chromatogram in *n*-butanol/acetic acid/water (4 : 1 : 5) for 96 hr. in Whatman No. 1 filter paper

X_1 and X_2, eight times (10–5 per cent) sodium hydroxide treated chlorite α-cellulose, hydrolysed with 85 per cent formic acid for 12 min. and 3 hr., respectively; G and G_1, glucose hydrolysed with formic acid (85 per cent) for 12 min., with and without proper purification, respectively; S_1, reference sugars—galacturonic acid, glucose, arabinose and xylose

The statement by Mazumdar and Sarkar[4] tha jute α-cellulose must contain less than 1 per cen furfural to free it from traces of xylose is open t criticism, as their furfural values[4] of the α-cellulos prepared by a 9·3 per cent solution of sodium hydroxid as well as by their slightly modified method (both o which they claim[4] to be free from pentosan) are 1·4 and 1·23 per cent, respectively. This would appea to mean that α-cellulose prepared by both thes methods and also by the A.C.S. method (2·55 pe cent furfural) contains pentose and supports ou findings.

Furthermore, regarding the proposed extra alternat arbitrary washings of α-cellulose with 10–5 per cen sodium hydroxide over that of the A.C.S. method we feel that by doing so Sarkar *et al.* are not onl deviating from the accepted definition of α-cellulos but also making something other than α-cellulose, a would be evident from the deterioration in colou and decrease in cuprammonium fluidity of a 0·5 pe cent solution ($D = 10·4$; X_1 and $X_2 = 9·2$) afte these alternate alkali washings. Yet, all the product of chlorite α-cellulose (D) after 1, 2, 4 and 8 alternat alkali (10–5 per cent) washings are found to contai readily detectable xylose and traces of arabinose although the furfural content of the eight-times treated sample (X_1 and X_2, Fig. 2) was 0·75 per cent. Thu pentosans are associated not only with conventiona α-cellulose but also with the product of α-cellulos (after repeated washings with 10–5 per cent sodiu hydroxide) having a furfural content even less tha 1·0 per cent, in contradiction to the later statement of Mazumdar and Sarkar[4].

When the duration of hydrolysis of a polysaccharid is as short as 12 min., besides the simple sugars, oligosaccharides are also expected to be formed, a reported by us previously[2] in the case of jut α-cellulose and shown in Fig. 2. While the detailed nature of the oligosaccharides is under investigation, Adams[10], by using the formic acid method, has also confirmed that oligosaccharides are produced. But comparing our chromatogram (X_1) with that o Mazumdar and Sarkar (X) it can be seen that although in the latter the glucose spot is very prominent, no oligosaccharide is found, which in view of the short time of hydrolysis indicates that their jute α-cellulose is easily hydrolysable to a simple sugar (glucose) without the intermediate formation of an oligosaccharide. We find this difficult to understand, especially as they have not reproduced the chromatogram of formic acid-treated glucose to enable comparison to be made with that of their jute α-cellulose.

The above results therefore support our findings that pentosans are strongly associated with jute -cellulose. Their bearing on the structure of -cellulose is under investigation.

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I have some of the α-cellulose prepared in connexion with the communication in *Nature* of December 5, 1953, and will gladly send it to any nterested chemist to verify our finding.

There is little to add to what Meyer has said about pure cellulose (*Nature*, 164, 786; 1949). It is not clear which of Adams's jute fibre and jute straw (in the table) contains xylose and arabinose in the α-cellulose (*Nature*, 172, 28; 1953).

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Abdominal Lymphatic Tissue as a Source of Hyperglycæmic Glycogenolytic Factor

It has been stated by Sutherland and de Duve[1] that the hyperglycæmic glycogenolytic factor of the pancreas is formed in the alpha cells of the islet tissue. Presence of an identical factor in the gastric mucosa ed the same workers to suggest that the argentophil cells of the gastric mucosa, a cell-type believed by some investigators[2] to be identical with the alpha cells of the pancreas, might also be the site of formation of this factor. The recent discovery that cobalt chloride selectively destroys the alpha cells[3] but not the argentophil cells[4] has, however, thrown doubt on the morphological relationship of these cells. The specific site of formation of the hyperglycæmic glycogenolytic factor has not yet been definitely established. The investigations reported here appear to throw further light on this controversial point.

Rabbits of both sexes, average weight 1·5 kgm., were used. The hyperglycæmic glycogenolytic factor was extracted from the pancreas of four groups of animals: (*a*) normal rabbits; (*b*) rabbits treated with cobalt chloride (50 mgm./kgm. body-weight as a 5 per cent solution by intravenous injection once a day for two days); (*c*) rabbits treated with a single intravenous injection of 200 mgm./kgm. body-weight of alloxan monohydrate in a 4 per cent solution; (*d*) rabbits rendered diabetic with alloxan as in group (*c*) and then treated with cobalt chloride as in group (*b*). The hyperglycæmic glycogenolytic factor extracted from the pancreas of these four groups of experimental animals was assayed both by *in vivo* and *in vitro* methods[1]. Hyperglycæmic glycogenolytic factor extracts were first incubated with cysteine and dialysed against chloride phosphate buffer.

In the *in vitro* studies, hyperglycæmic glycogenolytic factor activity was determined on rabbit liver slices incubated in chloride phosphate buffer at 37° C. For purposes of comparison of maximal activity, commercial insulin (Lilly) was used. Varying doses of hyperglycæmic glycogenolytic factor extracts were used and the results expressed in milligrams of fresh tissue required to produce half-maximal activity[5]. The results of *in vitro* studies are given in Table 1.

Table 1. Glycogenolytic Activity of Hyperglycæmic Glycogenolytic Factor Extracts of Various Tissues on Liver Slices

Animal	Tissue	Mgm. of tissue required for half-maximal activity
(*a*) Normal	Pancreas	60
	Gastric mucosa	100
	Lymph glands	40
	Spleen	100
(*b*) Treated with cobalt chloride	Pancreas	50
	Gastric mucosa	100
	Lymph glands	40
(*c*) Alloxan diabetic	Pancreas	50
	Gastric mucosa	100
(*d*) Alloxan diabetic and treated with cobalt chloride	Pancreas	50
	Gastric mucosa	100

While histological studies revealed that in the pancreatic islets of rabbits treated with cobalt chloride most of the alpha cells were either degenerated or destroyed, the hyperglycæmic glycogenolytic factor content of these pancreases was found to be at normal levels. These observations are contrary to the claims of Van Campenhout *et al.*[3] and de Duve *et al.*[4]. The hyperglycæmic glycogenolytic factor content of the gastric mucosa from the animals of groups (*a*) and (*b*) were similarly found to be undisturbed. These features naturally raised the question of specificity of the site of formation of the hyperglycæmic glycogenolytic factor in the two organs.

With the view of correlating the existence of this factor in the two different organs studied, a search was made for the presence of some type of cells common to both. In sections of the pancreas and of the gastric mucosa of rabbits, it was frequently observed that lymphatic tissue occurred in both, either as loosely scattered clusters of cells or as regular lymph nodes. The possibility of these cells being the source of hyperglycæmic glycogenolytic factor was therefore considered.

Abdominal lymph nodes, a large group of which is situated near the ileo-cæcal junction in rabbits, and also the spleen, were selected for study, and the hyperglycæmic glycogenolytic factor contents of these tissues were estimated. The results of the *in vitro* studies are given in Table 1. The extract from the abdominal lymph nodes showed marked activity; that of the spleen also showed activity, contrary to the claims of Sutherland and de Duve[1].

In *in vivo* studies, hyperglycæmic glycogenolytic factor from 2 gm. of pancreas from normal rabbits and from rabbits treated with cobalt chloride gave a 30 per cent rise of blood sugar in rabbits. Hyperglycæmic glycogenolytic factor from 2 gm. of abdominal lymph nodes gave 35 per cent rise of blood sugar in rabbits. Previous treatment with cobalt chloride did not alter the hyperglycæmic glycogenolytic factor content of lymph nodes.

Experiments designed to localize the site of formation of the hyperglycæmic glycogenolytic factor show that it is present in pancreas, gastric mucosa, abdominal lymph nodes and spleen of rabbits both of normal and of experimental groups. The destruction of the alpha cells of the islet tissue of the pancreas has no appreciable effect on the hyperglycæmic glycogenolytic factor content of the pancreatic extract, showing that these cells are not involved in the formation of this factor. The presence of the factor in the extracts of abdominal lymph nodes and spleen suggests that its site of origin may be the lymphatic tissues distributed in the various organs studied.

We wish to thank Dr. B. Mukerji for the interest he has taken in this work.

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Inhibition of the 'Condensing Enzyme' of *Aspergillus niger* by Magnesium

Stern and Ochoa[1,2] found that magnesium (or manganese) was required for maximum activity of the 'condensing enzyme' (oxalacetate + acetyl-coenzyme A ⇌ citrate + coenzyme A) isolated from pigeon liver, and used an assay system containing 4 μM magnesium chloride per ml. The same or similar systems have been used by others in comparing enzyme-levels in different organisms[3–5] and by us in studies of the 'condensing enzyme' of *Aspergillus niger*[6,7]. In later work with the *A. niger* enzyme, we found that magnesium ions were not required and that they were actually inhibitory. Inhibition of the *A. niger* enzyme by magnesium ions differentiates it from the avian enzyme and suggests that some of the lower specific activities reported for enzyme preparations from other organisms[3,5] may reflect the same phenomenon.

Crude extracts and second ammonium sulphate fractions (0·5–0·6 of 0–0·6 fractions) of fresh *A. niger* mycelium were prepared as previously outlined[6,7]. Crude extracts and second ammonium sulphate fractions (0·4–0·6 of 0·5–0·6 fractions) of lyophilized cells were also used as the source of the enzyme. *Escherichia coli* (0–0·6 ammonium sulphate fraction)[7] was used as the source of transacetylase. Ammonium sulphate fractions were dialysed against phosphate buffer before use. One millilitre of the assay system contained: phosphate buffer (*p*H 7·2), 25 μM coenzyme A, 12 units; oxalacetate, 20 μM; acetyl phosphate, 8 μM; L-cysteine, 4 μM; *E. coli* fraction 0·05 ml., *A. niger* fraction, 0·2 ml. of crude extrac or 0·02 ml. of ammonium sulphate fraction. When indicated, magnesium ions were added as magnesium chloride. Incubation was at 28° for 40 min.

Table 1. Effect of Magnesium Ions on Citrate Synthesis

Enzyme preparation	Mg^{++} added	Mg^{++} content, per ml. (μgm.)	Citrate formed, per mgm. protein (μM)	Inhibition (per cent)
1 Extract of fresh cells*	–	0·2	0·17	—
	+	96·2	0·14	17·6
2. Ammonium sulphate fraction of 1†	–	0·1	3·84	—
	+	96·1	2·39	37·9
3. Extract of lyophilized cells*	–	1·4	5·00	—
	+	97·4	4·00	20·0
4. Ammonium sulphate fraction of 3†	–	0·4	31·0	—
	+	96·4	20·6	33·5

* 0·2 ml. *A. niger* preparation/ml † 0·02 ml. *A. niger* preparation/ml

Magnesium was determined spectrographically on dried 1-ml. samples of the complete reaction mixture (without added magnesium ions). Intensities of the magnesium line 2781·4 A. were compared with standards of magnesium chloride using a step sector

Table 1 illustrates the inhibitory effect of magnesium ions (4 μM magnesium chloride) on four different enzyme preparations.

Fig. 1 shows the inhibition of citrate synthesis by different levels of magnesium ions when a second ammonium sulphate fraction of an extract of fresh cells was used as the source of the enzyme. Maximum inhibition (38 per cent) was attained with 4 μM of added magnesium chloride. Further increases, up to five times this level, did not alter the percentage inhibition.

We wish to thank Mr. W. Stockdale, Division o Physics, National Research Council, for carrying out

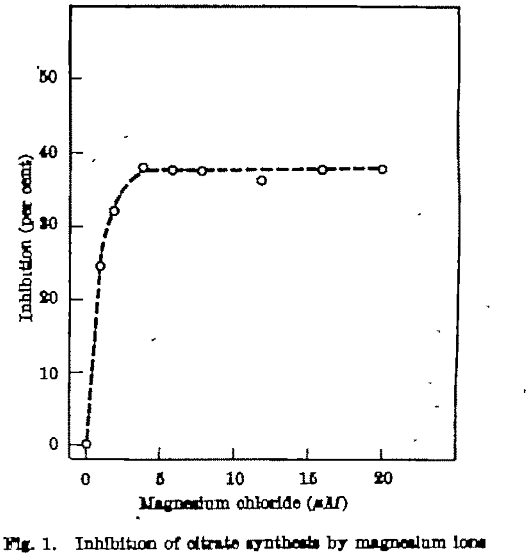

Fig. 1. Inhibition of citrate synthesis by magnesium ions

he spectrographic analyses, and to acknowledge the technical assistance of Mr. J. T. Slobodian.

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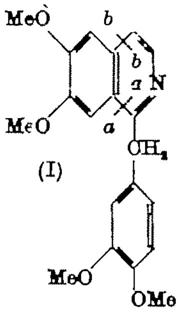
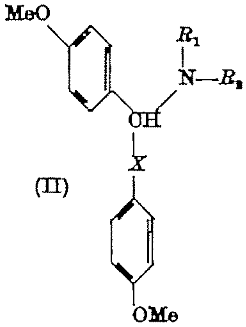
New Synthetic Antispasmodics

A recent publication[1] prompts us to report the preparation of a number of novel synthetic antispasmodics related to papaverine. The numerous synthetic analogues of papaverine (I) which have been prepared (see, for example, Blicke[2]) can be divided into two main groups: (1) those with an intact *iso*quinoline ring system (for example, eupaverine[3]) and (2) those in which the *iso*quinoline ring has been opened at the line *a*—*a* to give a *bis*-(2-phenylethyl)amine (for example, sestron[4]).



(I)



(II)

A third type of papaverine analogue, obtained by opening the *iso*quinoline ring along the line *b*—*b*, does not seem to have been investigated (except that α-diethylamino-4-methoxy deoxybenzoin is reported[5] to have half the antispasmodic activity of papaverine in an isolated observation), and we now report the synthesis and activities of a series of compounds of that type.

A series of N-alkyl-1 : 2-di-(*p*-methoxyphenyl)-ethylamines (II; $X = CH_2$), N-alkyl-α-aminodeoxyanisoins (II; $X = CO$), and N-alkyl-2-amino-1 : 2-di(*p*-methoxyphenyl) ethanols (II; $X = CHOH$) were prepared and, in view of the promising activity of certain 1-phenyl *iso*quinoline compounds, in which the methylene bridge was omitted (for example, neupaverine[3]), a number of N-alkyl-di-(*p*-methoxyphenyl)-methylamines (II; $X = —$) were also synthesized for this work.

Tested on isolated guinea pig ileum against spasms produced by barium chloride and carbachol, using papaverine and atropine as standards, all compounds exhibited spasmolytic activity. In order to obtain a valid comparison, the relative potencies are quoted on a molar basis (see Table 1).

Table 1 Spasmolytic Activities

Compound II			Relative potency (molar)	Compound II			Relative potency (molar)
X	R_1	R_2		*X*	R_1	R_2	
CO	H	Me	0·9	CH_2	H	H	0·8
CO	H	Et	1·2	CH_2	H	Et	0·9
CO	H	*iso*Pr	0·8	CH_2	H	*iso*Pr	1·2
CO	Me	Me	2·5*				
CO	Et	Et	0·2*				
CHOH	H	Me	0·8	—	H	H	0·8
CHOH	H	Et	0·8	—	H	Me	1·8
CHOH	H	*iso*Pr	0·5	—	H	Et	0·8
CHOH	Me	Me	0·2*	—	Me	Me	1·1
CHOH	Et	Et	1·2*	—	Et	Et	1·0
Papaverine			1·0	—	H	*iso*Pr	0·6

* With these compounds spasm of the guinea pig ileum was induced with posterior pituitary extract.

Relative neurotropic activity was between 0·005 and 0·2 of atropine, and acute toxicities (intravenous in mice) were uniformly between 60 and 80 mgm./kgm. for all series; that is, with an LD_{50} of two to three times that of papaverine ($LD_{50} = 30$ mgm./kgm.). In view of these promising results, these and other related compounds are undergoing further investigation, and details will be reported in full elsewhere.

We are indebted to the National Health and Medical Research Council for financial support.

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P. C. Wailes

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R. H. Thorp
R. Ladd
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Pharmacology Department,
University of Sydney. March 31.

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Efficiency of Oxidative Phosphorylation

The quantitative yield of phosphate fixed during cellular oxidations deserves critical investigation, for it determines the efficiency with which utilizable energy may be derived from assimilated foodstuffs and it may influence metabolic regulatory mechanisms[1]. This problem has been the subject of many investigations (cf. Krebs *et al.*[2] and Slater and Holton[3]). In general, the observed yield has increased over a period of years as newer methods of measurement have been developed and particularly as more knowledge has been made available concerning the preparation of undamaged mitochondria which are free from interfering cellular components.

For example, Ochoa[4], in 1944, observed a phosphorus/oxygen ratio of 1·4–1·7 for the single-step oxidation of α-ketoglutarate to succinate by a dialysed extract of cat heart. By correcting for previously measured losses of high-energy phosphate occurring in the system, a value of 3 for the actual ratio was deduced. In more recent investigations with mitochondria prepared from liver heart muscle by the procedure of Schneider[5], the same oxidative reaction proceeds with measured phosphorus/oxygen ratios greater than 3 [3,6,7].

Slater, Cleland and Holton, in an extensive study of heart sarcosomes[3,8], have consistently obtained phosphorus/oxygen ratios lower than 3 for α-ketoglutarate oxidation and have concluded[3] that values greater than 3 are in error. The over-estimation of phosphorylating efficiency is ascribed to an underestimation of oxygen consumption in the case of the work by Copenhaver and Lardy, and to a possible inherent error in the assumption by Krebs *et al.*[2] that rates of incorporation of $H^{32}PO_4^{2-}$ into adenosine triphosphate can be used to calculate phosphorus/oxygen ratios. Arguments supporting these contentions were presented *in extenso* by Slater and Holton[3] and those pertaining to our paper will be answered briefly here.

Stoichiometry of the reaction. Slater and Holton[3] find heart sarcosomes, in the presence of 0·01 *M* malonate, oxidize α-ketoglutarate beyond the stage of succinate (O/α-kg = 0·95–1·28; mean 1·13); Copenhaver and Lardy, in twenty experiments, obtained values of 0·8 to 1·1; mean, 0·975. From the low inhibition index of malonate vs. succinate, one would predict that 0·01 *M* malonate is sufficient to block succinate oxidation virtually completely. This was put to test using the experimental conditions described[6], and it was found that 5 μmoles of succinate (the average amount formed during the 15–25 min. experimental period) supported no discernible oxygen consumption above that in control flasks without added substrate. The respiration in the latter case was either zero or so low as to be an insignificant portion of that occurring in the presence of substrate. (Experiments have also shown that the hexokinase preparation used[6,9,11] does not fix inorganic phosphate in the absence of mitochondria.)

Measurement of oxygen consumption. Slater and Holton[3] consider a 5-min. equilibration period insufficient to bring the flask contents to equilibrium in the 30° Warburg bath. They cite an experiment attempting to duplicate the technique employed in this laboratory. They report that with their equipment a period of 22 min. was required to reach thermal equilibrium, that a lag in oxygen consumption occurred during the first 5 min. of measuring respiration, and that a phosphorus/oxygen ratio of 4·55 is obtained. Under our conditions (thin-walled flasks of 16 ml. volume, 3·0 ml. fluid, bath covering flasks above ground joint, shaking at 120 excursions/min. and stopcocks closed during last minute of equilibration period) thermal equilibrium is reached in 5 min. (± 2 mm. of Brodie's fluid). The complete absence of a lag period in oxygen consumption in our phosphorylation experiments is shown in eleven charts in the paper[6] accompanying that criticized by Slater and Holton.

Stability of mitochrondrial system. Slater and Holton[3] consider metal chelating agents such as ethylenediaminetetraacetic acid to be essential to stabilize the enzyme system of sarcosomes. It is possible that the higher level of adenosine triphosphate employed in our experiments (0·002 *M*) accomplishes the same result, for respiration is a linear function of time for periods of at least an hour when an adequate supply of inorganic phosphate and phosphate acceptor is present[9]. Under these conditions (Fig. 4, ref. 9) the measured phosphorus/oxygen ratios for α-ketoglutarate oxidation in the absence of agents which block the Krebs cycle is 2·8 at a 20-min. and 2·56 for a 70-min. experimental period. Slater and Holton (Table V, ref. 3) find a ratio of 1·71 for a similar unblocked system with rat heart sarcosomes prepared in saline-ethylenediaminetetraacetic acid. From this it is clear that the liver mitochondria prepared in sucrose were fixing more phosphate per unit of oxyge consumed than were the sarcosomes. As has bee pointed out[3], these differences are not inherent i the two tissues, for Maley and Plaut[7] find phosphoru oxygen ratios greater than 3 for α-ketoglutara oxidation by heart mitochondria and Slater an Holton[3] find 2·5 for liver mitochondria.

A most critical test of the degree to which oxidatio is 'coupled' with phosphorylation involves th measurement of respiration in the presence an absence of a phosphate acceptor system[10,11]. Th respiration of fresh mitochondria is enhanced som four- to fifteen-fold by the addition of a phosphat acceptor or by agents such as 2,4-dinitrophenol[1,1 and, in general, systems which do not exhibit thi effect have a lowered phosphorylation efficiency. I is felt that this test should be applied routinel when there is any doubt about the phosphorylatin efficiency of mitochondrial preparations.

Phosphorylating efficiency during oxidation of β hydroxybutyrate. It is generally agreed that th oxidation of α-ketoglutarate to succinate support one more phosphorylation than does the oxidatio of β-hydroxybutyrate to acetoacetate. Quantitativ studies of the latter oxidation with mitochondri have yielded phosphorus/oxygen ratios between 2· and 3 [4,5,11]. Ratios as great as 2·5 have been measure after 180 min. equilibration[11].

These results support the view that the phosphoru oxygen ratio for oxidation of β-hydroxybutyrat approaches 3, while that for oxidation of α-ketc glutarate to succinate approaches a value of 4.

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Chemical Form of Phosphorus-32 produced in Aluminium by Bombardment with Nitrogen

MULTIPLY-CHARGED ions of elements up to neo have recently been accelerated to energies of th order of 100 MeV. in the Nuffield Laboratory 60-in cyclotron at Birmingham[1]. Some of these ions hav been used in bombardment studies[2]. Among th radioactive products is phosphorus-32, which i formed, for example, in relatively large yield i bombardments of aluminium-27 with $^{14}N^{6+}$ ions. W have carried out experiments designed to show i what chemical state these atoms are held in the target

The results of the experiments indicate that o dissolving a bombarded aluminium foil in sodium ydroxide solution in the absence of air, about two-irds of the recovered activity is carried by gaseous hosphine and the remainder enters solution as a duced oxy-phosphorus ion, probably hypophosphite. he proportion forming phosphate ion is undetectable ithout the use of drastic oxidizing conditions. We ave shown that the reducing action of the aluminium dissolving, under our experimental conditions, is sufficient to convert more than a very small fraction previously dissolved hypophosphite to phosphine. his suggests, although it does not prove, that the dioactive phosphine is a true primary chemical action product.

The absence of phosphorus-32 in the form of hosphate ion indicates that the phosphorus-32 atoms, though undoubtedly initially formed with a high sitive charge, do not persist in that state. On the her hand, the presence of radioactive hypophosphite n shows that not all the phosphorus-32 atoms main in the lattice as phosphide ions, because if is were so one would expect to get all the activity phosphine. This suggests an intermediate valency ate.

It does not seem likely that oxygen atoms dventitiously present in the target can have affected e result. Whitmore showed that when phoshorus-32 is produced by fast-neutron irradiation of iourea or sodium sulphide, no activity appears as hosphine on treatment with air-free water; by far e larger part of the activity is found as one or ther of the oxyphosphorus acids[3]. However, no pecial precautions were taken to exclude oxygen gorously during the bombardment, and Koski has own that in the production of sulphur-35 by fast-eutron reactions in potassium chloride the rigorous pulsion of occluded air enables one to observe the lphur-35 atoms in a sulphide fraction rather than s sulphate[4]. The oxygen content of spectroscopically ure aluminium is, however, very low by ordinary andards except, of course, at the surface, and in ny event it is doubtful whether phosphorus atoms uld successfully compete for oxygen atoms with e aluminium.

As is well known, the reaction between ordinary lemental phosphorus and caustic alkali leads to the rmation of phosphine and hypophosphite ion in e molecular ratio 1 : 3. Our results would therere have been obtained if half the phosphorus-32 toms had reacted as phosphide and half as elemental hosphorus. An objection to this naive view is that ne could not fairly expect an isolated phosphorus tom embedded in a foreign lattice to undergo the me reactions as in its normal elemental environent. Furthermore, we find it hard to believe that e phosphorus-32 atoms are held in the aluminium non-equivalent states; for the lattice must be riously disturbed by the passage of the phoshorus-32 atoms (and other reaction products and ombarding particles) before coming to rest, the total nergy dissipated, in many experiments, being fficient to raise the temperature of the target early to the melting point. Consequently, all the hosphorus-32 atoms must have been able to find tes of minimum potential energy.

An explanation of the observations must therefore e sought in a consideration of the chemical species hich may be supposed to react with the phoshorus-32 atoms. These comprise not only water olecules, hydrogen ions and hydroxyl ions, but also ydrogen atoms produced by the reaction of neighouring aluminium atoms with the dissolving solution. On this basis we may postulate that the phosphorus-32 atoms are all present in a very low, or even zero, state of charge, and the reaction yields reflect competition between overall reactions such as:

$$P + 3H \rightarrow PH_3\,; \qquad P + 2H_2O \rightarrow H_3PO_2 + H$$

or

$$P^+ + 4H \rightarrow PH_3 + H^+\,; \qquad P^+ + 2H_2O \rightarrow H_3PO_2 + H^+.$$

It is clear that a great deal remains to be understood about this kind of problem, and we hope, when the cyclotron is in operation again after the current reconstruction is completed, to make a more detailed investigation. We should like to thank Prof. P. B. Moon and Dr. D. Walker, of this laboratory, and Dr. A. G. Maddock, of the University of Cambridge, for useful discussions.

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Methods of Calculation of Polarographic Currents for Depolarization Schemes involving Reactions of Higher Order

IN the course of investigations concerning the mathematical analysis of rate-controlled polarographic limiting currents, rigorous methods have been worked out which make it possible to evaluate the rate constants of chemical reactions involved in the depolarization process, when the reactions are of the first order (for review, see ref. 1).

If the depolarization process at the dropping mercury electrode involves a reaction of the second or higher order, the depolarization current resulting from the flux of the depolarizer at the electrode surface can be calculated by solving the following general system of equations:

$$\frac{\partial a_i}{\partial t} = D_i \frac{\partial^2 a_i}{\partial x^2} + \frac{2x}{3t} \frac{\partial a_i}{\partial x} + F_i\,(a_1, \ldots a_n)\,; \quad i = 1, \ldots n. \tag{1}$$

$$x > 0,\ t = 0 : a_i = \alpha_i\,; \tag{2}$$

$$x = 0,\ t > 0 : D_i \frac{\partial a_i}{\partial x} = \sum_{j=1}^{n} m_{ij}\, a_j\,; \tag{3}$$

where the second term on the right-hand side of equation (1) accounts for the expansion of the electrode against the solution[2], x is the distance from the surface of the dropping electrode, t the time measured from the beginning of drop formation, a_i and D_i the concentration and diffusion coefficient of reactant A_i, respectively, and m_{ij} the rate constants of the electrode reactions referred to unit area; these depend on the electrode potential. Now whereas for monomolecular reactions the last term of equation (1) may be written in general

$$F_i\,(a_1, \ldots a_n) = \sum_{j=1}^{n} k_{ij}\, a_j, \qquad (4)$$

this does not hold for the case of reactions of a higher order.

In view of the difficulties involved in the solution of problems of this type, the treatment will be restricted here to cases where the chemical reactions involved in the depolarization scheme are either very slow (case *A*) or very fast (case *B*).

In both cases, we first try to find linear combinations of the type

$$\psi_k = \sum_{l=1}^{n} \varkappa_{kl}\, a_l \qquad (5)$$

which would satisfy equations of the type

$$\frac{\partial\psi_k}{\partial t} = \overline{D}_k\, \frac{\partial^2\psi_k}{\partial x^2} + \frac{2x}{3t}\, \frac{\partial\psi_k}{\partial x}. \qquad (6)$$

In case *A*, equations (6) as well as the equations for the remaining concentrations a_l are transformed by introducing the independent variables s_i and η[3,4]:

$$s_i = \frac{x}{\sqrt{\frac{12}{7}\, D_i t}}, \quad \eta = Ct. \qquad (7)$$

The solution is taken to be of the form

$$a_i = \sum_{j=1}^{\infty} \varphi_j^{(i)}(s_i)\, \eta^j, \qquad (8)$$

where the functions $\varphi_j^{(i)}$ satisfy the equations:

$$\varphi_j^{(i)''} + 2s_i\, \varphi_j^{(i)'} - \frac{12}{7}\, j\varphi_j^{(i)} = g_j\,[\varphi_0^{(1)}, \ldots \varphi_{j-1}^{(1)}; \ldots; \varphi_0^{(n)}, \ldots \varphi_{j-1}^{(n)}]. \qquad (9)$$

Here g_j can be regarded as known functions of s_i. Since the solution of equation (9) with the right-hand side equal to zero is known[1-4], the solution of the complete equations (9) presents no further difficulty. The integration constants appearing in this solution can be determined from the boundary and initial conditions (2) and (3), respectively. The mean value of the polarographic depolarization current is then calculated in the usual manner[3,4]. The successful evaluation of the specific rate of dismutation of pentavalent uranium from the limiting currents of the uranyl ion represents a special case of this general treatment[5,6].

Considering case *B*, it is often possible to write the differential equations (1), left after the transformation (5) in an approximate form (cf. refs. 3, 4),

$$D_i\, \frac{d^2 a_i}{dx^2} - \phi_i\,(a_i\,;\; \psi_1, \ldots \psi_m) = 0, \qquad (10)$$

where $\psi_1 \ldots \psi_m$ are defined by equations (5). For small values of x, the functions ψ can be regarded as independent of x, so that:

$$D_i\left(\frac{da_i}{dx}\right)^2 = 2\!\int\!\phi_i\,(a_i;\; \psi_1, \ldots \psi_m)\, da_i + K. \qquad (11)$$

Since equilibrium of the chemical reaction is established at distances from the electrode which are negligible compared with the thickness of the diffusion layer, the value of the constant K in equation (11) can be determined. Equation (11), which represents the relationship between $\partial a_i/\partial x$ and a_i, makes it possible to eliminate the functions a_i from the mathematical formulation of the problem, just as in the treatment of very fast monomolecular reactions, and thus to reduce this problem to a simpler one, which is non-linear merely in the boundary conditions. It can be easily solved by means of the transformation (assuming the form[3,4]:

$$\psi_j = \sum_{k=0}^{\infty} \gamma_k^{(j)}\,[K_{jk}\,(s_j) - p_{jk}\, L_{jk}\,(s_j)\,]\eta^{k/2} + \frac{2}{\sqrt{\pi}}\, \psi_j^{(0)}\, L_0\,(s_j), \qquad (1$$

where

$$\psi_j^{(0)} = \sum_{l=1}^{n} \varkappa_{jl}\, a_l. \qquad (1$$

For the coefficients $\gamma_k^{(j)}$ recurrent relations a obtained by substituting (12) into the bounda conditions (3). The latter method has recently be applied in mathematical analysis of polarograph limiting currents due to the electro-reduction formaldehyde in unbuffered solutions. Under the conditions the hydroxyl ions, produced in the electro-process, catalyse the establishment of the equilibriu between the hydrated, polarographically inactiv and non-hydrated active forms of formaldehyd the former being always in a large excess over t latter[7].

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Oxygen-18 Abundance in Fresh Water

MASS spectrometric tests of the oxygen-18 abundance, a_f, in a hundred and nine freshwater sampl obtained from various parts of the world, ha shown very considerable variations. When t samples are compared in relation to the climat conditions of the area of collection, the results indica a much decreased oxygen-18 abundance as t climate becomes colder. The deviations from a s standard ranged between + 32 × 10^{-4} and − 17 10^{-4} atom per cent.

This is due, principally, to the fact that ocean-wat vapour travelling towards colder regions yields pr cipitation the oxygen-18 abundance, a_p, of which, (account of the comparatively low vapour pressu of $H_2{}^{18}O$, is higher than the oxygen-18 abundanc a_v, of the vapour. In the remaining vapour, a_v a a_p in consequence gradually decrease. This fa has been confirmed experimentally by measur ments on precipitation from warm fronts. The measurements are in agreement with the followi formula, computed for variations in a_p with t temperature, T° K., of the condensed vapour:

$$\Delta(\log a_p) = \Delta(c_1 + \log(c_2 + c_3 T) + c_4 \log T + \left(c_5 T - \frac{c_6}{T}\right) \times 0{\cdot}43429$$

the c's being constants depending on a_v at the b ginning of the condensation, the evaporation tem rature of the water, and the vapour pressures, p and ^{18}p, of $H_2{}^{16}O$ and $H_2{}^{18}O$.

Conversely, evaporation will cause a rise in the xygen-18 abundance, a_f, in the remaining water.

By repeated circulatory processes, consisting of ying up on account of $\Delta T°$ cooling, warming up d renewed saturation, fractionation takes place, hereby the oxygen-18 abundance of the vapour, a_v, nverges towards a value where the deviation from e oxygen-18 abundance in the added vapour nstitutes :

$$1{\cdot}22 \times 10^{-4} \times \Delta T \frac{f}{1-f} \text{ atom per cent,}$$

here f is the ratio of the absolute humidity of the tmosphere at the beginning and at the termination f the condensation.

Since

$$a_p \cong a_v \frac{^{16}p}{^{18}p}\,,$$

e value of a_p for a certain precipitation depends on : 1) the nature of the circulatory processes earlier assed through by the atmosphere, namely, evaporation temperature, magnitude of earlier precipitations f water, and condensation temperature ; (2) evapration during precipitation from the cloud to the round ; and (3) origin of the vapour.

Point (3) implies that vapour from freshwater ontinental vapour) is considerably lighter than ocean vapour. Thus, 106 measurements of oxygen-18 bundance in vapour, a_v, from the Copenhagen area, aken over a period extending from about April 1953 o April 1954, showed that there was a distinct correlaion between a_v and deviations of the wind from the asterly direction. There were, moreover, appreciable easonal changes in a_v in the course of the year. he deviations from a set standard varied between + 10·3 × 10^{-4} atom per cent in July and − 5·8 × 0^{-4} atom per cent in February, corresponding to a ore intensive cooling off in the winter season.

For a certain locality, the oxygen-18 abundance, $_f$, of freshwater also depends on : (4) the proportions f water lost by drainage and by evaporation from he ground ; (5) the exchange of oxygen-18 between he ground water and substances in the ground ontaining oxygen.

Measurements of sixty-one samples of precipitation howed comparatively large variations in a_p (ranging rom + 9 × 10^{-4} to + 31 × 10^{-4} atom per cent) ; owever, the mean value (+ 22 × 10^{-4} atom per ent) was in agreement with that of a_f for the ground vater ; consequently, points (4) and (5) can scarcely e of any significance in the conditions prevailing in enmark.

Since the significance of point (3) for the oxygen-18 bundance, a_p, of the average precipitation can be etermined from climatological data, while point (2) s of no significance in violent and/or persistent recipitation, it is possible by measurements on the recipitation, the vapour and the ground water nd by noting the climatological and the geographical onditions, to arrive at a quantitative interpretation f oxygen-18 abundance for freshwater, a_f, at a iven locality.

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Odour and Chemical Constitution

In a discussion of this problem, Dr. G. Malcolm Dyson (*Nature* of May 1, p. 831) refers to "the 'camphor-like' groups in which such diverse substances as camphor, hexachloroethane, benzene hexachloride and perchloronaphthalene have closely related odours".

Many years ago (*J. Chim. Phys.*, 35, 331 (1938), and also 3e Congrès National des Sciences, Bruxelles; 1950) and in my recent book, "Les Constantes Physiques des Composés Organiques Cristallisés" (Masson and Co., Paris, 1953, pp. 49–51 and p. 500), I have pointed out that most such substances belong to a natural group of organic compounds, defined by their low entropy of melting (< 5). As their molecules have a spherical shape, I proposed for them the name of 'globular compounds'; they possess many other common properties, although as different in their chemical constitution as natural camphor, α-hexachlorbenzene and artificial camphor, $CCl_3.C(CH_3)_2.OH$.

So far as I know, most compounds smelling like camphor have that configuration (methyl*cyclo*pentanol has not), but all globular compounds do not smell like camphor.

I have directed the attention of physiologists to this curious relation between the olfactory properties and the stereochemical configuration of such compounds, a relationship which is quite different from the study of small changes in the chemical constitution of organic compounds and their physiological action, as has hitherto been made.

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Caution in the Use of Liquid Propane for freezing Biological Specimens

One of the recent innovations in freezing and drying technique is the use of liquid propane for rapid freezing. This material has explosive possibilities when cooled in liquid nitrogen that many investigators do not seem to realize. Liquid nitrogen boils at − 195·8° C., liquid oxygen at − 183·0° C. It is common experience that if a vapour trap is cooled with liquid nitrogen and open to the atmosphere, oxygen will condense in it. Since propane melts at − 189·9° C., in the range of temperatures between its melting point and the boiling point of oxygen it is theoretically possible to get a mixture of liquid oxygen and liquid propane.

On one occasion when I was slowly condensing propane in a flask chilled with liquid nitrogen, I obtained what appeared to be such a mixture : that is, I obtained two distinct layers of liquid in the flask, one of which had the characteristic appearance of liquid oxygen.

This experience suggested two precautions to be observed when working with liquid propane : (1) when condensing the material, to keep a sufficiently rapid flow into the condensing flask to exclude air ; (2) keep the material at all times above the boiling point of oxygen, say, above − 180° C. Of course, similar precautions should be observed with other combustible materials the melting point of which is below the boiling point of oxygen.

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Scientific Officer (honours graduate, preferably with postgraduate experience in genetics), at the Plant Breeding Station—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (August 4).

Assistant (with a degree in agriculture or pure science, with special qualifications in botany or crop husbandry) in Agriculture—The Secretary, The University, Aberdeen (August 7).

General Assistant Engineer (with a degree in electrical or mechanical engineering or in physics), at the British Electricity Authorities Research Laboratories, Leatherhead for duties which include testing, development and research work in the laboratories; and in the field in connexion with the generation, transmission and distribution of electricity—D. Moffat, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting N/481 (August 7).

Lecturer (university graduate in physics, with teaching and/or industrial experience) in Physics, to teach to B.Sc. general degree standard—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (August 7).

Principal Scientific Officer (with a first- or second-class honours degree in engineering, or equivalent, and preferably with a knowledge of French and/or German and experience of committee work) in the Mechanical Engineering Research Laboratory (Materials Division), East Kilbride, Glasgow, to lead a team determining the mechanical properties of materials, studying fatigue, and examining machine parts which have failed in service—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4356/54 (August 12).

Physics Lecturer (with a first- or second-class honours degree, and preferably with experience in the nuclear reactor field at the appropriate level, and teaching ability) to take charge of the Physics Course in the Reactor School—The Establishment Officer, Atomic Energy Research Establishment, Harwell Berkshire, quoting 2/103/119 (August 13).

Assistant Lecturer in the Department of Geography and Anthropology—The Registrar, University College of Wales, Aberystwyth (August 14).

Assistant Lecturer in Zoology, and a Research Demonstrator in Zoology—The Registrar, The University, Reading (August 14).

Physicist (Ph.D. standard, and prepared to spend a considerable time abroad), to collaborate with geologists in the collection and preparation of rock samples and in the measurement of their magnetic properties over a wide area—Prof. Blackett, Physics Department, Imperial College of Science and Technology, London, S.W.7 (August 14).

Senior Physicist (with some knowledge of the chemical and biochemical procedures associated with the clinical applications of radioactive isotopes), to be responsible, under the direction of the Regional Physicist, for providing technical advice and assistance to clinical research teams using radioactive isotopes—The Administrative Officer, Board of Management for Glasgow Western Hospitals, Regional Physics Department, 9–13 West Graham Street, Glasgow, C.4 (August 14).

Lecturer (with a special interest in the strength of materials) in the Department of Mechanical Engineering—The Registrar, The University, Liverpool (August 21)

Lecturer in Applied Mathematics at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 27).

Lecturer and an Assistant Lecturer in the Department of Physics—The Registrar, The University, Manchester 13 (August 28).

Lecturer or Assistant Lecturer in the Department of Mathematics at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 30).

Chemist (with a specialized interest in analytical techniques), for a permanent academic appointment with the status of Fellow or Senior Fellow, responsible for the Analytical Section of the Department of Radiochemistry, Research School of Physical Sciences, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

Lecturer (with qualifications in cultural (including economic) geography, and ability to conduct postgraduate courses in economic, historical or colonial geography) in Geography; and a Lecturer in Chemistry, at Auckland University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

Senior Lecturer in Chemistry at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

Senior Lecturer (with an honours degree or preferably a higher degree and, in addition, teaching and/or industrial experience in metallurgy) in Metallurgy, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, August 31).

Senior Research Fellow (with experience in wind-tunnel work) in the Department of Aeronautical Engineering, to design new high-speed laboratory equipment, and to take a leading part in research work—The Secretary and Registrar, The University, Southampton (August 31).

Scientific Officer (with a good honours degree in chemistry, biochemistry or botany, and a sound knowledge of organic chemistry and keen interest in the living plant) in the Biochemistry Section, for research on the biochemistry and metabolism of the fruit tree—The Secretary, East Malling Research Station, near Maidstone, Kent (September 7).

Assistant Lecturer (with an interest in histology) in Anatomy—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (September 11).

Lecturer or Assistant Lecturer in Geography at Makere College, University College of East Africa—The Secretary, Inte University Council for Higher Education in the Colonies, 1 Gord Square, London, W.C.1 (September 30).

Scholars (with a M.Sc. degree or equivalent research experienc in the Departments of Biochemistry, Microbiology and Physiology, John Curtin School of Medical Research, Australian Nation University—The Secretary, Association of Universities of the Brit Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

Chair of Agriculture, Chair of Physics, Chair of Chemistr Chair of Botany and Chair of Zoology at Rhodesia Universit College, Salisbury—The Secretary, Inter-University Council for High Education in the Colonies, 1 Gordon Square, London, W.C. (October 18).

Assistant Lecturer (with a degree in physics or equivale qualifications, and preferably with industrial experience) in Natura Philosophy—The Secretary, Royal Technical College, Glasgow.

Chemical Engineer (with a first- or second-class honours degre in chemical engineering or equivalent, with considerable postgraduat experience in development work, including the design of pilot plant at a Ministry of Supply Establishment in S.W England, for wor concerned with the development of technical processes involving semi technical research, and the design and operation of pilot units—Th Ministry of Labour and National Service, Technical and Scientif Register (K), 26 King Street, London, S.W.1, quoting F501/54A

Demonstrator in Physics—The Registrar, The Universit Nottingham.

Geologist (with an honours degree in geology) with the Falkland Island Dependencies Survey, for service at Hope Bay in the Antarct —The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 quoting M3B/34380/TA.

Head of the Department of Organic Chemistry—The Academ Secretary, Weizmann Institute of Science, Rehovoth, Israel.

Lecturer (graduate, and able to teach agricultural botany an zoology, including entomology, to diploma standard) in Agricultura Botany—The Principal, Shuttleworth College, Old Warden Park Nr. Biggleswade.

Meteorological Assistants (male or female) (with considerabl experience in routine meteorological office work, especially the makin of observations and the plotting of maps); and a Senior Meteorological Assistant (male) (able to maintain meteorological instruments and prepare climatological records), with the Bermuda Government—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 quoting M3B/34501/NF.

Senior Lecturer in Chemical Engineering, to plan new course and laboratories—The Principal, Royal Technical College, Salford.

Senior Scientific Officer (with a first- or second-class honour degree in chemistry, or equivalent qualifications, and at least thre years postgraduate experience including supervision of staff in researc laboratories), to be responsible for advising technical and professiona staff on safety matters in relation to laboratories, pilot plants, an production techniques, in a wide range of chemical and physica research problems—The Administrative Officer (Recruitment), Atomi Weapons Research Establishment, Aldermaston, Berkshire, quotin 132/WGH/2.

Soils Research Officer (with a first- or second-class honour degree in an appropriate scientific subject, and experience in the techniques of physical and chemical analysis of soils and the interpretatio of the results obtained), at the Alice Holt, Surrey, branch of the Forestry Commission, to carry out soil studies in connexion wit ecological, silvicultural and pathological problems in British forestry—The Ministry of Labour and National Service, Technical and Scientifi Register (K), 26 King Street, London, S.W.1, quoting G254/54A.

Statistician (with suitable qualifications, and preferably experienc at field trials)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Brompton Hospital Reports. Vol 22 (1953). Pp. ix+165. (London: Brompton Hospital, Research Department, 1954.) 15s. net. [226

Library Association. Subject Index to Periodicals. January to March 1954. Pp. iv+71. (London: Library Association, 1954.) 3 quarterly issues and annual cumulation £10. (£8 8s. to members). Annual cumulation only £8 8s. (£7 to members). [226

International Tin Research Council. Report of the Tin Research Institute, 1953. Pp. 24. (Greenford, Mddx.: Tin Research Institute, 1954.) [226

Television Society. A Bibliography of Colour Television. Pp. 16. (London: Television Society, 1954.) 2s. 6d. [226

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KNOWLEDGE AND RESPONSIBILITY

THE anxiety and alarm which were aroused in the general community by the first reports of the effects of the explosion of the hydrogen bomb in the Marshall Islands on March 1, particularly on account of the contamination reported to have occurred outside the supposed danger-zone and of errors in meteorological prediction and miscalculations of the violence of the explosions, have now somewhat subsided. The Prime Minister, following the reassuring comments made by Prof. M. L. Oliphant and Prof. O. R. Frisch, has refuted the idea that the scientists were unable to set limits to the explosive power of the bombs they were testing. In that sense the explosions were not 'incalculable' and the limits of the danger, though wide, are clearly set.

Nevertheless, in spite of such clear explanatory articles as that of Prof. Frisch in the *Atomic Scientists Journal*, and Mr. Strauss's statement on the tests on March 31, the question has been raised in responsible quarters as to whether it is wise to proceed with such tests. The question was first raised in the belief that it was possible that the consequences of such explosions could no longer be predicted, and the suggestion implied that the decision to discontinue such tests was one for scientists themselves to take. It has further been questioned whether such tests are not merely unwise from a scientific point of view but also even strategically necessary. It has been suggested that atomic weapons may provide adequate deterrents just as effective as the hydrogen bomb and possibly more economical.

Such suggestions have tended to encourage a popular belief that the scientist carries a much larger share of responsibility than can fairly be attributed to him, and this view is also fostered by the way in which the general issue of the scientist's power over Nature is presented, for example, in Mr. Charles Morgan's "The Burning Glass" (Macmillan and Co., Ltd., 9*s*. 6*d*.). There have always been people who are ready to call a halt to scientific and technological advance. When Mr. Morgan writes in the introductory essay to his play, "History moves in phases; the power-phase may be drawing to its close; there may be a halt for many centuries in all but the minor developments of technology", he is expressing a hope which is evidently shared by many men and women and also by the central character of his play—Christopher Terriford—whom he describes as "not the only man of science with the wisdom to desire it".

Much to be found in Dr. Lewis Mumford's writings outstrips the imagination of power as a self-vindicating end; but this is not to accept the thesis that the scientist should abandon his quest for formidable sources of power, or at least should not disclose them to his fellow-men. To do so is in fact to accept a responsibility which belongs to the community and not to any one section of it, and the great value of this essay of Mr. Morgan's is that, dealing with power over Nature in general terms, it throws a good deal of light on the real issues involved in the use of the scientist or technologist in the service of the State.

The central theme of the play is the right of the scientist to withhold knowledge and whether there are not inexorable limits to the mind of man. Mr. Morgan believes that there are such limits, and that we should deliberately limit our powers over Nature, because the development of that power has reached a stage which implies a subversion of the natural order. In the belief that this subversion is devilish and that the limitation of power is the only way of restoring balance and sanity to life, Mr. Morgan portrays a scientist in whom the tradition of scientific research, with its presupposed community of knowledge to which his results are freely contributed, is in conflict with his impulse to conceal a discovery on which he has stumbled by one of those intuitive and inexplicable leaps of mind of the creative worker, because of its devastating consequences if put to military use.

In his introductory essay, "Power over Nature", Mr. Morgan discusses this conflict in Christopher Terriford's mind and some—but not all—of its implications for the world in the context of atomic power. The dilemma as portrayed here is one with which flashes of intuition might confront the creative worker in many fields of knowledge; but what comes out only imperfectly in the play is that the dilemma is false. The choice to withhold or communicate knowledge, and also the decision as to what action should be taken on it, is not one for the scientist as such. It is one for the community which has set him to work, and ultimately, in a democratic community, for the government which that community has put into power.

Nearly five generations ago, Tredgold defined the profession of civil engineer as "the art of directing the great sources of power in Nature for the use and convenience of man". We might, to-day, fairly speak of science, though Tredgold used the word 'art' in the sense in which it is used in the title of the Royal Society of Arts, implying the use of imagination and experience as well as technique. Mr. Morgan can fittingly write of power over Nature; but Tredgold's definition still gives the better clue to the heart of the problem. The task of the scientist or technologist is to place at the service of the community the resources it needs, and to show how best they can be used. He has the responsibility of warning the community of the dangers that may attend the misuse of such knowledge and the failure to use it with due safeguards. The decision whether or not to use that knowledge in a particular way or for a specific purpose is one which he shares with the community as a whole.

In that sense, accordingly, the problem for the scientist or technologist is one not of power but of influence. His responsibility is not for the use made of the knowledge he places at the disposal of society, but to see that his influence is most effectively exercised—to see that the consequences of using or abusing that knowledge are clearly and fully understood. Divesting himself of the power he is so often in error supposed to possess, he has to see that hi fellow-citizens appreciate the implications of the pow at their disposal, and to help them to make the inte lectual effort required for its control and wise use.

The hydrogen bomb, in fact, involves no fres responsibility for the scientist as such, least of a any new moral dilemma; and once these false ide are cleared out of the mind of the scientist himse and of the society in which he lives, there will b the less risk either of an anti-scientific attitude o the part of the public or of the scientist bein charged with a responsibility which he only shar with the whole community. As the Archbishop York said to the British Association at Liverpool, me of science "have an influence over contemporar thought and action which is possessed by no othe class of men. . . . They must educate their fellow countrymen to use rightly the inventions they hav given them, and must make plain the terrifying result which may follow their wrong use".

Beyond that the scientist has no right to go. H is not entitled, on his own responsibility, to withhol knowledge from the community he serves any mo than, as Dr. J. Bronowski pointed out in a recen broadcast, he is entitled to dictate to the natio about his own discoveries. He must be content t use his influence to guide his fellow-citizens to wis decisions; but he cannot impose these decisions. I return he can ask, in a free society, that he sha himself be free to follow his own conscience and tha society shall not dictate his life to him. He is entitle to urge on society the conditions in which effectiv scientific work is possible and to direct attention t the consequences which may attend restraints on th freedom of scientific investigation and intercours

The real challenge of the hydrogen bomb to th scientist is to consider even more carefully how be scientific thought can be put at the service of th community. If the community is to make th intellectual effort required in the shaping of it institutions to meet the requirements of an age i which technological advance has made so many its political divisions irrational and obsolete, the ma of science has a large part to play. He has to face i the first place the problem of the effective communica tion of knowledge and ideas, so that the leaders of th community can reach sound decisions based on clea appreciation of all the relevant factors, and so tha the community is prepared to accept whatever de mands these decisions may involve. This mean much more than questions of the presentation of hi own ideas and findings. It involves questions education and of public understanding, so that th issue is seen not as one of science letting natural force get out of hand, but of man's self-control and hi use of forces able to destroy him and his works.

For the scientist to take his place in that worl freedom of communication is vital. The scientis who has worked on guided missiles or atomic weapon is, as Dr. Bronowski rightly reminded us, seldom fre to speak as he would like, and this silence is a los to the community. Security considerations ma reasonably prevent the public discussion of technica details; but once such restrictions operate beyon e narrowest of such limits, they do more than mpede the exchange of ideas and the advance of ience and technology: they endanger national curity itself. Once the scientist comes to be silent, experiment or inquire only along orthodox lines, ience itself will atrophy and at last fail the nation which it is thus pursued. Without freedom for ience, and by attempting to silence or intimidate riginal and creative minds, in the end we forfeit curity itself.

Here, too, the scientist has a duty to speak, and hat is required of him in this perplexed and anxious orld to-day is not that he should refrain from ursuing his investigations and from seeking to extend ie boundaries of knowledge, or that he should preoccupy himself with moral issues that are the reponsibility of the whole community of nations. His mmediate responsibility is rather with the way in hich he can most speedily and effectively clarify ublic thinking about the scientific and technical spects of the situation, and facilitate an undertanding of the far-reaching military, economic and olitical decisions which are now imperative. He will e conscious that what he has to say as a scientist epresents only one factor in a complex situation, nd that this has to be compared with, and adjusted o, information from other fields, and evaluated with , in the formulation of policy. But it is important hat the scientist and technologist should, through heir professional associations, address themselves to his question of improving the means by which the echnical or scientific expert makes his contribution o the formulation of policy and the task of government generally. The task of education to be underaken must include that of the leaders of the community as well as of the general public. Above all, he extent to which the influence of the scientist is rought to bear on the formation of policy or the e-shaping of institutions will depend on the willingness of the individual scientist to attempt the prosaic ask of improving the channels of communication. Much will depend upon the effectiveness and clarity ith which he presents and interprets his results and deas to the community, and the fidelity and courage ith which he and his professional institutions defend he freedom of science, not simply for the advancement of science itself but also as an essential element n the preservation of a free society.

LIFE OF THOMAS YOUNG

homas Young
Natural Philosopher 1773–1829. By the late Dr. Alexander Wood; Completed by Frank Oldham. With a Memoir of Alexander Wood by Prof. Charles . Raven. Pp. xx + 355 + 4 plates. (Cambridge: At he University Press, 1954.) 30*s*. net.

IF the subject of this book did not make it immediately attractive, the authors' names would be sufficient recommendation in themselves. The ate Alex Wood gathered material for it over more han forty years and completed ten chapters and otes on two more. It has been finished and seen through the press by Frank Oldham, whose monograph, "Thomas Young, F.R.S., Philosopher and Physician" (London: Edward Arnold and Co., 1933), has, until now, been the standard authority.

In assessing the life and work of Thomas Young, the modern reader is torn between conflicting aspects of the man. If he had been always right we could unreservedly admire the precocious youth who gulped all knowledge of natural philosophy and of classical, European and oriental languages with full Quaker diligence and lack of conceit. We should have unstinted admiration for his mature work as a founder of the wave theory of light and for his solution of the hieroglyphic riddles of the Rosetta Stone, for his explanation of the mechanism of the human eye and for his numerous learned writings on medicine, physics and philology.

On the other hand, had he been less successful, we might condemn him as a quarrelsome man, ponderous and obscure in speech and in writing. His wide range of apparently unrelated interests might cause us to regard him as a butterfly mind rather than as a universal genius, and in his chosen career of medicine he was a failure in spite of much favourable opportunity.

Like most men, however, Young was neither wholly right nor wholly wrong. He was sufficiently right for most of his work to have stood the test of time and to be recognized now as a brilliant series of key contributions to the many fields which he studied. Unfortunately, he was also sufficiently wrong, particularly in his personal relations with other men of science, so as to be caught in the vicious web of priority claims and counter-claims which formed such a seamy side to the development of science in his period. The new material collected by Dr. Wood and Mr. Oldham does much to clarify Young's position and place him in a more favourable light.

It is very fitting that this book, which occupied so much of the leisure of Alex Wood's last years, should contain a sympathetic and eloquent memoir of him by Canon C. E. Raven. It will be appreciated by all those Cambridge men who owe so much to his great personality and teachings, and by all those who have found pleasure and profit in his writings.

DEREK J. PRICE

SCINTILLATION COUNTERS

Luminescence and the Scintillation Counter
By Dr. S. C. Curran. Pp. x + 219. (London: Butterworths Scientific Publications, 1953.) 32*s*. 6*d*.

THE development of methods of scintillation counting has advanced at an almost prodigious pace since Kallmann's first paper became known to a larger public in 1947. Superior in many respects to the older particle detectors and immensely flexible, the scintillation counter has found a steadily growing range of applications, and to-day it is firmly established as an indispensable tool in medicine and industry as well as in physics. Dr. S. C. Curran—himself a pioneer in this field whose unpublished work antedates that of Kallmann—has now written a little volume in answer to the widespread need for a comprehensive guide to the subject.

Well illustrated throughout its twelve chapters by instructive diagrams, the book is centred around a description of the basic mechanisms operating in a scintillation counter: the interaction of radiations and particles with matter, the luminescence process, photoelectricity and secondary emission. From there it proceeds to more technical items, such as the performance of commercial photomultipliers, the properties of scintillating materials and the preparation of crystals. The last chapters contain a survey of representative applications, including the direct counting of particles with open multipliers, and a brief discussion of various problems concerning the associated electronic circuits. Future developments and still unexplored possibilities are hinted at in many instances.

The author was certainly confronted with a thorny task in trying to bring order and proportion into this multitude of different topics. He has not shirked the countless obstacles on his way, but sometimes has not quite succeeded in surmounting them; his choice of emphasis or perspective is often unconvincing, and the great compression of material has led to a high stylistic density which makes the book difficult to read. That the two chapters on luminescence should be the weakest part of the whole can scarcely invite criticism, for it seems well-nigh impossible to give an adequate survey of so intricate and controversial a subject in merely forty pages. But—to touch only a few points—there is no need to digress on the ray-tracing methods of electron optics if afterwards no example is discussed of actual electron trajectories in one of the more common multiplier types; it confuses a delicate issue if the statistical fluctuations in the height of scintillation pulses are treated in connexion with the signal-to-noise ratio pertinent to cinema and television work; and in the section on crystal-growing, the sulphides and tungstates, with their attractive properties, would have deserved more than a few scant remarks. The inquisitive reader could have been helped here or there by the inclusion of references to suitable review articles, but several of the most competent ones are not mentioned.

Despite these shortcomings, the book will be most welcome as an introductory guide to prospective users of the scintillation counter, and as a handy manual to many research workers, bringing together, as it does, for the first time all the multifarious aspects of an exceedingly complex device.

Ernst Breitenberger

MODERN PHYSICS FOR DEGREE STUDENTS

An Introduction to Thermodynamics, the Kinetic Theory of Gases, and Statistical Mechanics

By Prof. Francis Weston Sears. Second edition. (Principles of Physics Series.) Pp. x+374. (Cambridge, Mass.: Addison-Wesley Publishing Company, Inc., 1953.) 7.50 dollars.

THIS text-book, written by the professor of physics at the Massachusetts Institute of Technology, constitutes one of the volumes of the "Principles of Physics Series". It is so eminently readable, however, that it will appeal not only to the physics student but equally to the engineering student who wishes to extend his reading beyond the limits of most engineering texts on thermodynamics.

The book brings together, at degree level, the fundamental principles of thermodynamics, kinetic theory and statistical mechanics. The first half deals with classical thermodynamics. An introductory chapter is followed by a discussion of the equation o state and *p-v-T* surfaces of ideal and real gases. Th sections on the first and second laws of thermodynamics, and their consequences, are separated b a chapter on changes of phase, in which the forms o the *p-v-T* surfaces for real substances are presente in a number of excellent three-dimensional diagrams These are a particular feature of the book. In chapter on the combined first and second laws, th engineer will find a very lucid treatment of th difference between the ice point and the triple poin of water, but will not agree with the statement tha his steam tables are based on the former as th datum state point. A very brief chapter on som engineering applications of thermodynamics concludes this first section.

The second half of the book is devoted abou equally to sections on kinetic theory and statistica mechanics. In the first of these, the derivation of th equation of state of an ideal gas, and a brief discussio of the Clausius and van der Waals equations of state are followed by the determination of the Maxwel distribution function, and a chapter on the transpor phenomena of viscosity, thermal conductivity an diffusion.

The concluding section follows the historical orde in the presentation of statistical mechanics, dealin first with the application of the Maxwell–Boltzman statistics to gases, with a paragraph on the specifi heat capacity of solids, followed by a section on th elementary theory of a paramagnetic gas.

In the section on quantum statistics, the Bose-Einstein distribution function is derived, but is applie only to the two special cases of an ordinary gas and photon gas, to show that the former application lead again to the Maxwell–Boltzmann distribution function and the latter gives the Planck distribution of energ density of radiation with frequency. The Fermi–Dira statistics for an electron gas are then discussed, bu are applied quantitatively only to the conditions a absolute zero of temperature, with a statement of th results obtained at temperatures other than this. final chapter deals with the theory of fluctuations, an its applications to the scattering of light, to Brownia motion and to background noise in amplifiers.

The limitation of the application of statistica mechanics to the simpler cases results in an exceptionally readable introduction to a difficult subject in which the physical implications of the mathematica manipulations are always clearly brought out. A the end of each chapter is a selection of problems with the answers provided. The MKS system of units i used throughout. The book is well produced, an suffers only from a number of minor misprints.

R. W. Haywood

AMERICAN SCIENCE WRITING

Scientific American Reader

Pp. xiv+626. (New York: Simon and Schuste 1953.) 6 dollars.

NOW in its 108th year, the journal *Scientifi American* was taken over five years ago by small group of science journalists who were committe to the belief that there is a growing interest in clea and exact reporting of contemporary scientific event Their skill, energy and enthusiasm has led to succes and to-day the journal has a circulation in excess o 125,000.

To extend their field of readers, the editors have elected some of the articles from their journal which are of particular interest and put them together n book form. These articles have been grouped into welve 'chapters' and include accounts of recent nvestigations in astronomy, geophysics, atomic physics, natural evolution, genetics, the nature of iruses, neuro-humoral activities, animal behaviour, he origin of man, neurology, cybernetics and the basis of sensation and perception.

In the main the quality of the book is remarkably high. The editors deserve tribute for the catholicity f their selection, while most of the writers have earned praise for their clarity of presentation. Since his book is intended to provide a survey of contemporary events in the world of science for the general reader, however, it is surprising to find no reference to recent developments in chemotherapy or electronics. General readers would also have welcomed reference to the latest discoveries in artificial fibres which are already doing so much to change the habits of Western man and woman. Even more remarkable is the complete omission of information bout those new combinations of metals which are enabling man to build aircraft and other machines which were but dreams some twenty years ago. (It s indeed surprising how so many writers of popular science seem to forget the science of metallurgy, with ts overwhelming impact on everyday life. Why?)

In an American book consisting of articles designed mainly for American readers, it is not unexpected that most of the reporting refers mainly to work done by American men of science. An opportunity for popularizing the international character of science may have been lost, however, by the glaring omissions f work being done in other continents. This is all the more peculiar, since many of the American writers f this book began their lives and studies in European and other countries.

Among the outstanding features of a well-written book is a lucid chapter on galaxies in flight by Prof. George Gamow; a good essay on the military nd political implications of the use of the hydrogen bomb by Prof. Hans Bethe; a splendid account of recent researches in geological science by Walter Bucher; and a remarkably clear exposition of the meaning of pain by Prof. W. K. Livingston. A description of experiments in perception by two psychologists is a good example of how science should not be presented to the general reader. The book contains some useful diagrams with valuable explanatory texts.

T. H. HAWKINS

CHEMISTRY OF HETEROCYCLIC COMPOUNDS

ondensed Pyridazine and Pyrazine Rings
(Cinnolines, Phthalazines, and Quinoxalines). By . C. E. Simpson; pp. xvi+394; 12.50 dollars.

Imidazole and Its Derivatives
Part 1. By Prof. Klaus Hofmann; pp. xviii+448; 3.50 dollars.

The Chemistry of Heterocyclic Compounds: a Series f Monographs. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953.)

IT can scarcely be doubted that progress in heterocyclic chemistry has been hampered by the lack f a comprehensive literature. Defined problems invite and inspire solution; but knowledge, when dispersed or in disarray, conceals its own gaps. The Weissberger series of monographs supplies one means by which the need may be met, and the two volumes here reviewed are respectively the fifth and sixth members of that series. Although in different ways, these volumes commemorate the work of two English chemists: for Dr. J. C. E. Simpson's authoritative writing on the chemistry of cinnolines perpetuates the inspiration he brought to the subject before his untimely death; and Prof. K. Hofmann's book is most fittingly dedicated to F. L. Pyman.

The book by Dr. Simpson is in three sections which correspond to the three types of heterocycle named in the title and include chapters both on the reduced systems and on more highly condensed, polycyclic systems. Each chapter deals with a sub-group of related compounds and is complete with a critical account of preparative methods, general properties and reactions, and a tabulated description of individual compounds, all fully documented. The chemistry of cinnolines and phthalazines is exhaustively covered up to the year 1949. The section on quinoxalines, however, although the largest in the book, omits references which are prior to 1917: for these the reader is referred to the review in Meyer–Jacobson's "Lehrbuch". This omission does not detract from the intelligibility of the section. Indeed, the whole book is characterized by a lucid and fluent exposition which succeeds in revealing both the chemical interest of the compounds and the gaps in our knowledge concerning them.

The volume on imidazoles (glyoxalines) has two sections, of which the first (pp. 3–324) is the main text of the book and is devoted to a review of fundamental imidazole chemistry. This is an excellent piece of work. It begins with a résumé of the evidence leading to the current concept of imidazole as a prototropic, highly associated and aromatic structure. There follows, class by class, a critical discussion of synthetic methods and chemical reactions of imidazoles, imidazolines and their derivatives. This is continued for imidazolidines as far as 2-imidazolidones and the corresponding thiones and imides, but at this stage there is an abrupt, unheralded transition to an excellent and comprehensive account of benzimidazoles. Compounds such as hydantoins are thereby omitted and, however expedient this may be, one regrets the break in continuity and unity. It is presumably in accordance with the policy expressed in earlier monographs of the series that imidazole alkaloids are also omitted. These comments do not detract from the value of the material presented. The treatment is sufficiently detailed to reward even the specialist, and yet it maintains a highly readable quality that must commend it to all organic chemists. References are assembled at the end of each chapter, and some of them relate to work published in 1952. The second section is a catalogue—comprising names, melting points, melting points of some derivatives and literature references—of all compounds which fall within the same scope and are found in the literature during the period 1919–50. It is thus in its way a supplement to Beilstein's "Handbuch".

Both volumes are well produced, adequately illustrated by clear structural formulæ and helpfully equipped with subject indexes. In certain places the second volume would benefit, through a less-encumbered text, had superscript numerals been used for references as in the other volume. But this is a small point amid so much that is commendable and welcome.

JAMES D. LOUDON

THE LIBRARY OF THE ROYAL INSTITUTION, 1799–1954

By K. D. C. VERNON

Librarian, Royal Institution

THE Library of the Royal Institution is known to many mainly as the place where the audience at the Friday Evening Discourses gathers before the lecture to meet friends and to look at the exhibits of scientific and general interest. But the Library has a story of its own, which has not been told before in consecutive form.

The first mention of the Institution's Library occurs in the Managers' minutes of April 20, 1799, about six weeks after the original meeting at which the Institution was formed, when it was reported that Sir John Coxe Hippisley, one of the original Managers, presented "A Voyage round the Mediterranean" by Lord Sandwich, and that Thomas Bernard, who, after Rumford, played the foremost and most active part in founding the Institution, presented "A View of Nature", by Richard Joseph Sulivan, a work in six volumes. Other gifts followed immediately.

In June 1799 the house in Albemarle Street, formerly the property of a Mr. Mellish, was acquired at what proved to be a bargain price, and for the next four years the Library continued to grow by means of many generous gifts and by purchases made under the orders of the Managers. The story of these early years can be traced from the Minute Books and from early reports on the state of the Institution written by Count Rumford and published in the first volume of the *Journals of the Royal Institution*. The Library in those days was situated on the ground floor, and consisted of a conversation room and two reading rooms. In the conversation room, 'Proprietors' and 'Subscribers' (the terms used for the members) could obtain at the most reasonable prices, according to one of Rumford's reports, soups of various kinds—doubtless Rumford's soups—tea, coffee, chocolate and other refreshments. "The Reading Room," Rumford said, "is spacious and airy . . . and as it is furnished with double windows and thin white window blinds, it is uncommonly quiet and pleasant though it is situated on the ground floor and near the street. The carriages which pass are scarcely heard through the double windows; and as the blinds prevent it being overlooked from without, it has an air of stillness and retirement which is very striking, and very pleasant to those who frequent it."

The room that is now known as the Main Library, on the first floor, was originally used as a lecture room, until the theatre was built in 1801, when plans were made for turning this room into a "Library and Collection of Reference". Rumford left the Institution in April 1802, however, and with his departure the making of new plans slowed down and the Managers rather halted to take breath and collect their thoughts for the future.

Besides the gifts which were being added to the Library, Rumford made arrangements for the regular receipt of foreign scientific journals and books of importance. The receipt of these foreign publications was quite an achievement at that time, because Britain was then heavily engaged in the Napoleoni Wars, and Rumford boasted in one of his reports i 1801 that "so effectual are the measures that hav been taken for procuring all new foreign scientifi books without delay, that they frequently come t the Institution, from the continent, while they a yet wet from the press".

Davy arrived in March 1801 and Thomas Youn a few months later. Garnett, the first professor, ha fallen foul of Rumford, and left in 1801. Young, o his arrival, immediately started to take an intere in the Library, and the minutes report several tim that he recommended the Managers to purcha certain books and journals for the Library. He mad good use of it for reference purposes, and the wel known engraving "Eminent men of science in th Library of the Royal Institution in 1807–8" indicat some of the other famous men who must have com here to use the books.

The Library was now beginning to prove its wort judging by what Thomas Bernard, the first treasure said about it in a glowing report to the Committee Visitors in 1803 on the present state and progress the Institution: "The Library and proposed collectio of books of reference will form a library establis ment honourable to the British nation, favourable science, advantageous to the pursuits of scientif men, and very conducive to the increase of the fun and of the utility, prosperity, and permanency the Institution". In 1803 a scheme was started f the formation of an additional library of referen for scientific men. This library of reference was be housed in what is now the Main Library on th first floor. The plan was to open a subscription li and everybody who contributed more than £1 would become a hereditary patron; those who su scribed between £50 and £100 would be patrons f life; and subscribers of lesser sums, whose su scriptions together came to £100 or more, cou appoint out of their number one patron for li The application of these subscriptions in providi and fitting up the Library was to be in the hands the patrons, who were also to make their own rule to appoint their own president, treasurer, secreta and committees to conduct their business. Th plan, whereby the upper library became a separa department within the Institution, was later prove unworkable; but it did achieve immedia success at first. Many famous men became patro of the Library, nearly £3,800 was subscribed with a month, and nearly £5,400 within three years— goodly sum in those days for starting a library.

With this money many valuable books were pu chased, and their selection was made with great sk and knowledge, probably under the direction of E Spencer, the chief patron. The largest purchase w made in 1804, when the entire library of print books of the late Thomas Astle, the well-know antiquary and Keeper of the Records in the Tow was bought for a thousand guineas. This libra which now came into the Institution's possessio contained, I believe, more than two thousa volumes which had mainly been collected by Astle father-in-law, the Rev. Philip Morant, author of "The History of Essex", and we still have the manuscript catalogue of this collection. It was rich n topography and history, and many of the books ontain manuscript notes in them by Astle and their previous owners. A lovely copy, bound in red morocco, of Astle's own book "The Origin and Progress of Writing", the 1598 edition of "Holinshed's Chronicles", and a collection of rare and interesting political and antiquarian tracts are among the reasures acquired in 1804. Many of these books from Astle's library would, I think, constitute a valuable source of information for historical research cholars; but their existence here is not widely known.

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* Substance of a talk given before a meeting of the Library Circle at the Royal Institution on March 3.

In June 1803 the patrons appointed Mr. William . Harris, formerly a bookseller's assistant, to be in charge of the Library at a salary of £150 a year and the Managers allowed him to live in the House.' Harris's task was to collect and arrange the Library under the general supervision of the patrons, Dr. Charles Burney acting as honorary librarian. Harris had two assistants, one for the lower and the other for the upper room, and the Library was kept open until 11 p.m. each night.

In July 1803 it is interesting to find that Mr. T. F. Dibdin applied for the situation of principal librarian of the Royal Institution; but he was told that it was not intended to proceed to the choice of a ibrarian until after the following Christmas. Thus the Royal Institution lost the chance of employing a man who later became one of the most famous bibliographers of all time.

But Harris, who was soon afterwards formally appointed Keeper of the Library, served the Institution well. Not very much is known about him; but we have a few facts and we can assume others. He was responsible for building up and arranging the Library at the time when £5,000 was available for spending on this object, and therefore he had the fine opportunity of going to sales and purchasing many books on behalf of the Institution. Dibdin, in his "Bibliographical Decameron", when describing the famous sale of the Roxburghe Library, tells this little story. "Short men were smothered; and nothing but the standing upon a contiguous bench saved the writer of the Bibliographical Decameron from suffocation. Even the worthy Mr. Harris, Librarian of the Royal Institution, who measures some five feet 10 or 11 inches, was compelled to have recourse to the same expedient; and, in so doing, gallantly rescued (at the peril of a compound fracture n his right arm) my excellent friend Mr. James Heywood Markland from an almost overwhelming pressure."

In 1809 Harris produced the first printed catalogue, which was highly praised at the time. Dibdin, in his "Bibliomania", speaks of it thus: "If a lucid order, minute and correct description of the volumes of an admirably chosen library, accompanied with a copious and faithful alphabetical index, be recommendations with the bibliographer, the present volume will not be found wanting upon his shelf. It is the most useful book of its kind ever published in this country. Let the bibliomaniac hasten to seize one of the five remaining copies only (out of the 50 which were printed) upon large paper". Harris, I suspect, was a friend of Dibdin's! By that time the Library of Reference contained more than 12,000 volumes of the best authors and editions in every branch of science and literature, and much credit is due to Harris for the good foundations which he laid for the Library. In 1821 he produced a second edition of his catalogue.

Besides living on the premises, Harris supervised the House under Davy, and it was through an action of Harris's that the opportunity arose for Davy to make his now famous offer to Faraday in 1813 of a post at the Institution. The incident, which led to such remarkable consequences for the Institution, happened one evening in 1812 when Harris heard a commotion in the lecture room and found William Payne, the laboratory assistant, fighting with Mr. Newman, the instrument maker, on a question of attending to the needs of Prof. Brande. Harris presumably reported the matter to Davy. Payne was dismissed, and Davy, a few months later, offered the job of laboratory assistant to Faraday. Thus Harris, by a lucky chance, did more for the Institution than he ever realized. He continued as librarian until the end of 1823 when, through lack of funds, his situation was regretfully terminated. He had served the Institution well for twenty years.

The system of having the Upper Library run under the management of the patrons of the Library and the remaining rooms under the control of the Managers worked well at first; but the dual control system was bound to fail in the end. From the minutes it is obvious that from 1812 onwards the patrons were maintaining the Library with less and less effect. The original funds had been spent, few new subscriptions were coming in and by 1816 the patrons found it difficult even to pay the librarian's salary. Gradually, therefore, the Managers had to step in, and by December 1826, when William Singer was appointed librarian, it was the Managers of the Institution and not the patrons of the Library who henceforward paid his salary. The system of having patrons dragged on until the 1860's; but it gradually passed into limbo and the Library then, quite rightly, came under the direct control of the Managers.

Among the patrons of the Library there were many interesting people. Earl Spencer, who was president of the Institution for twelve years, was also president of the patrons. He took a lively interest in the formation of the Library and, with his vast knowledge and love of books, he was an ideal person to advise and direct the policy of purchasing. His own famous library at Althorp was one of the richest private libraries in Europe—it was sold in 1892 and is now in the John Rylands Library, Manchester. When the Institution missed the opportunity of employing T. F. Dibdin, Earl Spencer snapped him up and made him his librarian at Althorp.

Dr. Charles Burney, the famous musician and author, was one of the honorary librarians for eleven years until his death in 1814, and he took a great interest in the Library, its formation, its growth and its policy. Burney, of course, was famous for his charm and brilliant conversational powers, and I like to think that he must have frequently disregarded the 'Silence is requested' notice in the Main Library.

Rumford was a most generous donor of books, and we still have many volumes which were presented by him; and it is interesting to note that he went on presenting volumes of the *Phil. Trans.* for years after he left the Institution. Perhaps his feelings towards the Institution after his departure in 1802 were not quite so hard and bitter as his biographers have told us.

Sir Joseph Banks, Davy, Thomas Coutts, the banker and founder of Coutts's Bank, James Edwards, the wealthy bookseller and bibliographer, and William Wilberforce were also patrons. To these men and to the other patrons the Institution owes a debt, not only for their generosity, but also for the wisdom and care that they expended in building up the Library.

Faraday, of course, presented many books during his lifetime, and these have an intrinsic and sentimental value here. On his death he bequeathed to the Library his now famous manuscript note-books and diaries, and a number of his own printed books, some of which he had bound himself. With his customary modesty he said in his will ". . . these I offer for the Library of the Royal Institution, if the Managers should think them worth a place". He was one of the patrons of the Library, and it is certain that he took a great interest in it. In some of the old accessions registers long lists of books appear from time to time under the heading "Purchased with Mr. Faraday's concurrence".

Now the Managers, in the Institution's early days, were quite determined to maintain strict discipline over all who used the Library, and upon anybody who dared to misuse it they took most stringent action. For example, the following notice was put up in the Institution after the loss of two books from the Lower Library in 1806: "If the above books have been borrowed under the idea of a right so to do, the Managers request that they may be brought back; and that all persons will abstain in future from taking away any book, as being positively contrary to the laws of this Institution. If, however, it should appear, as in a former instance, that either of the above mentioned books has been fraudulently taken away, the Managers, being determined to subject such an offender to the utmost rigour of the Law, offer a reward of ten guineas, to be paid to the informer upon conviction".

Again, there is the story of Frederick Accum, a German chemist who worked in London and achieved considerable fame in the early nineteenth century by his inventive skill and by his publications. He became a member of the Royal Institution and was employed here for two years from 1801 until 1803 as "Assistant chemical operator"; but he continued to remain a member after resigning this post and was a frequent user of the Library. In the minutes of 1820 it was reported that Mr. Sturt, the assistant librarian, had reported that a number of books had been made imperfect by having several leaves and plates taken out of them, and that these mutilated books were those that Mr. Accum was in the habit of reading. The secretary had directed Mr. Sturt to have holes bored in the cupboard of the room adjoining the Reading Room for the purpose of watching more closely the persons who frequented that room, and on December 20 Mr. Sturt saw Mr. Accum enter the room, where he remained nearly two hours, during which time he watched him very closely from the cupboard and had no doubt but that he had torn several leaves out of a volume of *Nicholson's Journal*, which he had been reading, but owing to a pile of books which was lying on the table, he could not be positive and therefore he did not then interfere. Immediately after Mr. Accum had quitted the Institution, which he did in a hurried and confused manner, Mr. Sturt examined the books which he had seen in Mr. Accum's hands and found that Parmentier's "Treatise on the Composition and Use of Chocolate" had been taken out of *Nicholson'* *Journal*, vol. 5, which he was positive had been entir the week before. The matter was then reported t the local magistrate, who issued a warrant to searc Mr. Accum's house in Compton Street. A numbe of leaves, which Sturt identified as being torn out o books belonging to the Institution, were found. Th case was then brought before the magistrate; bu the magistrate ruled that however valuable the book might be from which the leaves found in Mr. Accum' house had been taken, yet the leaves separated fro them were only waste paper. If they had weighe a pound he would have committed him for the valu of a pound of waste paper, but this not being th case he discharged him.

The Managers, however, were not satisfied wit this ruling and resolved that a Bill of Indictment b preferred against Mr. Accum. This Bill of Indictment was preferred against him for feloniousl stealing and taking away 200 pieces of paper of th value of four pence, the property of the members o the Royal Institution of Great Britain. But by th time this second case was due for trial in April 182 poor Accum had disappeared and returned to hi native Germany, thus forfeiting his honour and £20 bail.

It seems that Accum was probably guilty o mutilating books; but one cannot help but feel tha the punishment was too harsh for the crime. Ou copy of *Nicholson's Journal*, vol. 5, with it missing pages is to-day evidence of these strang happenings.

Under Faraday, Tyndall and Dewar, the Librar continued to grow and in 1857 a new printe catalogue was published. This catalogue was th work of Benjamin Vincent, who was then the keepe of the Library, and supplements were published dow to 1914. Vincent was a scholar in his own right an edited Haydn's "Dictionary of Dates" and th "Dictionary of Biography".

In 1896 Ludwig Mond presented No. 20 Albemarl Street, and thus the Library was extended by th addition of two more rooms.

Henry Young succeeded Vincent as librarian, an Mr. Ralph Cory, as he recently related in his discours on "Fifty Years at the Royal Institution", joine Young in 1899. Mr. Cory was in charge in 193 when the Library was redesigned and rebuilt, and h faced the immense problems of disposing of the book while this work was going on and then in re-shelvin them when it was completed.

The contents of the Library cannot be describe here; but it still possesses among its 65,000 volume many early works of interest. A fine copy of th 1543 edition of "De Humani Corporis Fabrica" b Vesalius; the 1499 Aldine edition of "Astronom Veteres"; a first-edition copy of Gilbert's "D Magnete", 1600; Burton's "Anatomy of Melancholy in the 1652 edition; Hooke's "Micrographia", 1667 Schott's "Technica Curiosa", 1665; Ramelli' "Diverse et Artificiose Machine", 1588; and a fin set of Gould's "Birds" are a few examples chosen a random. But the Library, which is particularl strong in its sets of periodicals, 350 journals bein currently received, is not confined to science, an contains works on history, topography, literature an other subjects, many of which are of considerabl interest. This fine collection is kept here for th purpose of serving the Institution's object, which i the promotion of science and the diffusion an extension of useful knowledge.

THE NATURE OF PLANT SPECIES

NEBULOUS and indefinable as the ancient concept of the species may be, discussion of it continues to be profitable in providing the opportunity for reviewing progress in the study of the variation of living organisms and of reassessing the taxonomic methods whereby existing knowledge is recorded and catalogued. Not unexpectedly, this proved the main function of a conference arranged by the Botanical Society of the British Isles on "The Species Concept in Relation to the British Flora", held in London at Church House, Westminster, during April 9–10. In the unfortunate absence of the president, Canon C. E. Raven, this fourth conference of the Society was opened by Prof. T. G. Tutin (University College, Leicester). The programme followed the pattern of former years, with formal papers, exhibits and a concluding field excursion—on this occasion, jointly with the British Bryological Society, to Box Hill, Surrey, under the leadership of Mr. E. C. Wallace.

With the efflorescence during recent decades of so-called experimental taxonomy, it is not surprising that several of the papers read at the conference should have been concerned with the impact of experimental studies on the species problems of orthodox taxonomy, and that applications of new techniques were to be seen among the exhibits. Prof. S. C. Harland (University of Manchester) was regrettably prevented from being present through illness, and his paper was read by Miss H. Jackson. In it, Prof. Harland said that the aim of experimental studies on plant populations is not primarily taxonomic revision, but rather to formulate relationships in terms of genes, chromosomes and cytoplasm. Data useful for classificatory purposes arise more or less as a by-product, and the occasions when experimental results actually demand radical taxonomic revision are relatively few. Crossing is the most familiar experimental method; but graftability provides an index of relationship not often taken into account. A successful graft between two species must indicate relatively close biochemical relationship between their tissues, and the evidence available from horticultural experience, in Rosaceae, Solanaceae, etc., has significant implications. On the whole, it appears that grafting is not possible between representatives of different families, and the correlation between inter-graftability and capacity for sexual hybridization is quite good. The evidence from grafting experiments combined with that from hybridization has provided justification for taxonomic changes such as, for example, the fusion of the genus *Erioxylum* with *Gossypium*.

Discussing the taxonomic problems arising from variability within species, Dr. J. H. Burnett (University of Liverpool) said that it has been customary to give nomenclatural recognition only to those infra-specific units which are readily detectable through their morphological distinction, and these are not necessarily the most important from the point of view of the survival and behaviour of the species. Heritable infra-specific variation may be genic, chromosome numerical or chromosome structural in origin, and, from the point of view of a morphologically based taxonomy, the variants may be manifest or cryptic. Single gene differences are likely to gain taxonomic recognition when they affect a feature like flower colour, but less so when they concern a characteristic like glucoside content, as in *Trifolium repens*. Races differing in chromosome number may show a wide range of morphological distinctness. In the British flora, cytologically heterogeneous species exist like *Iris pseudacorus* in which no serious attempt at taxonomic subdivision has been made because of apparent morphological homogeneity, while in other instances (for example, *Monotropa hypopithys* and its segregate *M. hypophegea*) taxonomic subdivision preceded the discovery of cytological heterogeneity. Populations differing in chromosome structure are found within such species as *Datura stramonium* and *Paris quadrifolia*; here again, from the point of view of orthodox taxonomy, much of this type of variation is cryptic. The exhibits of Dr. C. T. Prime and Mr. G. Panigrahi illustrated some of the complexities introduced by the existence of cryptic or semi-cryptic cytotypes within flowering plant species, the former dealing with *Arum maculatum* and *A. neglectum*, and the latter with *Caltha palustris*, in which a truly astonishing range of chromosome numbers has been reported.

The relationship between the categories of the older and newer 'taxonomies' was discussed in papers by Dr. J. Heslop Harrison (University College, London) and Mr. J. S. L. Gilmour (University Botanic Garden, Cambridge). Dr. Heslop Harrison stated the case against any attempt to give narrow genetical definitions to nomenclatural taxonomic categories, and particularly to the species, pointing out that in practice binomials are given to variational units of many different types. Even with outbreeding sexual organisms, uncompromising genetical definitions, based, for example, on fertility/sterility criteria, are either inoperable in practice or produce results widely at variance with those arising from the use of criteria derived from comparative morphology. The more subtle biological species concepts such as that of Mayr have abandoned any pretence of providing an experimental test of species status, and in effect ultimately come simply to describe some of the biological properties of the 'good' species of taxonomy. If the categories of nomenclatural taxonomy are maintained with their present general-purpose application, the need may still exist for special classifications based upon genetical, cytological or other special criteria in genecological and similar research. It remains questionable, however, whether a 'taxonomic' approach is now required at all in evolutionary studies, where the requirement is to investigate processes rather than to recognize stages. Mr. J. S. L. Gilmour said that all classification should have a purpose, and that the attributes chosen for the construction of classifications are naturally selected with regard to their purposes. Orthodox taxonomy has achieved a high measure of success in producing a classification of the plant kingdom based principally on morphological attributes, taking distribution also into account. The so-called experimental taxonomy, with its concern for the processes of micro-evolution, has different aims and therefore adopts different criteria. The facts discovered in experiment may, of course, have relevance to orthodox taxonomy, but it would be a mistake to attempt to absorb the experimental categories into nomenclatural taxonomy in the belief that the latter would thereby be 'improved'. Disagreement still exists as to how the experimental categories themselves should be defined, and already in this field terminology is chaotic. It is with the hope of introducing some semblance of order that a development of the 'deme' terminology[1] has recently been formulated after discussion between several British genecologists and taxonomists. The use of Turesson's genecological category system was illustrated in a paper by Dr. C. H. Andreas (University of Groningen), who, describing the Dutch forms of *Stellaria nemorum*, said that while there might be doubt as to the appropriate taxonomic ranks to be given to these, they are to be looked upon as ecotypes, being clearly differentiated in their ecological tolerances.

Dr. H. Hamshaw Thomas (University of Cambridge), in directing attention to the stability of many specific characters as revealed by the fossil record, provided a valuable counterbalance to the impression of complete fluidity so easily gained from many present-day discussions of the species problems of flowering plants. There are few fossil records of angiosperms continuous over long periods of time such as exist in various animal phyla, but from the available evidence it is clear that certain generic and even specific characters have been extraordinarily stable. Identifications of the leaves of genera such as *Acer*, *Betula* and *Populus* in early Tertiary deposits have been amply confirmed by wood and pollen studies. Remains of flowers are not abundant, but such as are available—*Populus* and *Cinnamomum* in Oligocene amber, for example—testify to the antiquity and stability of present-day types. Certainly there is little in the record to support the concept of gradual evolution from a proto-angiosperm with flowers consisting of a mass of 'fertile leaves'.

The increasing importance being attached to vegetative features in the treatment of critical taxonomic groups among modern flowering plants was illustrated by papers contributed by Prof. T. G. Tutin and Dr. R. Melville (Royal Botanic Gardens, Kew). For several reasons, not the least being their lesser liability to environmental modification, floral parts provide most of the technical diagnostic features cited in Floras; nevertheless, said Prof. Tutin, the experienced field botanist recognizes most of his plants by their general appearance, to which vegetative features contribute by far the greatest part. In many anemophilous alliances, the reduction and standardization of floral pattern is such that few diagnostic features can be derived from this source in any case, and in families like Chenopodiaceae and Gramineae, discrimination of species requires the adoption of other criteria, including habit, colour, and vegetative and anatomical characters, many of which can only be assessed by measurement. Among British grasses, anatomical features have for some time been used for the recognition of critical taxa, and more recently features of the leaf epidermis have proved valuable for the separation of species not readily distinguishable in other ways. They can, for example, be used to discriminate *Puccinellia distans* and *P. pseudodistans*, and provide justification for the recognition as a separate entity of the enigmatic Irish taxon, *Puccinellia maritima* var. *hibernica* of Praeger and Druce. Dr. Melville explained the significance of characteristics derived from the foliage of arboreal species where the flowers are either not available or useless as a source of taxonomic characters. Although leaf shape may show great variation during growth, the sequence observed from youth to maturity and from the beginning to the end of a season's growth follows a consistent plan, and such a sequence—the leaf spectrum—may be treated as a single complex character. A study of elm hybrids suggests that the factors controlling leaf shape in one part of the leaf spectrum may be mainly derived from one parent, while those controlling another part may be inherited from the other. The spectrum may thus vary in a complex manner; but is not beyond interpretation with a knowledge of the characteristics of the parents.

The taxonomic problems of cryptogams were discussed in papers by Prof. I. Manton (University o Leeds), Prof. A. Burges (University of Liverpool) and Dr. E. W. Jones (University of Cambridge) and illustrated by exhibits by Dr. S. Walker, Mr. J. D. Lovi (both of the University of Leeds) and Dr. E. Burrow and Dr. S. M. Lodge (both of the University of Liverpool). Surveying the recent work of the Departmen of Botany of the University of Leeds on the cytotaxonomy of ferns, Prof. Manton stressed that with pteridophytes, as with flowering plants, the morphologically based species of taxonomy generally embrace complexes of infraspecific units distinguishable by physiological, cytological or other characteristics. In such common British species as *Asplenium adiantum-nigrum*, *A. trichomanes*, *Polypodium vulgare* and *Cystopteris fragilis*, different cytotypes exist which possess independent geographical distributions and ecological tolerances. Understanding of these species requires knowledge of the world distribution of the component races, while the inter-relations of the races themselves can be examined by the analysis of chromosome pairing in artificial hybrids between them The results of the examination of the distributional patterns of the cytotypes are occasionally found to contradict generally held principles derived from angiosperm studies. Thus the thesis of a correlation between increasing levels of polyploidy and increasing latitude finds no general support from fern cytotaxonomy. A preliminary survey of the fern flora of Ceylon in which 60–70 per cent of the known species have been examined cytologically shows that in this tropical island some 60 per cent of the species are polyploid, compared with 53 per cent in the British Isles where all species have been investigated. Similarly, within species, it is often found (as, for example, with *Cystopteris fragilis* and *Dryopteris dilatata*) that it is the races of lower chromosome number which possess the more northerly ranges. In exhibits dealing with fern cytotaxonomy, Miss M. G. Shivas dealt with the relationship of the two subspecies of *Asplenium adiantum-nigrum* in Britain, Dr. S. Walker presented data on the *Dryopteris spinulosa* complex in Europe, and Mr. J. D. Lovis illustrated work on the problem of *Asplenium trichomanes*. The last-named case is typical of many arising with pteridophytes, where diagnostic characters have perforce to be drawn mostly from foliar characters which are notoriously plastic. No qualitative differences have been found to separate the two cytotypes of *A. trichomanes*, although they are distinguishable on the basis of quantitative characteristics including, especially, spore size.

Commenting on the problems of fungal systematics, Prof. A. Burges said that many of the difficulties encountered with flowering plants exist, often in aggravated form, together with others peculiar to the group arising from the special genetical mechanisms found in it. Heterokaryosis, for example, provides a mechanism of variation unparalleled among the higher plants, and there have been few attempts to develop new concepts of species in the fungi to take such phenomena into account. The difficulties which arise in all biological taxonomy from the fact that what is being classified is a 'slice' at a given time of an evolutionary continuum are emphasized in genera such as *Puccinia*, where a short generation time means a very much higher potential evolutionary rate. Wheat rust races in Australia have been known to replace each other over an area of continental dimensions in periods as short as two years. Phenotypic plasticity—a source of difficulty in higher plant systematics—is often encountered in extreme form in fungi. The different manifestations of the same organism on different hosts, or even on different parts of the same host, are sometimes so dissimilar as to have led to their classification in different genera. Only culture techniques can serve to clarify situations such as these; but, even so, problems of typification and nomenclature remain acute.

Biochemical and other physiological criteria have become of importance in fungal and bacterial systematics; but so far they have not assumed significance n the classification of the bryophytes, although, as emphasized by Dr. E. W. Jones, the search for new taxonomic characters in this group continues. Early bryophyte systematists placed reliance largely upon gross morphology of vegetative and reproductive organs; but, more recently, anatomical and histo-ogical characters have assumed primary importance n species discrimination, and even cytological features ike the presence and nature of oil bodies in the living cells. All parts of the bryophyte thallus seem to be susceptible to environmental modification, and recent critical culture work which has demonstrated that many described forms are not genotypically distinct has led to the relegation to synonymy of many species names. There is little agreement, however, as to what shall be taken as species limits, and the tendency is o call every recognizably different genotype a species however slight its distinctive features. The apomictic reproduction of minor variants by vegetative means adds to difficulties here. Dr. Jones pointed out that any theoretical difference between the species concept as applied to bryophytes and to phanerogams lies in the fact that the bryophyte plant is the gametophyte whereas the phanerogam plant is the sporophyte. Hybridization has thus unusual consequences: it is possible, for example, to have a hybrid capsule attached to a non-hybrid gametophyte. Hybridization can also complicate algal systematics, and in their exhibit Dr. Burrows and Dr. Lodge demonstrated how the hybrid index technique devised by Anderson for flowering-plants has proved applicable to the analysis of hybrid swarms involving British species of *Fucus*. Environmental modification is also a complicating factor in this genus. Variation in *Fucus vesiculosus* and *F. inflatus* shows some degree of ecological correlation, and, in rough water, plants of the two species are very similar in their growth form. Cultural methods have been devised, and are expected o reveal whether or not the named habitat forms of the two species have a genotypical basis.

The importance of the development of culturing methods was also apparent in exhibits illustrating current work on British flowering-plants. Mr. P. F. Yeo (University of Cambridge) showed how taxonomic problems in the semi-parasitic genus *Euphrasia* are amenable to investigation now that the technique of cultivation using *Plantago lanceolata* as a host has been perfected; the relative significance of environmental and hereditary effects can now be assessed and the reproductive biology studied. Mr. D. H. Dalby (University College, London) has developed a suitable technique for the cultivation of the salt-marsh genus *Salicornia*. He demonstrated how in this genus, where reduced floral structure has resulted in a reliance on vegetative features for the discrimination of taxa, progeny tests have shown variation in habit to be hereditary in some instances and environmentally conditioned in others. Two cytological series, a diploid and a tetraploid, exist in southern England, and parallel sequences of habit-types occur in each.

Hybridization as a complicating factor in the taxonomy of critical groups was illustrated in the exhibits of Miss W. T. M. O'Connor (University of Liverpool) and Mr. P. Gay (University College, London). Miss O'Connor showed how hybrid swarms involving *Centaurium littorale* and *C. minus* could be analysed by the use of Anderson's hybrid index technique, and Mr. Gay provided new data on the variability of *Erica ciliaris*, a Lusitanian heath which in Britain, at the northern end of its range, is apparently severely affected by hybridization with *Erica tetralix*. Mr. Gay put forward the hypothesis that the Irish *E. mackaiana* may be the product of the hybridization of *E. ciliaris* and *E. tetralix*.

In the concluding paper of the conference, Dr. W. B. Turrill urged a 'synthetic' approach to the taxonomic problems remaining in a flora like that of the British Isles, where the methods of comparative morphology are approaching the limits of their usefulness. Being opposed to any segregation of experimental from orthodox taxonomy, he felt that taxonomists should be prepared to use any kind of character which might help to make a more widely useful classification. He was particularly insistent that the methods of synthetic taxonomy are in no sense closed to the amateur botanists who form the greater part of the membership of the Society: in fact, they open up to the amateur a new and largely untouched field in which almost any effort will contribute new knowledge.

In an evening meeting during the conference, Prof. A. R. Clapham (University of Sheffield) and Dr. S. M. Walters (University of Cambridge) reported to guests and members the considerable measure of progress made in the organization of the scheme for the production of a distribution atlas of the British flora, since guarantees of support for the project had been received from the Nuffield Foundation and the Nature Conservancy. Details of the scheme have been discussed by Dr. Walters in a recent article[2].

The smooth progress of the conference was largely due to the work of Dr. J. G. Dony, in charge of the organization. It is expected that the full proceedings will be published in book form.

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[1] Gilmour, J. S. L., and Gregor, J. W., *Nature*, **144**, 333 (1939)

[2] Walters, S. M., *Nature*, **173**, 1079 (1954).

TOTAL SOLAR ECLIPSE OF JUNE 30

BRITISH EXPEDITIONS' RESULTS

By PROF. R. O. REDMAN, F.R.S.

ON account of several favourable factors, extensive preparations were made by European astronomers to observe the total solar eclipse of June 30; totality was of reasonably long duration, 2½ min. on the centre line, the sun was in a good star field, weather prospects were reasonably promising, and the belt of totality was easily accessible in Norway and Sweden. This article is an account only of the activities of British observers, on the ground in Sweden and in the air north of Britain.

In general, the actual weather conditions were disappointing. The chances of a clear sky had been rated highest (a little more than 50 per cent) for the coasts of Sweden, and the east-coast island Öland had been chosen for the site of many expeditions. Öland, however, with most of the Swedish mainland, was covered with thick cloud and so far as is known few observations of any value could be made there.

Farther east and somewhat off the centre-line, the island of Gotland had a good sky, while on the west coast of Sweden, to which most British astronomers had gone, totality was seen through thin cloud. In addition to conventional ground parties, a number of aircraft flew to various parts of the totality belt, north of the Shetlands and north-westwards towards Greenland, with results mentioned in more detail below.

The Royal Greenwich Observatory supplied two parties of observers. Dr. R. d'E. Atkinson went to Öland, to continue work done by him at the 1948 and 1952 eclipses, when he had made photographs of the solar crescent near totality for geodetic purposes and also to study the profile of the moon's limb. On the west-coast island Syd-Koster, near Strömstad, Mr. T. Gold and Dr. A. Hunter, with assistance from Messrs. D. W. Sciama and E. W. Bastin, had erected a 7-in. refractor of 21 ft. focal length with the purpose of photographing the star field around the sun, to measure the relativity displacement. In such work the star images can be distinguished against the background of corona only if general conditions are very good; but on this occasion the sky was not perfectly clear and scintillation was moderate, so that the photograph obtained shows little but corona. The work, however, gave valuable experience with a novel telescope shelter which might well be copied at future eclipses.

Also on Syd-Koster was a group from the Cambridge Observatories, Prof. R. O. Redman, Dr. D. W. Dewhirst, Dr. H. von Kluber and Dr. A. H. Jarrett (of the St. Andrews Observatory), alongside a group from the London University Observatory, Prof. C. W. Allen, with Messrs. C. R. Spratt, E. W. Foster and A. S. Assad. These two groups were given much general assistance by Mrs. L. von Klüber, Mr. M. F. Ingham and Mr. Jan Högbom. Prof. Redman photographed the chromospheric spectrum using a large slit spectrograph of 24 ft. focal length, with an unusually good plane grating lent by the Mount Wilson and Palomar Observatories. The spectrograph was fed by a coelostat and a concave mirror of 36 ft. focal length. Both second and third contact photographs were considerably under-exposed, mainly on account of the poor sky. Drs. von Kluber and Jarrett were engaged in an experiment which has been repeatedly tried without success by various eclipse observers during the past twenty-five years, namely, to photograph the corona in the light of the green line at 5303 A., doing this through a Fabry–Perot interferometer so that the fringes are superposed on the picture. From measurement of the fringes one may hope to obtain information of local movements and rotation of the corona, and of the distribution of kinetic temperature. The strength of the green coronal line varies with the sunspot cycle; the eclipse fell at sunspot minimum in a time of quite exceptionally low solar activity, and the 5303 A. line was known from coronagraph observations to be unusually faint. Despite all the unfavourable conconditions, successful photographs were obtained showing interference fringes, a tribute to the extreme care and thoroughness with which the apparatus had been designed and prepared. With the third Cambridge instrument, a quartz (slit) spectrograph fed by a concave mirror of 8 ft. focal length, Dr. Dewhirst obtained good photographs of the ultra-violet chromospheric spectrum at both second and third contacts. These are to be used to measure the electro temperature of the chromosphere by Zanstra' method.

The London University Observatory's programm was aimed specially at the outer corona and wa therefore considerably affected by the thin cloud The full programme of work was carried through but to what extent the sky has affected the result will only be known after measurement of the plates Prof. Allen and Mr. Spratt took a series of calibrate photographs of the corona, some in blue and som in red light, using two cameras mounted on the sam polar axis (focal lengths ~ 1 metre). At abou 7 metres in front of each camera, on its optical axis was an occulting disk designed to remove the inne corona, or to reduce its light in a pre-determine way by vignetting, so that a great range of surfac brightness in the corona could be covered satisfactoril in one exposure. The two disks were mounted on wooden tower and driven laterally at the appropriat speed to retain alignment with the cameras durin totality. Meanwhile, with a second instrument, fast one-prism slit spectrograph having an *f*/1 camer of the Maksutov type, Mr. Foster and Mr. Asa obtained a number of photographs of the corona spectrum. The spectrograph was fed by a coelosta and small telescope, and in the optical train precedin the slit was an occulting bar having essentially th same purpose as the occulting disks of the direct photograph cameras.

On Öland the St. Andrews University Observatory represented by Prof. E. Finlay-Freundlich, co operated with the Potsdam Observatory in a thoroug and elaborate attempt to observe the relativity displacement of stars near the sun. The expeditio shared the complete disappointment of many other in this part of Sweden.

Of various observations from the air, two deserv mention. Mr. J. Paton, of the Department of Natura Philosophy, University of Edinburgh, was a passenge in an R.A.F. machine flying to the belt of totality as part of a navigational exercise, and during eclips tried without success to detect a daytime aurora with the help of interference filters isolating the gree auroral line. Although the attempt was made in zone of high auroral frequency, it was not favoure by the present very low level of solar activity, whic is likely to be associated with an absence of stron auroræ.

Important work was carried out by Dr. D. E Blackwell and Mr. J. P. Hignell, of the Cambridg Observatories. With very generous assistance fron the R.A.F., they photographed the outer corona i exceptionally good sky conditions (and in considerable personal discomfort), through the open door of special Lincoln bomber flying at about 30,000 ft They used a specially designed multiple camera giving eight images simultaneously on one plate, o varying intensities and polarizations. The object wa to get better measures of the surface brightness an polarization in the outer corona, where existing dat are known to be unreliable, to a greater distanc from the sun than would be possible with observation from the ground.

At Cambridge, where the optical eclipse was partial measurements of solar radio noise were made by th Cavendish Laboratory's radio astronomy team unde Mr. M. Ryle. Since much of the radio radiation arise in the corona there is no great advantage, excep possibly at very high frequencies, in restrictin observing sites to the belt of optical totality. Th

Cambridge observations, made on five wave-lengths over the range 0·6–8 metres, aimed at checking results obtained in other ways for the distribution of radiation emission over the corona.

Observers from the Royal Greenwich Observatory were financed by the Admiralty, while those from the Cambridge and London University Observatories were supported almost wholly by a Government grant from the Royal Society through the Joint Permanent Eclipse Committee. St. Andrews observers were also supported in part from this grant. The astronomers concerned have also been grateful for generous assistance from other sources. Much help was received from the R.A.F., and also from the Swedish authorities, who through Prof. Y. Öhman, of the Stockholm Observatory, made arrangements to facilitate travel, Customs inspection, etc., in Sweden. Residents in Sweden living near eclipse camps treated the visiting astronomers with great kindness.

In addition to regular observers engaged on specific programmes of investigation, a party of about 140 members of the Royal Astronomical Society and the British Astronomical Association saw the eclipse through thin cloud in western Sweden, and a small number of others viewed it from aircraft north of Britain.

OBITUARIES

Dr. O. J. R. Howarth, O.B.E.

Dr. O. J. R. Howarth, who died on June 22 at the age of seventy-seven, was one of the earliest recruits to the Oxford School of Geography after he had taken the Final Honours School of Modern History in 1900, and geography remained his professional interest throughout his life. He edited the "Oxford Survey of the British Empire" in 1914 with Prof. A. J. Herbertson and wrote a number of text-books for the Oxford University Press. Later he became specially interested in protecting the countryside and in town and country planning, and in 1937 he wrote "The Scenic Heritage of England and Wales" for the Council for the Preservation of Rural England. He was president of Section E (Geography) of the British Association in 1951 and president of the Geographical Association in 1953, when his address dealt with the importance of teaching geography from a Commonwealth point of view.

His major occupation, however, was the secretaryship of the British Association, which he held for thirty-seven years—from 1909 until 1946. During this time the activities of the Association underwent considerable changes, as with the general recognition of the national importance of science and scientific research, for which it had striven so hard in the nineteenth century, some of its functions were gradually taken over by other bodies. The Association owes a great debt to Howarth for his long and devoted service, and to the skill and economy with which he carried on its administration with a very small permanent staff. I know from my own experience how grateful successive local secretaries, who had to organize annual meetings of increasing size, were to Howarth for his wise advice and guidance on all the details of the arrangements on which the smooth working of the meetings depended.

The future of the Association, how it could best fulfil its purpose under changing conditions, was the constant thought in Howarth's mind, and his knowledge and experience was of the greatest value to successive general officers. One great service he rendered was his short history of the Association, "A Retrospect, 1831–1931". It gives in a short compass a masterly sketch of the fortunes of the Association during its first century. In it Howarth concentrated the results of many years of study, and from his knowledge of the outstanding personalities and episodes, and with his crisp, clear style, he showed how much the Association had contributed to the advancement of British science. The idea of the book was first suggested in 1919 by Sir Charles Parsons, who made a generous contribution towards the cost of its publication in 1922. Later, again at his suggestion and with his help, it was revised and brought up to date for the centenary meeting of the Association in London in 1931.

During the long presidency of Sir Richard Gregory during the Second World War, interest in the Association was kept alive by a series of conferences on topics of immediate public concern and on the problems that would arise when war ended. Their success owed much to Howarth's untiring enthusiasm and hard work. It was his great satisfaction to see the Association emerge in 1945 stronger in heart than ever and ready to assume even larger burdens.

Most modest as to his own ability, quiet and unassuming, Howarth valued above all else in his career the opportunity the British Association gave him to enjoy the friendship of some of the leaders of science, and with their help to uphold its great traditions. He was looking forward eagerly to the meeting next September in Oxford and to renewing memories of the 1926 meeting with the small band of survivors; but that, alas, was not to be. Almost his last act was to prepare a script for the British Council on the history of the Association; but he died before he could record it.

Mr. E. F. Law

By the death of Edward Fulton Law on May 22, in his seventy-seventh year, the profession of metallurgy loses one who had been closely identified with the rapid progress which has been made both in ferrous and in non-ferrous metallurgy during the past fifty years—as a contributor to the proceedings of the Iron and Steel Institute and to those of the Institute of Metals and as a partner in a firm of consultants (Messrs. Riley, Harbord and Law, of Westminster) until the time of his death.

With a background of training which included chemistry under Tilden at the Royal College of Science (1894–98) and metallurgy under Roberts-Austen at the Royal School of Mines and at the Royal Mint (1898–1902), Law was one of a group of young men (among whom were H. C. Jenkins, A. Stansfield, W. H. Merrett, O. F. Hudson, G. D. Bengough, H. C. H. Carpenter and Walter Rosenhain) who came directly under Roberts-Austen's stimulating influence, and in all of whom the spirit of inquiry had been quickened by spending varying periods in his private laboratory at the Mint. It was there that Law took part in the work of the Alloys Research Committee of the Institution of Mechanical Engineers, which was still in progress at the time when the recently published Fifth Report had done so much to arouse interest in the application of the pyrometer and the microscope to industrial problems.

It was, in fact, in the rapidly developing art of metallography at the turn of the century that Law's exceptional manipulative skill found full expression. This is abundantly shown by the quality of the photomicrographs which appear in his contributions to the publications of the Iron and Steel Institute, to those of the Institute of Metals and particularly perhaps those which appear in the successive editions of his work on "Alloys and their Industrial Applications", first published as one of Griffin's Metallurgical Series of text-books in 1909. The frontispiece to that volume, a reproduction in colour of heat-tinted micro-sections, is one of Law's skilful adaptations of the facilities afforded by the autochrome plates (which had just been introduced by MM. Lumière, of Lyons) to differentiate micro-constituents under high powers. This early application of colour photography to metallographic work formed the subject of a short paper to the Iron and Steel Institute in 1908 and attracted the attention and interest of the Royal Microscopical Society and of the Royal Society of Arts, to which bodies a number of examples were exhibited.

After a period of private practice in Westminster, from 1903 onwards, Law became associated with the late F. W. Harbord (of Messrs. Riley and Harbord); but shortly before the First World War he accepted an appointment with Messrs. Sir W. G. Armstrong Whitworth and Co., Ltd., at their establishment a Openshaw, Manchester, where he remained unti 1922 in charge of the production of armour-plate He then returned to Westminster as a partner in th firm with which he had been formerly associated. I 1939, however, at the outbreak of the Second Worl War, his previous links with those responsible fo naval construction had led to a request by th Admiralty that he should join the late Sir Stanle Goodall at Bath. He remained there during th earlier years of the War, afterwards returning t Westminster on the death of his partner, Mr. F. W Harbord, to resume his consulting practice, i association with Mr. Vernon Harbord and Mr. T. G Howard.

Mr. Law was an associate of the Royal School o Mines and a Carnegie silver medallist. After serving for many years on the Council of the Iron and Stee Institute, he was elected an honorary vice-presiden of that body in 1950. He was also an original member of the Institute of Metals. His engaging personality and long experience in helping to solve many o the difficulties with which engineers and metallurgists had been confronted had brought him valued friendships throughout Great Britain.

S. W. SMITH

NEWS and VIEWS

Mining at Sheffield: Prof. I. C. F. Statham

PROF. IRA C. F. STATHAM, who has just retired from the chair of mining in the University of Sheffield, was born in Staffordshire and was educated at the University of Birmingham. He went to Sheffield in 1919 as a lecturer in the Mining Department and succeeded the late Prof. Douglas Hay as head of the Department in 1925. In his early years on the staff he carried out a number of researches on the ventilation of mines and ancillary problems, and later, as head of the Department, he continued to initiate and supervise research on this and other aspects of mining. He was responsible for the initial fundamental research work concerning flame-proof enclosures for mining electrical apparatus, and the subsequent routine testing and development of mining switchgear. His services as a consultant have been much in demand both in Britain and abroad, and his outstanding contributions to mining education and research have been recognized by the awards of the Futer's Gold Medal of the National Association of Colliery Managers, the Thornton Medal of the Association of Mining Electrical and Mechanical Engineers and, more recently, the Douglas Hay Medal of the Institution of Mining Engineers. He is a past-president of the Midland Institute of Mining Engineers, a vice-president of the Institution of Mining Engineers and a past-president of the Institute of Mine Surveyors. When Prof. Statham went to the Department, he found it housed in a few rooms at the front of the Applied Science Building; but in 1932 it acquired a new and larger building, and this, in 1953, was extended to meet the expanding requirements of the reorganized coal mining industry. These extensions and developments have been largely his responsibility. Although he reached the retiring age in 1952, he was invited to stay on for a further two years to complete his labours in creating the large Mining Department, fully equipped for modern teaching and research, that to-day stands as a lasting tribute to his tenure of the Sheffield chair.

Prof. F. S. Atkinson

PROF. STATHAM is being succeeded by Mr. F. S. Atkinson, at present assistant to the production director of the North Eastern Division of the National Coal Board. Mr. Atkinson was educated at Chesterfield Grammar School and the University of Sheffield, where he graduated B.Eng. with honours and obtained the Diploma in Mining in 1922, at the same time serving his apprenticeship at the Tinsley Park Colliery Co. From 1924, Mr. Atkinson was successively assistant to the manager of Frickley Colliery and manager of Hatfield Main Colliery until his appointment to the chair of mining in the University of Leeds in 1936. He resigned from the chair in 1941 on his appointment as mining agent of Upton Colliery. In 1946 he was appointed chief mining engineer of the Indian mines owned by Shaw Wallace and Co., Ltd., which post he held for three years until he went to his present position with the National Coal Board. Mr. Atkinson thus has a wide knowledge of the mining industry, both in Britain and abroad; he has published numerous articles in mining journals.

Theoretical Physics at King's College, London: Prof. C. Domb

THE appointment has been announced of Dr. Cyril Domb to the chair of theoretical physics in the University of London at King's College. Dr. Domb was a major scholar of Pembroke College, Cambridge, from 1938 until 1941 and graduated by way of the Mathematical Tripos. During 1941–46 he was at the Admiralty Signals Establishment and from 1946 held a senior research fellowship at the Clarendon Laboratory, Oxford. Since 1952 he has been a University lecturer in mathematics at Cambridge; he was awarded the Rayleigh Prize in 1949. Dr. Domb is distinguished for his work on the solid state, paricularly in relation to the statistical mechanics of o-operative phenomena.

Higher Technological Education in Great Britain

In reply to a question in the House of Commons on July 20, the Chancellor of the Exchequer stated hat the plans announced for development of higher echnological education in Leeds and Birmingham apply only to work in the universities, and do not nclude the upgrading of technical colleges. A considerable constructional programme is being carried out with the assistance of non-recurrent grants to improve and enlarge the accommodation at univerities for technological work, and the cost of the new buildings for these studies which have been started n 1953 and 1954 is estimated at about £2·7 million, nost of which will be met by grant.

A memorandum on higher technological education drafted by the Parliamentary and Scientific Committee before the Chancellor of the Exchequer made his first statement on July 13 states that there is a considerable unsatisfied demand for scientists, engineers and other technologists in British industry, particularly for metallurgists and chemical engineers and those able to take posts in management or production. This demand is expected to grow, and the Committee considers that further government action to improve facilities for higher technological education is urgently needed. So far as the universities are concerned, the Committee recommends an ncrease in the proportion of students of science and echnology within the present limits of student numbers, and expansion of postgraduate facilities particularly in fields of study of importance to local industrial interests. It also recommends extending the conditions of admission to postgraduate work and an ncrease in the number of bursaries from government and industrial sources. As regards colleges of technology, the Committee recommends that a limited number, ultimately twenty, of colleges of technology should be given charters as royal colleges of technology, with the maximum academic autonomy, and financial independence on a quinquennial basis such as the universities enjoy, subject to a special grants committee closely co-operating with the University Grants Committee. Both the regional advisory councils and the local authorities of the region would be represented on the governing bodies as well as cientific, technological, industrial and commercial nterests. The colleges, which would include a reasonable infusion of the humanities in the courses, would be entitled to award the degree of bachelor of technology, and this should be of sufficient standard to qualify its holder for postgraduate work in a university. The memorandum refers also to the shortage of science teachers and the need for intensive and long-erm efforts by industry and the professional nstitutions to break down the prejudice of those leaving school against careers in applied science, as well as the need for greater co-operation between ndustry and the universities and technical colleges n the interchange of staff and in other ways.

Financial Estimates for the Department of Scientific and Industrial Research

In reply to questions in the House of Commons on July 20 regarding the Department of Scientific and Industrial Research, Mr. J. R. Bevins, Parliamentary Secretary to the Ministry of Works as representing the Lord President of the Council, said that the estimates for the present financial year provide for an increase in gross expenditure of £71,440 and an increase of staff of 197 compared with last year. It is expected that about fifty of the additional posts will be filled by industrial staff, and most of the others will be in the scientific officer, experimental officer and assistant (scientific) classes. Provision for a further two hundred posts, of which about fifty will be for industrial staff, is planned for each of the four financial years 1955–56 to 1958–59. The present establishment at the Chemical Research Laboratory is 193 compared with 184 in July 1953, and consists of 159 non-industrial and 34 industrial staff. Nine of the present twelve vacancies are expected to be filled in the near future. The major works included in the Department's building programme for 1954–55 are the Hydraulics Research Station (£159,800), Mechanical Engineering Research Laboratory (£254,600), National Physical Laboratory (£111,700), Radio Research Station (£92,500) and the Water Pollution Research Laboratory (£115,000). The Water Pollution Research Laboratory will be completed and occupied this year, and the work at the Hydraulics Research Station should also be nearing completion. Work on the new Radio Research Station began this year and is expected to be completed in 1955–56. The provision for the National Physical Laboratory is principally for the commencement of construction of a new ship tank (for research and testing on the form of ships' hulls and propellers), which is expected to take some four to five years to complete.

Heavy-Water Reactor (Dimple) at Harwell

The United Kingdom Atomic Energy Authority has announced that a heavy-water reactor (or atomic pile) which has been built at the Atomic Energy Research Establishment, Harwell, is now in operation. 'Dimple' is a low-powered thermal neutron research reactor. The heavy-water moderator is contained in a tank which is surrounded by a graphite neutron reflector. Outside this is a concrete radiation shield. The reactor fuel is submerged in the heavy water. Both the type of fuel and its arrangement in the tank can be changed quickly so that what is, in effect, a different design of reactor can be built up in a matter of a few days. The reactor will only be operated at very low power so that its structure does not become sufficiently radioactive to prevent the necessary handling. The behaviour of the wide variety of design can, therefore, be investigated experimentally in a relatively short time. The versatility of Dimple will make it an extremely valuable tool in the design of future power-producing reactors and for measuring essential constants in reactor physics. One of the first functions of Dimple will be to carry out experimental work for *E.443*, the new and more powerful heavy-water reactor which is now being built at Harwell to provide the high neutron flux essential for some research purposes.

European Atomic Energy Society

Representatives from eight European Atomic Energy Commissions have agreed to establish a European Atomic Energy Society (Société Européenne d'Énergie Atomique). The eight nations represented are: Belgium, France, Italy, The Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The chief aim of the new Society is to promote co-operation in nuclear energy research and engineering. To achieve this the Society will: (*a*) promote the arranging at regular intervals of international meetings for scientists and engineers working in the field of peaceful application of nuclear energy; (*b*) promote the circulation of reports and other information of unclassified nature; (*c*) work for standardization of nomenclature and symbols in nuclear energy; (*d*) promote the study of hazard and safety measures arising from the application of nuclear energy; (*e*) promote publication of nuclear energy works, and possibly encourage the establishment of an international journal in the field; (*f*) establish a centre of information on availability of nuclear energy materials and equipment. Participation is limited to those nations which have already established nuclear energy projects. The statutes provide, however, that by unanimous decision of the existing members invitations to join the Society may be issued to other European Atomic Energy Commissions which, in the opinion of the Society, have established such projects.

The Society was formally established at a meeting at the Royal Society in London on June 15, at which Sir John D. Cockcroft, director of the Atomic Energy Research Establishment of Britain, was elected president of the Society for the first year. Mr. Gunnar Randers (Norway) was elected executive vice-president, and Dr. Bertrand Goldschmidt (France) vice-president. The Society will be governed by a Council consisting of one delegate from each of the eight member organizations. A working group under the leadership of the executive vice-president will take care of the activities of the Society between Council meetings. One of the tasks of the working group of the Society is to prepare international conferences on the application of atomic energy. The difference between the recently formed European Atomic Energy Society and the European Nuclear Research Centre in Geneva should be noted. The Geneva establishment will carry out pure scientific research while application of industrial atomic energy is explicitly excluded from its activities. The European Atomic Energy Society is intended as a European forum for promoting the development of industrial uses of atomic energy.

Closing of the Mushroom Research Station, Yaxley, and Transfer of Work

As a result of the arrangements made between the Mushroom Research Association, Ltd., the Glasshouse Crops Research Institute and the Ministry of Agriculture, the Mushroom Research Station at Yaxley, Peterborough, will close before the end of this year, and mushroom research will be resumed at the new Glasshouse Crops Research Institute, Littlehampton, as soon as suitable buildings and equipment are ready. Of the staff at Yaxley, Mr. P. B. Flegg, Miss D. G. Gandy and Miss I. I. Warman will join the new Institute in due course. The director of research, Dr. R. L. Edwards, will remain at Yaxley until November 30 to complete the cropping experiments now in progress and to prepare a final report; after that he will transfer to commercial mushroom-growing and practise as a private consultant. After the closing of the Station, communications concerning the research programme should be addressed to Dr. W. F. Bewley, director of the Glasshouse Crops Research Institute, at first in Cheshunt, Herts, and later at the new buildings in Littlehampton, Sussex. Requests for advice, examination of samples, etc., should be sent to the nearest horticultural officer of the National Agricultural Advisory Service, who will forward them t his regional laboratory or to the Research Institut if necessary. Information concerning internationa conferences on mushroom science can be obtaine from Dr. R. L. Edwards, at Ratcliffe Lodge, Sout Luffenham, Oakham, Rutland.

Meteoritics: a New Journal

From the time of the inception of the Meteoritic Society in 1933, its *Notes* and *Contributions* wer published regularly in the monthly magazine, *Popula Astronomy*, until December 1951, when that periodic was discontinued. By arrangement of the Council o the Society with the University of New Mexico, new publication entitled *Meteoritics: The Journal o the Meteoritical Society and the Institute of Meteoritic of the University of New Mexico* has been established The first number, consisting of an introduction an twenty-three articles, appeared in December last yea and serves as a complete issue for 1953 (pp. 123 obtainable from the Secretary of the Meteoritica Society, Dr. John A. Russell, Department o Astronomy, University of Southern California, Lo Angeles 7, Cal.; 4 dollars a year). Meteoritics i concerned with the investigation of the matter tha reaches us from space beyond the earth. Prof. F. C Leonard discusses its recent progress and futur development in a paper which includes an addres delivered at the opening of the new Institute o Meteoritics—the only establishment of its kind n the world—and a list of some fifty problems awaitin solution or requiring further research. In respons to a questionnaire as to the contributions an problems thought to be most important, Prof Harrison Brown states his conviction that study o trace elements and isotope fractionation will indicat the conditions under which meteorites were formed and Dr. F. L. Whipple lists among his major contributions the absence of hyperbolic meteorites an the recognition of planetoidal and cometary type The articles cover a wide range of interests, one o the most notable being a systematic study of th formation of craters by high-speed particles. Th new journal, which is attractively printed and illustrated, is expected eventually to become a quarterly The editors and other officers of both the Societ and the Institute are to be congratulated on a initial success which augurs well for the future o their enterprise.

The Starfish

No. 7 of *The Starfish*, the journal of the Associatio of School Natural History Societies, has recentl been published (obtainable from G. I. Crawford 18 East Drive, Carshalton, Surrey. 2*s*. to non members). The journal is edited by G. I. Crawford Major Maxwell Knight and R. S. R. Fitter. It open with a report of the annual general meeting of th Association and an account of the exhibition held o November 7 at the British Museum (Natural History) John Ounsted describes the Botanical Society of th British Isles, stressing the facilities it offers t juveniles. R. H. Winterbottom (Dulwich College records a winter census of gulls. Michael L. Elliot (West Buckland School) gives a fascinating an revealing account of how he keeps and studies adder in captivity. Patricia Brown (Orange Hill Girl Grammar School) describes how trout are kept a her school. Christopher N. G. Sell (Bishop's Stortford College) and some colleagues have been makin observations on moths with the use of a mercury vapour light-trap. The fauna of the umbels of cow parsnip (*Heracleum sphondylium*), the majority of which was insects, is described by R. G. Pearson (Dauntsey's School). R. William Boardman (Bishop's Stortford College) presents a unique ecological study—the cryptogams of a derelict cucumber house. The journal concludes with reports from member schools and some reviews of natural-history books.

Wheat Breeding in the Near East

ATTEMPTS to improve cereal production necessarily include a study of host–disease relationships. At the third meeting of the United Nations Food and Agriculture Organization on wheat and barley breeding in the Near East, held recently in Damascus, Dr. T. Abdel-Hak gave an account of work at Giza Experiment Station on the relative susceptibility of wheat varieties to stem rust, bunt and flag smut, and on the physiological races of stem rust in Egypt, Syria and Turkey. Of 236 varieties of wheat produced locally in Egypt or introduced from other countries, fourteen proved resistant to all three diseases and were thus suitable for future breeding programmes. Resistance to stem rust was less general than to bunt or smut and also varied with the physiological race of rust present, Reliance being the only variety of wheat nearly immune to all the stem rusts so far isolated in Egypt. Prevalence of the different races might change from one year to another. The same race (17) had been predominant in Egypt since 1949; but a new one (53) isolated in 1950 had greatly increased in importance by 1953. Race 17 was also predominant in Syria and Cyprus, whereas in Turkey race 14 occurred most frequently. Although certain races had been isolated in Turkey or Syria which had so far not been found in Egypt, in general there was a great similarity both in the occurrence and prevalence of wheat stem rusts in all the Near East countries. This might indicate uredospore migration, and both further research and co-operation between the various countries in the region are needed to determine the true facts of the case.

Entomology and Public Opinion

THE United States Department of Agriculture has produced an excellent booklet describing the work of professional entomologists. The booklet has been designed particularly to help the layman to understand the part played by 'pure' and 'applied' entomology in his everyday life. Its opening page shows a Dakotan farmer looking at a field of corn which has been devastated by locusts; such incidents happened in the Dakotas in 1932. They have not happened since, and the rest of the booklet, with arresting pictures and prose, describes the reasons. The protection of food from insect pests, the virtual elimination of yellow fever and malaria, the rare occurrence of plague, typhus and relapsing fever, protection against clothes moth and other insect pests in the home, are some of the topics used for illustrating the work done by government and other entomologists in the United States. Existing research projects in entomology are also described in a booklet which is to be commended as a means of helping the layman to understand the nature and purpose of science.

Application of the Electrical Potential Analyser

RESEARCH REPORT No. 22 of the Aluminium Development Association (pp. 24; from the Association, 1953; 7*s.* 6*d.*) contains a description of an electrical potential analyser for the solution of the problem of the determination of the torsion constants for bulbs and fillets such as may be used in structural sections. The report is by P. J. Palmer, and the work was part of the investigations sponsored by the Development Association and conducted by Prof. S. C. Redshaw at the University of Birmingham. The solution could have been obtained by the use of the mathematical relaxation method or by the experimental soap-film method; but the electrical analogy method, which is really the electrical equivalent of the relaxation process, is simple, rapid and accurate and requires little skill in operation. The electrical potential corresponds to the mathematical stress function. After a brief introduction and an outline of the mathematics of the torsion problem, the report describes the analyser and the operation of the apparatus and then gives a series of test results. These are presented in the form of curves and tables and relate to a number of sections including angle fillets, *T*-junction fillets, single- and double-sided bulbs, and sections and fillets with unequal web thicknesses. For one of the test sections a detailed comparison between the relaxation and analyser solutions is given. The accuracy of the results obtained, about 5 per cent, is discussed, and it is stated that this could be still further improved if a larger number of internal points were used and if the accuracy of the external electrical resistances were higher.

Announcements

WE regret to announce the following deaths:

Sir Henry Clay, warden during 1944–49 of Nuffield College, Oxford, and president in 1929 of Section F (Economics) of the British Association, on July 30, aged seventy-one.

Mr. H. E. Dale, C.B., principal assistant secretary during 1927–35 to the Ministry of Agriculture and Fisheries, author of books on the higher Civil Service in Great Britain, on July 30, aged seventy-eight.

DR. G. W. A. DICK, of the Medical Research Council, National Institute for Medical Research, London, has been appointed to the chair of bacteriology in The Queen's University of Belfast. The following have been appointed lecturers in the University: Colonel D. R. Crone, civil engineering (surveying); and Dr. A. D. E. Pullin, physical chemistry.

THE Association of Agriculture and the Burton Manor Residential College for Adult Education, Burton-in-Wirral, Cheshire, are arranging a course on "Biology and Geography", to be held at the College during August 24–27. One day will be devoted to biological aspects with emphasis on agricultural crops and animal husbandry, and on another the main theme will be geography, in particular the changing pattern of the countryside and the specialized area of dairying districts of Cheshire. There will also be a number of excursions. The course is designed primarily for teachers of rural studies, but should also appeal to all those interested in the countryside. The inclusive fee, including accommodation, is £3 15*s*. Application forms, to be returned by August 18, can be obtained from the General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1.

RESEARCH AND DEVELOPMENT IN ALUMINIUM

BANBURY LABORATORIES OF ALUMINIUM LABORATORIES LTD.

ALUMINIUM LABORATORIES LTD., a subsidiary of Aluminium Ltd., was formed in 1936 to carry out research, development and exploration for the Aluminium Ltd. group of companies. In 1938 the Banbury Laboratories of the company were built, with the responsibility for research on the problems of fabrication and utilization of aluminium. The Second World War curtailed the activities at Banbury, the laboratories being taken over by the Ministry of Aircraft Production, and another similar laboratory was built at Kingston, Ontario; in 1950 the Arvida, Quebec, laboratory was completed to carry out research in the fields associated with the extraction of the metal. When work at Banbury restarted in 1946, it soon became plain that the accommodation would not be sufficient for the volume of work which was envisaged as a result of the expansion of the aluminium industry during the War. A large programme for extending the premises was therefore drawn up, and these extensions were finally completed in June last. Carried out at a cost of £300,000, they have trebled the floor area, giving a present total of 65,000 sq. ft.

The main features of the extensions are a new two-storied north wing, 345 ft. long, housing laboratories, offices and library, and a single-story experimental block with facilities for structural testing and the building of prototype plant and equipment. Every care has been taken in the design of the new premises, by Sir Percy Thomas and Son, to provide adequate facilities for the varied types of experimental work carried out. For example, the laboratories and offices are heated throughout by radiant ceiling panels to allow full use of the floor space; they are built on a modular principle with movable partitions which can be re-arranged to meet future needs, and all requisite services are built into the laboratory benches. Where necessary, air extraction and forced ventilation are provided, and full air-conditioning is supplied to certain laboratories where control is desirable.

The work carried out at Banbury is of two types—research and service. The service work may be taken to include work in the patents field, or in solving the technical problems of associated companies, or in the wider field of development of uses for aluminium. The research work, although directed principally to industrial needs, includes an important proportion of background work intended to add to the basic store of knowledge about aluminium and thus assist in the solution of future industrial problems.

There are approximately a hundred members of the Research Department, including about thirty-five graduates, divided into four groups; chemists, engineers, metallurgists, and physicists. While each group has its own field of activity, there are many problems requiring co-operative effort, leading to joint work by the groups. Examples of this are lubricating problems in metal deformation, where chemists and engineers work together, and alloy development, which is a problem tackled jointly by physicists and metallurgists. In this short article it may be sufficient to indicate the main interests of the different groups, bearing in mind that similar and complementary work in most of these fields is carried out by the sister laboratory at Kingston, Ontario.

Among the more important researches on which the metallurgists are engaged may be mentioned the study of the continuous casting process, with particular emphasis on the thermal conditions present in the cast shape and their relation to the stresses induced in it. Other metallurgists are working on textural problems such as grain size and the 'earing' of those sheet alloys intended for pressed and drawn parts. In addition, metallurgists and physicists are jointly exploring the application of modern physical metallurgy concepts to alloy formation. In this investigation, as in many others, there is continuing co-operation and discussion with the universities.

The Chemistry Division, while supporting a certain amount of analytical research, has a particularly strong interest in surface chemistry. Work is active on lubrication and, while the engineers are interested in the mechanism of lubrication, the chemists are studying the formulation and chemical behaviour of different mixes, the objects being to solve the problems encountered in the use of cold-rolling lubricants, which sometimes give stains when coiled strip is annealed, and to meet the special requirements for hot-rolling lubricants. Another aspect of the Chemistry Division's work is the investigation of the various surface treatments used on aluminium, such as brightening, anodizing and dyeing, and electroplating. A pilot plant for the study of the processes involved in the milling, filtering and preparation of aluminium paste pigment has also been provided in the new extensions.

In the Engineering Division considerable attention is still being devoted to the problem of metal fatigue, including the behaviour of built-up members and structures, and several useful contributions have been made to the literature of the subject; particular attention has been paid to the development of testing with resonance methods of inducing vibration by the use of the slipping clutch. Work on the mechanism of metal deformation during fabrication and subsequent conversion into end-products is also being carried out. This has as its objectives the improvement of the efficiency of fabricating processes, such as rolling, extrusion and forging, and the establishment of a sound theoretical basis for the forming operations (for example, pressing and deep drawing) of interest to the user. The work of the structural research section is both theoretical and practical, and the equipment includes a test rig in which structures up to 40 ft. long and 7 ft. 6 in. wide can be tested.

The activities of the Physics Division include research on the mechanism of heat transfer and propagation of energy in and through aluminium. The latter has grown out of a war-time interest in the non-destructive testing of sheet ingots and extrusion billets by ultrasonic inspection methods. Research in this direction has continued; several improved techniques are being devised, and fundamental work on the subject has thrown light on phenomena such as the recrystallization of cold-worked aluminium.

The heat-transfer studies are of interest both to the fabricator, in connexion with the heating and cooling of metal, and to the user, in applications where the properties of aluminium as a thermal insulating material are of value. A further important section of the Physics Division is devoted to instrumentation. This not only makes electronic and other equipment for use in the Research Department but also appraises commercial equipment for associated companies.

Although much of the development work on utilization is undertaken by the fabricating companies themselves, problems frequently arise which call for the resources of an industrial laboratory. The Technical Service and Development Department is responsible for dealing with these problems on behalf of associated companies or their customers. The Department has a staff of about forty, including ten graduates. It deals with a variety of day-to-day and long-term problems, the chief of which are metal working and joining, and canning. The welding section, for example, is equipped with a variety of inert-gas shielded arc-welding equipments and is able to give information, advice and instruction on their use. Another important aspect of the Department's work is the development of aluminium containers for the canning of food and beverages. The canning section is engaged on studies of the design, manufacture, use and testing of aluminium cans, and is equipped with pilot plant for carrying out all the operations, from the pressing of the cans to the testing of the canned product.

One of the most prominent features of the extensions is the new library and filing centre, which provides access to technical literature of all kinds, both from its own stocks and by reciprocal arrangement with other libraries.

With the completion of these new extensions, Aluminium Laboratories Ltd., Banbury, is now able to undertake the increasing volume of technical work resulting from the current expansion of the aluminium industry, and in association with its sister laboratories in Canada it is contributing to the solution of many of the fundamental and day-to-day problems encountered in the fabrication and utilization of the metal.

HENRY SALVATORI LABORATORY OF GEOPHYSICS, STANFORD UNIVERSITY, CALIFORNIA

By Prof. JOSHUA L. SOSKE

THE dedication of the Henry Salvatori Laboratory of Geophysics in the School of Mineral Sciences at Stanford University, California, on May 15 marked a significant step in the development of joint industrial-educational efforts to advance the relatively young science of geophysics. The new Laboratory is the gift of Mr. Henry Salvatori and the Western Geophysical Company of Los Angeles, California, of which he is president. It is one of several such major gifts by Mr. Salvatori and his Company to the University, another having been his establishment of the Henry Salvatori associate professorship in geophysics in 1951, which the present writer holds. In speaking at the dedication ceremonies, Mr. Salvatori expressed the conviction that the support thus far given Stanford University in geophysics should be but the beginning of much more widespread support of educational efforts in the discipline. He is a pioneer in geophysics, and is a co-developer of the reflexion seismograph method of prospecting for oil and gas.

The Laboratory is a striking example of the growing tendency of industry in the United States to attempt, through the support of higher education, to achieve two broad goals: first, to discharge its responsibility to education whence most of its trained leaders come, and second, to ensure future growth by encouraging both research and the continued production of highly trained personnel. Economic geophysicists are particularly aware that it is education to which they must look for persons to utilize present techniques, to develop new techniques through research, and to develop administrators of both research and operations within their own organization.

In short, a company engaged in exploratory geophysics is no better than the individuals who operate it; and since the bulk of these persons come from the colleges and universities, it seems quite proper that the company should co-operate in the development of basic research and curricula in geophysical engineering. The generous support of Mr. Salvatori and the Western Geophysical Company indicates their belief that half-measures will not accomplish their purposes.

Basically, the objectives both of the University and of industry are so simple they may be described in two phrases: the development of professional attitudes and the production of graduates in geophysics with professional competence. The first deals with the responsibility of the geophysicist to his employer or client and to the general public welfare. The second deals with the possession of technical knowledge and skills necessary for the geophysicist working in either economic or scientific fields.

In a broader sense, this will require that students of geophysics be subject to at least four distinct areas of education. These areas are listed in the order of exposure which Stanford proposes:

(1) In the School of Humanities the student will secure the training necessary for clear, forceful and productive thinking required in analysing problems and arriving at solutions. Here he will also learn how to express his findings effectively in both written and oral form.

(2) In the Department of Mathematics the student will become familiar not only with techniques but also with deductive reasoning, logic and precision.

(3) The third area consists of the fundamental sciences, such as geology, physics, chemistry, electronics and general engineering principles. Emphasis is to be placed upon the particular subject most directly concerned with the branch of geophysics chosen by the student. At Stanford University the geophysics student is particularly fortunate in the strength of the faculties in these related fields.

(4) The fourth area involves both the general and specialized training in exploratory geophysics. A curriculum has been designed with sufficient flexibility to provide the orientation necessary for both the physics-inclined and the geology-inclined students.

In summary, these are the objectives of the planned programme of the Division of Geophysics at Stanford, in the order of their importance:

(1) The primary purpose is to provide theoretical and practical training for engineers and scientists in the field of geophysics. During instruction, emphasis

is placed upon the requirements for exploration geophysicists by basic industries, educational institutions and government agencies. The world's basic industries alone employed 1,100 geophysical parties full-time during 1953, at an approximate cost of 400,000,000 dollars. The importance of this activity is plainly evident in the fact that half the known oil reserves of the United States have been discovered with the aid of geophysical techniques. Yet it is estimated that fewer than two hundred students trained in this science graduated from colleges and universities of the United States in 1953. This places the present supply of geophysicists completely out of proportion to the demand.

(2) The second purpose is to make available to students in all branches of the School of Mineral Sciences at Stanford University the opportunity of becoming familiar with the fundamental concepts of modern methods of geophysical prospecting. The wide acceptance of the techniques of applied geophysics as an important tool of the exploration geologist suggests the necessity that at least an elementary understanding of them be made a part of the education of every geologist.

(3) The third objective is to encourage and to carry on creative research in geophysical exploration methods. The Salvatori Laboratory provides facilities which will permit this research, both pure and applied. There is abundant opportunity for interested individuals and commercial firms to aid in the acceleration of this search for basic knowledge so important to the future of geophysics.

EXPERIMENTS ON ARTIFICIAL STIMULATION OF RAIN IN EAST AFRICA

By D. A. DAVIES

Director, East African Meteorological Department

IN previous communications[1,2], descriptions were given of experiments on the artificial stimulation of rainfall carried out in 1951 and 1952 at Kongwa, Tanganyika. The results of these experiments have been published as Memoirs of the East African Meteorological Department[3,4]. Two further series of experiments in East Africa can now be described; a full report is in preparation.

The seeding agent used throughout was finely ground hygroscopic salt (mainly common salt) and the method of seeding was the hydrogen-balloon method already described[2].

In the earlier experiments the analysis of the results was based on the readings of the close grid of rain-gauges which covered the area. This method has the advantage of being entirely objective. In the two series of experiments under consideration it was not possible, for a number of reasons, to install a similar grid of rain-gauges, and the results of the experiments are based on the personal observations of the field-officer conducting the experiments. In most cases this officer was a meteorological assistant of the East African Meteorological Department chosen for his exceptional competence in meteorological observational work, and who was given special training for this work. For short periods scientific officers of the Meteorological Department were present and, on some occasions, officers of other Government departments conducted experiments after having received necessary instruction. As will be seen later, there is remarkable consistency between the results obtained by all observers.

The first series of experiments was conducted at Amboseli in southern Kenya during the period October 18–December 12, 1953. Balloons were released whenever large cumulus clouds were present. The aim was to release up to five balloons into each cloud, each balloon carrying about 15 gm. of finely ground hygroscopic particles. Dispersal of the particles was effected by the explosion of a small charge of gunpowder, ignited by a time-fuse. The length of the time-fuse was adjusted to cause dispersion just above the base of the cloud. On days when no large cumulus clouds appeared, no experiments were conducted.

During the period of 56 days, seeding took place on 25 days and the total number of cloud seedings was 29. On five occasions the balloons missed the target cloud, leaving 24 occasions of useful experiments. On 19 of the 24 occasions, rain was observed to fall from the seeded cloud. The rain was described as light or very light on 16 of the 19 occasions; moderate on two occasions; and heavy on one occasion. On four of the occasions when the rain was described as very light, it evaporated before reaching the ground. The interval between the explosion and the observance of rain ranged from 16 to 38 min. (mean 26 min.), and the duration of the rain from 3 to 55 min. (mean 15 min.).

The five occasions out of the 24 on which rain did not follow the explosions are of interest. On four of these occasions rain was falling from the cloud before the explosion took place and in all four cases the rain was reported to have decreased in intensity shortly after (7–30 min.) the explosion, but later to have become more intense again. On one occasion there was a temporary cessation of rainfall. On the remaining occasion two balloons were released into a large cumulus which broke up after 20 min.

On the five occasions that the balloons missed the target cloud they entered smaller clouds on four occasions, and in all cases the clouds were reported as having dispersed. On the fifth occasion the balloon exploded in mid-air and a small cloud was seen to form in the vicinity shortly afterwards.

The experiments so far referred to were all conducted by staff of the East African Meteorological Department. During the same period, seven experiments were carried out in an adjacent region near Kajiado by a European game ranger, who states that the experiments "took place on days when the whole visible horizon was free from rain squalls, so prevalent at this time of year, and were finally halted with the advent of the 'short' rains in the District". The clouds chosen for seeding were generally large cumulus clouds, but on one occasion the sky was completely overcast and the clouds may have been thick strato-cumulus (possibly with cumulus embedded). The results reported by the game ranger were that on five of the seven occasions rain was observed to fall from the seeded cloud between 15 and 30 min. after the explosion of the charges; on one of these occasions the rain was reported as not reaching the ground. No results were obtained on the other two occasions. The falls of rain were again generally light; but on one occasion a heavy storm developed.

Turning now to the second of the experiments, these were conducted at Dodoma, in Tanganyika, during the period January 3–March 31, 1954. The procedure regarding the selection of clouds on which to experiment was essentially the same as for the earlier experiments described above.

During the period of 88 days, seeding took place on 36 days and the total number of seedings was 44. On 11 occasions the balloons missed the target cloud, or the target cloud had started to disperse before the explosion took place, leaving 33 occasions of useful experiments. On 23 of the 33 occasions, rain was observed to fall from the seeded cloud. The rain was described as light or very light on 20 of the 23 occasions; moderate on one occasion; and heavy on two occasions. On five of these occasions when the rain was described as light or very light, it was reported as evaporating before reaching the ground. The interval between the explosion and the observance of rain ranged from 13 to 35 min. (mean 23 min.), and the duration of the rain from 4 to 28 min. (mean 14 min.); but on one occasion rain was reported as recommencing shortly after the first shower and lasting several hours.

On 10 occasions out of 33 on which rain did not follow seeding, or if it occurred was unlikely to be due to seeding, are of interest. On one of these rain was already falling from the cloud before the explosion, and on this occasion the rain ceased 10 min. later. On another occasion there was rain which by virtue of the wind direction was probably not connected with the experiment. On a third occasion there was rain from the target cloud; but the close proximity of other precipitating clouds makes it doubtful whether the seeding had caused the rain. On the remaining seven occasions the cloud was observed to break up and disperse.

Of the 11 occasions (out of the total of 44) on which for various reasons no rain stimulation was to be expected, two resulted in the dispersal of a small cloud which was not the target cloud, four resulted in the accelerated dispersal of the target cloud which was already dispersing, one did not appear to expedite the dispersal of an already dispersing cloud, three exploded in clear air because the target cloud had vanished, and one did not produce an explosion, presumably because the fuse was extinguished.

The Dodoma experiments just described were carried out by staff of the Meteorological Department. Another series of similar experiments was, however, carried out at Dodoma in December 1953 by a European government officer. The full report from this officer has been delayed by sickness and is still awaited; but in discussion he stated that light rain occurred on most occasions 20–40 min. after the explosion.

On several occasions, in both the main series of experiments, changes in the colour of the cloud were reported in the vicinity of the explosion. In most cases dark grey turned temporarily to patches of light grey; on a few occasions brown patches or streaks were reported.

An analysis of the effect of the number of balloons used shows that in almost all cases when three or more charges were released into the cloud, rainfall was afterwards observed; in most cases where one was released the clouds were small and dispersal followed. The significance of this should not be overestimated, since there was a natural tendency for fewer balloons to be released when chances of successful stimulation seemed less. For example, if after the first balloon or second balloon had been released the cloud showed sign of dispersing, no further balloons were released.

With regard to the five occasions when the balloon entered a cloud from which rain was already falling, the seeding of these clouds was in all but one occasion intentional, the aim being to determine the effects of seeding on such clouds. On that occasion the balloon missed the target cloud and entered the rain cloud.

In assessing the significance of these experiments it is important to bear in mind the limitations of the method of observing the results which had perforce to be adopted. This method consisted essentially of visual observation, by the officer conducting the experiments, with the assistance of binoculars. The readings from a sparse network of rain-gauges were also available in both series of experiments and were of some assistance. Within these limitations every possible care was taken. The time of release of each balloon, the time of explosion, the time of commencement and the duration of rain downwind from the point of release of the balloon and the distance and azimuth of the point of first occurrence of the rain were all carefully recorded. Details of the observed changes in the seeded cloud and the apparent intensity of the rain were also recorded, together with any other information which seemed relevant. Surface and upper winds were measured by pilot balloons.

Having regard to all these considerations, it is thought that the figures quoted above for the frequency of observed rainfall following the seeding are adequate to justify the conclusion that the cloud seeding did stimulate rainfall on the majority of occasions, but that such rainfall was generally very light or light. This conclusion tends to be supported by the fact that the results show several points of similarity with those of the earlier experiments at Kongwa in 1952, which were carried out using the same technique but with a different method of assessing results.

In the 1952 Kongwa experiments there was an increase in total rainfall on days of seeding at a distance downwind from the fixed point of release of the seeding agent corresponding to a time interval of about 30 min. On some occasions at Kongwa, seeding resulted in dispersion of small cumulus clouds. In addition, the Kongwa experiments suggested "that the introduction of such (hygroscopic) particles into large cumulus clouds may produce an immediate interference with the rain-producing processes in such clouds, and that this effect might result in a reduction of rain in the immediate vicinity". All these points seem consistent with later experiments.

The theoretical interpretation of the experiments will be discussed in the report being prepared; but it may be said that, making reasonable assumptions regarding certain cloud parameters, the theoretical time of occurrence of the rain based, for example, on Bowen's collision process theory[3] shows reasonable agreement with the observed values. If it is assumed that the average cloud-droplet diameter is 20 μ, the liquid water content 1 gm./m.^{3}, the upward air velocity 1 m./sec. and the initial diameter of the drops formed by the hygroscopic particles 100 μ, then the time at which rain should appear from the base of the cloud is about 22 min. The amounts of rain which fell on some occasions are, however, too great to be accounted for by Bowen's theory unless the assumptions regarding the cloud parameters are seriously in error. The assumed value of 1 m./sec. for the vertical velocity of the rising air current in the cloud may well be too low in certain cases, and this would have a significant effect on the amount of rain resulting. Alternatively or additionally, a chain reaction due to breaking up of drops[6] and/or a turbulence effect[7] may have been operative, neither of which is provided for in Bowen's theory.

It is hoped to conduct further experiments this year using similar techniques. In these experiments it is proposed that the particle size of the hygroscopic substance shall be reduced to about 20 μ diameter, with the object of producing water drops in the cloud initially of about 50 μ diameter. The particle size hitherto used has been mainly between 50 μ and 75 μ, which results in water drops at least 100 μ diameter. This revised procedure should result in more rain being produced, but after a longer time interval.

[1] Davies, D. A., *Nature*, 167, 614 (1951).
[2] Davies, D. A., *Nature*, 169, 1001 (1952).
[3] Davies, D. A., Hepburn, D., and Sansom, H. W., E.A. Met Dept Memoir, 2, No. 9 (1951).
[4] Davies, D. A., Hepburn, D., and Sansom, H. W., E.A. Met. Dept Memoir, 2, No. 10 (1952).
[5] Bowen, E. G., *Quart. J. Roy. Met. Soc.*, 78, 37 (1952).
[6] Ludlam, F. H., *Quart. J. Roy. Met. Soc.*, 77, 402 (1951).
[7] East, T. W. R., and Marshall, J. S., *Quart. J. Roy. Met. Soc.*, 80, 26 (1954).

DUTCH–NORWEGIAN JOINT ESTABLISHMENT FOR NUCLEAR ENERGY RESEARCH

REPORT FOR THE YEAR 1952–53

THE Joint Establishment for Nuclear Energy Research (JENER), which was set up in April 1951 jointly by the Netherlands and Norway for the purpose of carrying out research and development work in the field of atomic energy, is supported financially by the governments of the two countries and by private industry. The Establishment is governed by a joint commission consisting of three representatives from the Netherlands and three from Norway and is directed by Mr. Gunnar Randers. The organization's research establishment and laboratories are situated at Kjeller, fifteen miles north-east of Oslo, Norway, and include the heavy-water-moderated uranium reactor, Joint Establishment Experimental Pile (JEEP), which is now in continuous operation. The second annual report of the Establishment, which has now been published*, gives full details of the progress made during 1952–53.

The factual report is preceded by the text of the opening address which Mr. Randers delivered at the international conference on heavy-water reactors held at Kjeller and Oslo during August 11–13, 1953, and by a short descriptive article on recent developments in radioisotope production and application in Norway. In his address, Mr. Randers explained that the main purpose of the conference was to hear the opinions of scientific workers as to the possibilities and difficulties of the particular approach adopted by Norway to the study of atomic energy, namely, by working exclusively with heavy-water reactors and natural uranium. It is not known whether reactors with natural uranium are practical for use in industry; but Mr. Randers asserted that, so far during the work at the Establishment, nothing has been found to rule out the possibility. The cost of fuel in a natural uranium reactor is approximately the same as in an enriched reactor; but the extremely high cost of heavy water presents a real problem for the future of heavy-water reactors. Mr. Randers outlined his reasons for the selection of a heterogeneous reactor—that is, one with uranium rods in heavy water—and pointed out that in such a reactor 1 per cent of the uranium could be burnt. He said that at Kjeller they are considering the construction of a heterogeneous heavy-water reactor to produce up to 25,000 kW. This reactor would use 10 tons of uranium, be cooled by heavy water at a temperature slightly above 200° C. and at a pressure of 35 atmospheres, and be moderated by heavy water at approximately 60° C. Attached to the boiler there would be a saturated steam turbine of about 25 per cent efficiency. The insulating material between the hot circulating heavy water and the cooler moderator might be beryllium oxide. It was hoped that the money for the venture would be forthcoming, but in the meantime considerable progress is being made with the design of the reactor.

The annual report mentions that since September 1952 JEEP has been in almost round-the-clock operation for five days a week—during ordinary staff working-hours for experimental work by the scientific staff, and at other times at maximum power-level for isotope production. In order to compensate for the heavy load of isotope material, two additional fuel rods, making a total of sixty-four, have been inserted in the reactor. The shielding has also been improved, and a mechanical system for extracting fuel rods has been constructed in addition to a storage cell for hot rods. Methods of visual inspection of the rods and of the inside of the reactor have been developed, and a permanent unit for recombination of dissociated heavy water built and installed. The extraction of heat from the reactor takes place in two stages, first from the heavy water to ordinary water and then from the ordinary water to free air. The hot air was originally discharged into the atmosphere, but now the heat from the air has been harnessed and utilized to heat the reactor hall. The extension to the reactor building to house new laboratories and offices was due for completion in September last.

Steady progress has been maintained with the equipping of the chemical laboratory, and an adequate staff has now been built up. The spectrographic laboratory is fully equipped, and some metallurgical research has been commenced. The constant surveillance of the heavy water in the reactor and some preliminary research work in transuranium chemistry are two of the main activities of the Chemistry Department which are specifically referred to in the annual report.

Work in the Physics Department has been directed more and more towards pile neutron physics, and the Kjeller reactor has proved to be a useful tool for physics research. The equipment and facilities available for neutron spectroscopy and neutron diffraction are described and illustrated in the report, in addition to the pile oscillator, gamma spectrograph, pulse height analyser, beta spectrometer and mass spectrometers. For the routine production of radioisotopes, resulting in a hundred and forty isotope shipments and service irradiations for customers outside the Establishment, and ninety-seven for the use of the Establishment's own staff, the reactor has been operated at an energy-level giving 1–5 × 10^{11} neutrons/cm.^{2}/sec. thermal neutron flux in the isotope channels and about eighty hours of effective irradiation time per week. Deliveries of carrier-free iodine-131 commenced in February 1953, and radioactive gold was expected to be ready for production by the end of the year. The preparation of organic compounds labelled with carbon-14 has been continued, and some fifteen compounds are now available. In the autumn of 1952 a regular consultative service was started by the Isotope Department for Norwegian industry, and details of the various industrial firms and the investigations undertaken with the particular isotopes used are listed in the annual report.

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* Joint Establishment for Nuclear Energy Research. Second Annual Report, 1952/53. Pp. iv+41. (Blindern, Oslo: Akademisk Trykningssentral, 1953.)

The final sections of the report deal briefly with reactor development; health physics; the information service and its publications; the accounts of the Establishment for the period July 1, 1952–June 30, 1953; the personnel in the various departments; and the various scientific meetings and conferences attended by members of the staff of the Establishment during the period under review.

BRITISH HYDROMECHANICS RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1952–53

THE sixth annual report of the British Hydromechanics Research Association, covering the period October 1952–September 1953[*], records satisfactory development in both the activities and finances of the Association. Although the scale of operation is modest, it is stated that the Association's technical prestige has risen considerably and that it is being consulted as an authority on fluid mechanics by a widening range of industries.

The first five-year period of government grant-aid expired at the end of the year under review, and an application for its continuation and augmentation submitted to the Industrial Grants Committee was received sympathetically. However, the new grant, although rising to a higher maximum than the original, is not so favourably proportioned; for the first £18,000 of income the grant is £9,000 and then £75 per £100 up to a maximum additional grant of £9,000. It is expected that subscriptions from present members for 1953–54 will exceed the minimum grant-earning figure.

The two visitors to the Association, Brigadier R. A. Bagnold and Prof. L. Rosenhead, appointed by the Department of Scientific and Industrial Research, continued to take a keen interest in the activities of the Association and to attend meetings of the Council and research committees. During the year the constitution of these committees was revised, and those formerly dealing with fundamental fluid mechanics, instruments, and pipe-flow problems were combined into a single committee dealing with non-machinery problems, while the other research committees were enlarged. Details of these committees, together with a list of their members, and of the ordinary and associate members of the Association, are given in the report.

The staff of the Association has been increased and now numbers thirty-three, the senior staff consisting of the director of research, Mr. L. E. Prosser; the deputy director of research, Mr. R. C. Worster; five research engineers and one junior research engineer; the secretary and the librarian. From the research work undertaken since the Association's laboratory was opened in 1951, much useful information has emerged, particularly in relation to sump design, pulsating flow metering, pre-rotation in centrifugal pumps and the precision manometer. Some of the more recent work and of the results obtained are briefly described in the annual report. Instruments for the metering of pulsating flows have been successfully developed, and preliminary work with simple suction-pump layouts has been extended to models of actual or proposed installations. The collection and study of data on the friction loss in pipes and fittings have now been completed. A technical note dealing with the pressure surges resulting from a failure of the power supply to a pumping set has recently been published and, as little information is available on the subject, work has been started on an investigation of the rate of gas release from liquids when the pressure is reduced.

There is considerable interest in the hydraulic transport of large coal, and the Association has accordingly undertaken an extensive investigation of the basic hydraulic process involved. The results obtained so far indicate that the hydraulic transport of coal on a large scale should be economic over distances of several miles. A promising application is the vertical transport of coal from the pit bottom or working face to the surface, and the main practical problem of raising the mixture of coal and water to the required pressure is being tackled by the development of a coal feeder for delivering the coal into a pipeline where the water has previously been raised to high pressure by conventional means.

Fuller information about the various investigations can be obtained from the numerous technical notes, research reports and published papers of the research staff of the Association, a complete list of which is included in the annual report.

INSTITUTE OF PHYSICS

ANNUAL REPORT FOR 1953

THE thirty-fourth annual report of the Board of the Institute of Physics, covering the work of the Institute during 1953 (obtainable from the Institute at 47 Belgrave Square, London, S.W.1), records that the Board of the Institute met six times, and its various standing committees twenty-four times, during the year. The membership increased by 248 to 4,595. Applications for election or transfer to the various grades of membership of the Institute received during 1953 numbered 581, compared with 651 in the previous year. The degrees of a further four universities, in particular the newly established degree in applied physics of the University of Manchester and the associateship in applied physics of the Royal Technical College, Glasgow, were recognized by the Board, and two technical colleges which had applied for extension of recognition were visited by representatives of the membership and examinations committee. Seven of the thirty-two candidates for the graduateship grade of membership of the Institute were successful; for the National Certificates in applied physics the numbers of candidates continued to increase, being 151 candidates for the ordinary level and 55 for the higher certificate, compared with 137 and 33, respectively, in 1952.

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[*] British Hydromechanics Research Association. Sixth Annual Report, October 1952 to September 1953. Pp. 26. (From the Association, Nettleswell Road, Harlow, Essex.)

The circulation of the Institute's two journals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, increased during the year, and there was a further improvement in the advertisement revenue. The last three monthly issues of the 1953 volume of the *Journal of Scientific Instruments* were enlarged in order to reduce the delay in publication of original contributions, and provision has also been made for similar enlargement of the *British Journal of Applied Physics* during 1954 both to reduce delay in publication and to extend the scope of the *Journal*. The twelve issues of the Institute's *Bulletin* (issued to members only) included summaries of some of the meetings of the Education Group, the Board's reports on "Problems concerning the Education of Physicists" (afterwards re-issued as a pamphlet) and on "Summary of Salaries and Enrolments", in addition to a number of important articles based mainly on lectures delivered at meetings of the Institute. In the "Physics in Industry" series, a new volume entitled "Modern Mass Spectrometry", by Dr. G. P. Barnard, was published during the year, and the first four booklets in the new "Monographs for Students" series were issued.

The second convention of the Institute, held in Bournemouth during May 27–30, was attended by approximately 450 members and their ladies and guests; its agenda included the thirty-third annual general meeting of the Institute, a discussion on the education of physicists and twelve group meetings, at which twenty-three papers were read. Lectures were given by Sir John Cockcroft on recent advances in nuclear physics[1] and by Dr. A. C. Menzies on recent developments in applied optics[2], and Canon C. E. Raven gave an evening address on the impact of physics on science and religion[3].

The Institute has seven branches in Great Britain, an Indian branch under the chairmanship of Sir C. V. Raman and an autonomous Australian branch with divisions in different States. In addition to the branches in Great Britain, there are seven specialist subject groups—electronics, electron microscopy, industrial radiology, industrial spectroscopy, stress analysis, X-ray analysis and education—which arrange their own programmes of scientific meetings and conferences. Seven specialist conferences were held by the various branches and groups, including a two-day meeting of the Industrial Radiology Group jointly with the Hospital Physicists' Association, and a conference of the X-Ray Analysis Group on film methods and microdensitometry and on identification by X-ray analysis. As in previous years, the Institute collaborated with the University of Bristol in a summer school and conference, held at Bristol during July 13–16, on the theory of the plastic deformation of metals, and it was also associated with a conference organized by the Clarendon Laboratory, Oxford, and held there during July 18–23, on the subject of ionization phenomena in discharges. The proceedings of the conference on "Static Electrification" which was held by the Institute at Bedford College, London, during March 25–27, have been separately published[4].

The Institute has been represented on many joint committees and bodies, including committees of the British Standards Institution, the Royal Society and the Parliamentary and Scientific Committee, and further details are given in the annual report. The Faraday Society, the Royal Meteorological Society and the British Institute of Radiology, which together with the Physical Society form the four participating societies of the Institute, have given notice of withdrawal from participation in accordance with the provisions existing in the constitution. The Physical Society is in a different position from the other three societies since its members are physicists, and will continue to have two seats on the Board of the Institute. In order to encourage members to support *Science Abstracts* and to enable them to continue to enjoy the privilege of purchasing copies of both *Physics Abstracts* and *Electrical Engineering Abstracts* at reduced rates in spite of increased costs of production, the Board has agreed to make a modest annual basic payment to the management committee of the abstracts from its publications account, and the Institute in return will be represented on the management committee.

This year the thirty-fourth annual general meeting of the Institute was held at the Institute's house in London on May 18, when the following were elected to take office on October 1: *President*, Sir John Cockcroft; *Vice-President*, Mr. G. R. Noakes; *Honorary Treasurer*, Dr. S. Whitehead; *Honorary Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Dr. K. A. G. Mendelssohn and Mr. H. P. Rooksby. Prof. W. E. Curtis and Dr. C. Sykes (past-presidents), Mr. O. W. Humphreys, Dr. T. L. Ibbs and Prof. F. A. Vick (vice-presidents), Dr. H. Barrell, Dr. N. A. de Bruyne, Dr. P. H. S. Henry, Mr. A. T. Pickles, Dr. W. H. Taylor and Mr. R. G. Wood continue to serve on the Board.

[1] *Brit. J. App. Phys.*, 4, 289 (1953).

[2] *J. Sci. Instr.*, 30, 441 (1953).

[3] *Bull. Inst. Phys.*, No. 43, 75 (1953).

[4] *Brit. J. App. Phys.*, Supp. No. 2 (1953).

FORESTRY IN BRITISH HONDURAS

ANNUAL REPORT FOR 1952

THE annual report for 1952 of the Forest Department of British Honduras*, whence came the mahogany so well known in Britain during the nineteenth century, states that the Department reached thirty years of age in April 1952. The report furnishes abundant evidence of the vacillation of the authorities concerned as to the value of the Department and of the forests to the Colony. "Because of staff shortages and changes," says the report, "it was impossible to issue Forest Department Annual Reports for the years 1950 and 1951."

The Department's difficulties are mainly due to staff shortages. The post of conservator was vacant throughout the year, and two officers acted in the post. There were apparently three gazetted officers only on the staff at the end of 1952 (one on leave and one newly joined). It is scarcely surprising to read that the forest boundaries are overgrown and require reclearing and that the forest estate is at present inadequate and is also insufficiently secure: during 1952 the lease of large areas of land in the forest reserves to the Colonial Development Corporation for agricultural purposes was being negotiated. If this is the case, the legal position of the so-called forest reserves is obviously very unstable.

Finally, as can be well understood, no working plans are in force. Yet at its commencement the Department started under the most promising auspices: it was tentatively created for two years, and three technically trained forest officers were appointed. The fourth annual report of the then young Department (it had passed the two-year ordeal successfully) was issued in 1926 and was reviewed in *Nature* (119, 256; 1927). The following extract from this review merits reproducing: ". . . it is easy to see that the young department has already made good. So far, the work has been mainly devoted to assisting the several lumbering companies at work in the forests on government leases. In some respects the operations are proceeding on lines similar to the working of the Burmese forests by the British forest officers of earlier days. Obviously, however, the work of exploring the government forests, collecting topographical and other details, has been commenced (the superior staff now amounting to six), and it is hoped to be able to carry out the exploration of the practically unknown territory of the Western Highlands. . . . At the time of writing, a reliable base-line has been established between Vaca and the Rio Grande and a good general idea of the forests of this region obtained". That was twenty-seven years ago. The extracts from the present report already given indicate the history of the Forest Department since then and the ignorance on the part of the authorities of the value of the forest estate to the people and the Colony itself.

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* British Honduras. Forest Department. Annual Report for 195 (with Statistics in Standard Form for 1950 and 1951). Pp. 42. (Britis Honduras: Government Printer, 1953.)

E. P. STEBBING

CAMBRIDGE UNIVERSITY EDUCATIONAL FILM COUNCIL

THE seventh annual report of the Cambridge University Educational Film Council states that Prof. J. F. Baker has succeeded Sir Lawrence Bragg as president and that two new vice-presidents, Mr. S. C. Roberts, master of Pembroke College, and Prof. J. A. Steers, head of the Department of Geography, have been appointed. With the use of a Merlin Gerin camera in the Department of Engineering, a number of 16-mm. ciné pictures at 4,000 frames per second of tensile specimens being broken have been obtained. Some medium-speed pictures, at 100 frames per second, of the operation of a new testing machine have been taken; cinematography is also being used in connexion with the flow of gases in internal combustion engines. Members of the Departments of Anatomy and of Physiology have collaborated in the making of a film, "The Behaviour of Dissociated Sponge Cells". The use of films in teaching has been maintained especially in the University Faculties and Departments of Anatomy, Archæology and Anthropology, Economics and Politics, Engineering, Geography, Slavonic Studies and Zoology. In the Department of Education lectures on the use of visual aids continue as a regular part of the course. In a continuation of the film sessions for students of history, the films "Peter the Great", "Kameradschaft", "Day of Wrath", "Ivan the Terrible", "Journey into History", "Images Gothiques" and "Ange de la Paix" have been shown. The purchase of some 16-mm. editing apparatus has improved film-making facilities in the University. There remains, however, the need for a central cutting room, and an arrangement by which films may be processed within the University.

A proposal discussed between the Film Council and a member of the B.B.C. Television Service may greatly assist the making of films in the University. Film-making facilities would be provided, and also a copy of any film used, in return for the provision of suitable science subjects for television programmes. The Film Council again urges that all the films made in Cambridge by the late Sir Joseph Barcroft should be traced and catalogued, and, where necessary, edited, copied and preserved. The Council has also recommended further Cambridge films for inclusion in the Scientific Film Library. Projection arrangements are much as they were a year ago, and there is still a lack of continuous 35-mm. projection facilities in the University.

EVIDENCE OF FIRE IN SOUTH AFRICAN CAVE DEPOSITS

DR. KENNETH P. OAKLEY

British Museum (Natural History)

IN 1947 great interest was aroused by Prof. Raymond Dart's announcement that evidence had been found at the Limeworks in the Makapansgat Valley, Central Transvaal, that *Australopithecus* was a user of fire. He based this conclusion on Dr. V. L. Bosazza's identification of fragments of a brown glass-like substance in the basal grey beds there which had yielded remains of this hominid. The vitreous material was regarded as having resulted from the action of fire in the presence of lime, phosphates and ash[1].

Some anthropologists have doubted these conclusions. There is no evidence that *Australopithecus* was a tool-maker, and on general grounds it appears most unlikely that the use of fire preceded the manufacture of tools. Moreover, three other possible explanations of the vitreous material in the Makapan deposit might be advanced: although siliceous and vitreous in appearance, it may have been produced by some chemical action not requiring a high temperature; even if the material is true glass, it may have been due to fires ignited by men living contemporaneously with *Australopithecus*; or it may have been produced by fires ignited at the mouth of the cave by some natural conflagration.

The second possibility certainly has to be taken more seriously now that there is evidence indicating that tool-making hominids (that is, 'men' in common parlance) were living contemporaneously with Australopithecines in South Africa[2]. The idea that the vitreous material possibly originated through a natural conflagration might seem more far-fetched; but quite recently evidence has come from the Cave of Hearths, farther up the Makapansgat Valley, which shows that this, too, is at least a plausible hypothesis.

Through the courtesy of Prof. C. van Riet Lowe, I had an opportunity in March 1953 of visiting the Makapan sites in company with him and with Prof. and Mrs. Dart. At the Cave of Hearths, I was much impressed by the thickness (more than 4 ft.) of what appeared to be cindery ash forming the so-called basal hearth in the Upper Acheulean zone of the cultural sequence. This 'hearth' is generally regarded as the oldest proved evidence of the use of fire by Stone Age man in Africa. I was, however, puzzled by two features of the ash: (1) it appeared to contain no fragments of charcoal or burnt bone; (2) it rested directly on a clean surface of stalagmitic dripstone. Dripstone is normally formed only in the interior of caves, not where they open as rock-shelters. On the other hand, men do not regularly light fires in the deep recesses of caves, but as a general rule only at their openings. Yet if there had been any appreciable time-interval between the accumulation of the dripstone in this cave and its conversion into an open rock-shelter, say, by cliff falls or denudation, one would expect to find that some soil or rock debris had collected on the surface of the dripstone before men began burning fires on it. There was no trace of such material below the 'hearth'.

Excavations at the Cave of Hearths carried out between June and October 1953 by Mr. Revil Mason, under the general direction of Prof. van Riet Lowe[3], revealed hearths at ten levels in the 30 ft. of deposits overlying the 'basal hearth', ranging in age from Fauresmith (Earlier Stone Age III), through five stages of Middle Stone Age culture, to the Late Stone Age. Samples of all the main hearths have been sent to London for carbon-14 age-determination at the British Museum Research Laboratory. (A few have been forwarded to Prof. W. F. Libby at the Institute of Nuclear Studies, Chicago, who has reported that a hearth sample of Middle Stone Age IV showed an age of 15,100 ± 730 years.) In order to check whether the samples submitted contained adequate quantities of carbon, pilot fractions of them were assayed by Miss P. Hammond and Mr. A. E. Rixon in the Palæontological Laboratory of the British Museum (Natural History). The results were as follows:

Hearth level	Weight of sample (gm.)	Percentage of free carbon
Late Stone Age	819	7·7
Middle Stone Age V	1,106	8·5
" " IV	256	4·9
" " III	240	8·7
" " II	282	8·3
" " I	408	7·6
Earlier Stone Age IV	261	4·1
" " III	203	8·7
Basal hearth (E S.A.I.)	338	0·0

The absence of carbon from the pilot fraction of the basal-hearth sample was so unexpected that two additional pilot fractions of the basal-hearth sample were tested; but in neither was any trace of free carbon found. Another sample of the same deposit, collected independently by me in March 1953, was also tested, and likewise proved to contain no free carbon.

The discovery that samples of the 'basal hearth' were devoid of free carbon suggested to me, in the light of my field observations, that the deposit was not wood-ash as had been assumed, but that it might be calcined bat-guano. I therefore asked Mr. Rixon to test the phosphate content of the samples; and he reported that they were in fact largely phosphatic (averaging more than 20 per cent P_2O_5, compared with 15 per cent in a sample of experimentally calcined bat-guano and 2 per cent in an overlying undoubted hearth). A further test showed that the material contained sufficient oxides of iron to account for its colour (dark grey with yellowish streaks).

When the basal-hearth deposit was first encountered in 1937 (a thickness of only a few inches was then exposed), Prof. van Riet Lowe submitted a sample to the Director of the Geological Survey of South Africa, who reported that it contained some free carbon, and in its harder parts some glassy slag-like material[4]. Thus it may well be that the deposit is composite, and that in its upper half, and where it thins out at the margins, there is possibly some admixture with the ashes of the first fires lit by Late Acheulean man. Indeed, Prof. Lowe has told me that two stone hand-axes have been found in the loosely consolidated deposit, one 2 ft. below its surface, and that both appear to be fire-pitted.

The conclusion that the bulk of the basal-hearth deposit is calcined bat-guano might suggest simply that Stone Age man used this material as fuel. Maybe he did; but nevertheless the fact that the deposit in question is devoid of charred bones and rests directly on a clean surface of stalagmite strongly indicates that here it is a natural, mainly undisturbed, accumulation which was adventitiously burnt.

Bat-guano commonly accumulates on the floors of the interiors of caves, and it is not at all unusual to find a deposit of this material resting directly on a dripstone formed when the cave was wetter. If bat-guano had accumulated on dripstone in the original Cave of Hearths, and then a cliff fall opened up the cave so that it became a convenient rock-shelter for human habitation, it is quite possible that the first fires to be lighted by man would have been placed on top of dried bat-guano. The guano of insectivorous bats, consisting largely of insect wings and elytra, is very inflammable. (In the middle of the past century, a hunter is said to have attempted to smoke a bear out of a cave in Blanco County, Texas, by igniting the bat-guano. The result was an explosion, after which the deposit continued to burn for two years[5].) In the circumstances which I have postulated, the guano would have caught fire, and aided by a through draught it would have become in time completely calcined; draughts are common in these caves, as Piet Potgieter's men learnt to their dismay when they tried to smoke out the Makapan tribesmen from the historic cave in this same valley a century ago.

If the brown glass-like fragments found by Bosazza in the *Australopithecus* deposit at the Makapansgat Limeworks were in fact produced by the fusion of sandy cave-earth, one has to allow the possibility that it was brought about by the burning of bat-guano ignited at the cave entrance by a natural grass fire. Dr. Desmond Clark has described to me how on an occasion when he was working in the Mumbwa Caves in Northern Rhodesia a grass fire reached the mouth of one of them and, drawn by a through draught, roared in for a few minutes as if in a furnace. In such circumstances the ignition of bat-guano and local fusion of intermixed sand would be by no means inconceivable.

[1] Dart, R. A., *Amer. J. Phys. Anthrop.*, n.s., 6, 276 (1948); Proc Pan-African Cong. Prehist., 1947, 97 (1952).

[2] Oakley, K. P., *Amer. J. Phys. Anthrop.*, n.s., 12, 17 (1954).

[3] Lowe, C. van Riet, *S. Afric. Arch. Bull.*, 33, 25 (1954).

[4] Lowe, C. van Riet, *S. Afric. J. Sci.*, 35, 371 (1938).

[5] Hutchinson, G. E., *Bull. Amer. Mus. Nat. Hist.*, 96, 396 (1950).

THE AUSTRALOPITHECINE OCCIPUT

In a recently published essay[1], Prof. S. Zuckerman has discussed at some length the evolutionary position of the australopithecines under the thre headings of evidence relating to: (1) the brain, (2) th face and teeth, and (3) upright posture. The first tw sections are dismissed after very brief discussion, th main subject of the essay being a discussion of evidenc relating to posture. Under this heading the author is chiefly concerned with the nature of the occipital region of the skull and the pelvis. After much discussion and speculation, Zuckerman comes to the conclusion that the Swartkrans prehominid must have had a "powerful and shelf-like" nuchal crest because it had a sagittal crest. He further concludes that it "carried its head on its vertebral column far more in the manner of a gorilla than of a man".

There is, however, direct evidence on the presence or not of a nuchal crest in the known australopithecine material. One of the relevant specimens is the occipital fragment of a calvarium from Makapan described by Dart[2]. This specimen consists of the greater part of the occiput, as well as a good deal of the parietal bones, of an adult. On the original, which is very well preserved, the areas of attachment of the temporal and nuchal muscle masses are plainly visible. The temporal muscles clearly did not actually touch the nuchal musculature. The temporal lines are very widely separated posteriorly but converge as they pass forward, so that they are practically in contact in the midline at the point where the specimen is broken. This point is well behind the vertex—a fact which is easily proved by comparing the specimen with the complete skull from Sterkfontein, which belongs to the same species[3]. The superior nuchal line and the temporal lines thus enclose a relatively large, roughly triangular, area which was not covered by temporal or nuchal muscles. From other specimens from Swartkrans and Sterkfontein, it is abundantly clear that in the australopithecines the temporal lines approach each other most closely in the general region of the bregma or just posterior to it. Anteriorly and posteriorly of this region they diverge fairly sharply. It is therefore manifest that the temporal lines of the Makapan occipital fragment, which are already almost touching well behind the vertex, must have fused farther forward—hence there must have been a sagittal crest. There is, however, no 'shelf-like' nuchal crest. Instead there is only a slightly thickened ridge of bone, marking the position of the superior nuchal line, which is no more strongly developed than that commonly encountered in modern euhominids.

A second specimen which yields direct evidence on this point is *SK* 48 from Swartkrans. This had a well-developed sagittal crest; but only that part of it near the bregma is present, the remainder having been lost in the course of recovering the specimen. This specimen is one of the two referred to by Zuckerman—and was seen in the original by him in 1951—as having a sagittal crest but of which the occiput is missing. In actual fact the greater part of the occiput is present but is a bit distorted and displaced. Fortunately a part of the critical region is preserved and this shows that no nuchal crest was present in the midline. To the right of the midline the superior nuchal line is thickened more than is the case in the Makapan occiput but not so much as in Rhodesian man. On the left of the midline the bone is damaged. Here again there is no evidence of a powerfully developed, shelf-like nuchal crest. A third specimen, *SK* 49 from Swartkrans, also has the anterior part of the sagittal crest preserved as well as a good deal of the occiput, and in this also there is no shelf-like nuchal crest, nor does the sagittal crest reach back to the occiput.

The observed facts show clearly that the conditions necessary for the formation of a powerful nuchal crest were not present in the australopithecine skull, while those necessary for the formation of a partial sagittal crest sometimes did occur. A relatively small amount of expansion of the anterior part of the neurocranium would have resulted in the removal of the conditions giving rise to the latter also. Zuckerman's conclusion that the nature of the australopithecine occipital region does not support the contention that they were bipedal is therefore not consistent with the facts.

A recently prepared specimen, which has not yet been described, is of very great importance with regard to the posture of the australopithecines. A detailed description of this specimen will be published elsewhere; but because it has so direct a bearing on the matter here discussed, a few salient features will be mentioned. The specimen, from Sterkfontein, consists of nine thoracic vertebræ with a number of ribs, all the lumbar vertebræ, the greater part of the sacrum, the right innominate (previously known), and most of the left innominate, as well as a considerable portion of a femur. The spinal column was articulated but the innominates and sacrum were displaced. The sacrum is simply a small edition of the euhominid bone and has a well-developed promontory—which is, however, not so well developed as in modern man. The pelvis, when assembled, is very similar in the general proportions and orientation of the bones to that of man and differs very sharply from the pongid homologue. This is especially apparent in the orientation of the iliac blades and the shape and orientation of the pelvic canal. Lack of space prohibits full discussion of these and other features here; but detailed study of this remarkable specimen shows clearly that it belonged to a bipedal creature. This is fully consistent with the cranial features such as lack of nuchal crest, orientation of the occiput and position of the foramen magnum—the last especially in the Swartkrans prehominid.

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[1] Zuckerman, S., "Correlation of Change in the Evolution of Higher Primates", in "Evolution as a Process", edited by Huxley, Hardy and Ford (1954).

Dart, R. A., *Amer. J. Phys. Anthrop.*, n.s., 6, 259 (1948).

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THE essay[1] to which Dr. J. T. Robinson refers is mainly an account of the development of the sagittal and nuchal crests; of the balance of the skull; of the anatomy of the temporo-mandibular joint; and of the way teeth become worn. This study showed that in apes and monkeys a sagittal crest is almost invariably associated with a nuchal crest and with a simian planum nuchale. It also showed that if one of the two crests is missing, it is almost invariably the sagittal crest that is lacking. For this reason I suggested that unless *Paranthropus crassidens*, the australopithecine from Swartkrans, is a single exception to a morphogenetical process common to all known Anthropoidea, it followed that its possession of a high sagittal crest implied that it had possessed a powerful nuchal crest or occipital torus.

Dr. Robinson now states that there is "direct evidence" to show that the general proposition "sagittal crest implies the presence of nuchal crest" did not apply to the Australopithecinae. Anything is, of course, possible, and the idea that the australopithecine apes do, in fact, constitute an exception to what seems to be an otherwise general morphogenetic rule is consonant with other claims that have been made for these fossils. But what is possible is not necessarily probable, and certainly does not follow from the so-called direct evidence which Dr. Robinson now cites.

This evidence consists of, first, the occipital fragment of a calvarium from Makapan which was originally described by Dart in 1948[2]. In this specimen, as Dr. Robinson points out, the temporal lines are separated posteriorly, but converge as they pass forward, although they remain separated in the specimen "by an interval of not more than 5 mm."[4]. Dr. Robinson suggests that the point where the specimen is broken is well behind the vertex, and he argues that the lines "*must* have fused farther forward [italics mine]—hence there must have been a sagittal crest". *Ergo*, a sagittal crest is not necessarily associated with a shelf-like nuchal crest.

Quite apart from the novelty of this logic, the "must" is completely unjustified. In female chimpanzees and gorillas, particularly in those which are 'adult' but not fully mature, the temporal lines usually diverge posteriorly, and approach most closely or even meet in the midline behind the bregma, without forming any sagittal crest. This point was recognized by Dart in his detailed description of the Makapan specimen. The fact that the sagittal and lambdoidal sutures of the calvarium had not completely fused suggests that the animal to which it belonged was not fully mature. The lambda area is abnormal, due to the presence of "a sutura transversa occipitalis . . . with subsidiary sulci", but there is nothing remarkable in the disposition of the temporal lines in the specimen as compared with modern apes. Had the animal lived longer than it did, it is possible that the sagittal lines would have met, and it is even conceivable that a sagittal crest may in due course have been formed. Had this, however, been the case, one would have expected the superior nuchal lines to have formed a much more marked crest than they do, especially laterally.

The second specimen which, according to Dr. Robinson, presents features that controvert the proposition sagittal crest presupposes nuchal crest, is Swartkrans *SK* 48. The 'official' description, with photographs (Plate 3) of this specimen, appears in Broom and Robinson's monograph[3]. Here, the occipital region is described as being "very considerably crushed upwards and forwards". Dr. Robinson now says that the greater part of the occiput is present in the specimen, "but is a bit distorted and displaced". The excellent cast that is available in the British Museum conforms to the original description. Regardless of this unexplained discrepancy, Dr. Robinson's point that the nuchal crest was deficient in the midline, though present to the side, is also misleading, if he is intending to imply that this is something different from what occurs in adult apes. Again, the fact is that in chimpanzees and gorillas (especially the female), the least prominent part of the nuchal crest is not infrequently in the midline. One reason for this is that the first part of the occipital torus to form in monkeys and apes is the lateral end, where the temporal lines begin to fuse with the occipital crests. This, as I suggested in the essay to which Dr. Robinson refers, implies that the posterior horizontal and oblique fibres of the temporal muscles grow more rapidly than its anterio and vertical fibres. The description I gave was in no sense complete, and my observations about the further development of the temporal lines applied mainly to those animals (for example, male gorilla and male baboon) in which a sagittal crest is bes developed. In these, the primary meeting point o the two temporal lines is usually towards the posterio part of the sagittal suture, a fact which again can only reflect the relative rate of growth of the posterior horizontal and oblique fibres of the temporal muscles in these creatures. But in the orang outang the temporal lines meet more anteriorly sometimes just behind the bregma, and usually about midway between the bregma and the inion This is what also occurs in the female chimpanzee in which a sagittal crest does not develop, and in the male chimpanzee, in which a crest occurs only occasionally. In those unusual cases where a sagitta crest develops in the gibbon, the temporal lines having fused postero-laterally with the occipital crests usually meet each other just behind the bregma. In many monkeys, again, the upper borders of the sagittal lines do not meet, but remain parallel to each other, in spite of the presence of a strong occipital crest. What is said here applies only to the monkeys and apes. In the loris, a primate belonging to the suborder Prosimii as opposed to Anthropoidea, a sagittal crest may develop over the vertex of the skull, even though the nuchal crests are present only postero-laterally.

The third specimen, which, according to Dr Robinson, presents features that controvert the proposition "sagittal crest presupposes nuchal crest", is *SK* 49. This skull has apparently not been described before, and the amount of information provided now makes it impossible to comment on Dr. Robinson's observations. It would be interesting to know if the posterior part of the sagittal crest (or suture) and the occipital region are better preserved than they are in *SK* 48, or in the second apparently female skull described in Broom and Robinson's original monograph.

The fourth piece of 'direct evidence' to which Dr. Robinson refers relates to a series of post-cranial bones. Whatever these may reveal, they have no direct bearing on the general proposition "presence of sagittal crest presupposes existence of nuchal crest", which to the best of my knowledge is based upon the generality of known facts about the morphogenesis of the primate skull. In any event, now that part of a manifestly human mandible has been found in the same deposits as have yielded the australopithecine apes[4,5], it will be necessary to decide what post-cranial bones relate to what cranial fragments before drawing conclusions about the correlation or lack of correlation of cranial and post-cranial features in the whole group of these fossils.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Measurements on the Neutron Multiplication in a System of Uranium Rods and Ordinary Water

In order to determine the multiplication constant of a system of uranium rods and ordinary water we have made two different experiments with a radium–beryllium source.

A total of 129 uranium rods, 30 mm. in diameter and about 2 m. long, were suspended in a hexagonal lattice in a tank with distilled water. The lattice constant was varied from 40 mm. to 65 mm. in steps of 5 mm. The uranium rods were encased in aluminium tubes, 0·3 mm. thick. The tank had a diameter of 1·2 m. and a height of 2 m. Since the diameter of the uranium core was always less than 0·8 m., the water reflector could in all cases be considered infinitely thick. As detectors, we used boron trifluoride chambers.

(1) Some ordinary exponential experiments[1] were carried out. From these measurements we can calculate the material buckling or 'Laplacian', B_m^2, and obtain the infinite multiplication constant, k, from the formula

$$B_m^2 = (k - 1)/M^2, \qquad (1)$$

where M^2 is the migration area for fission neutrons.

Due to the presence of the water reflector, the radial part α^2 of the buckling cannot be calculated from the extrapolated radius. We have instead calculated it from measurements near the centre of the core, where the influence of the reflector is small. If, in this region, the neutron density can be expanded in a power series,

$$n(r) = A - B r^2 + C r^4 - \ldots, \qquad (2)$$

it is easy to show that the radial part of the buckling at the centre is

$$\alpha^2 = 4 B/A. \qquad (3)$$

For the tightest lattices, irregular fluctuations in the measured distribution prevented the determination of the radial buckling.

Far away from the source the neutron density decays exponentially in the axial direction, and a relaxation-length $1/\gamma$ is measured. For intensity reasons the higher harmonics were not negligible, where the radial distribution was measured, and therefore corrections have to be applied to the axial buckling, $-\gamma^2$, valid for exponential distribution.

For M^2 we have used the value 45 cm.^{2}, which is probably accurate to 10 per cent.

(2) We have also used an integrating method due to Heisenberg and Wirtz[2]. In this case the source was placed in the middle of the core, and the total number of neutrons in the core (N_c) and in the reflector (N_r) were determined by integration. The strength of the source was calibrated by measuring the total number of neutrons (N_s) with uranium rods removed. From these data the multiplication constant can be calculated by means of the formula:

$$k - 1 = \frac{\Sigma_s(N_r - N_s)}{\Sigma_c N_c}, \qquad (4)$$

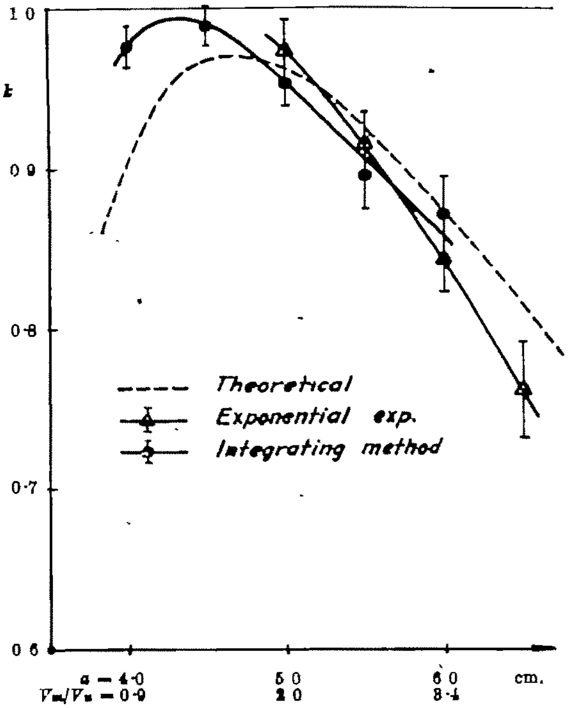

Fig. 1

where Σ_0 and Σ_c are the macroscopic absorption cross-sections of the water and the core respectively. We have, however, to apply some corrections to this formula. On account of the fast fission effect in uranium-238, the number of source neutrons will increase before they reach thermal equilibrium. Therefore, the quantity N_0 must be multiplied by a factor larger than unity. Further, N_c must be divided by the resonance escape probability.

The two experimental curves of the multiplication constant as a function of lattice spacing are compared in Fig. 1 and are seen to be in good agreement with each other. Also shown in this diagram is a theoretical curve[1]. In calculating this curve account has been taken of fissions produced by fast neutrons from one rod in the adjoining rods as well.

Further information about this experiment will be published elsewhere.

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March 1.

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Spontaneous Fission Properties of Elements 97, 98, 99 and 100

Isotopes of several heavy elements ($Z = 94$–100) have recently been produced in the Materials Testing Reactor (MTR) in Arco, Idaho. It has thus been possible to extend the data on partial spontaneous fission half-lives to isotopes of berkelium, californium, element 99 and element 100 [1–3]. Table 1

Table 1. NUCLEAR PROPERTIES OF SOME ISOTOPES OF ELEMENTS 97, 98, 99 AND 100

Isotope	Ref.	Radiation	Half-life	Alpha energy (MeV.)	Spontaneous fission half-life	Predicted spontaneous fission half-life from Z^2/A
$^{249}_{97}$Bk	3, 4	β^-	~ 1 yr.	—	> 10^{7} yr.	—
$^{246}_{98}$Cf	6	α, spontaneous fission	35·7 hr.	6·75	2·1 ± 0·3 × 10^{3} yr	1·2 × 10^{3} yr
$^{248}_{98}$Cf	6	α, spontaneous fission	205 ± 40 days	6·26 ± 0·03	~ 7 × 10^{3} yr.	10^{4} yr.
$^{249}_{98}$Cf	3, 4	α	400 ± 100 yr.	5·81 ± 0·03	> 10^{6} yr.	—
$^{250}_{98}$Cf	3, 4	α, spontaneous fission	9·4 ± 2·3 yr.	6·03 ± 0·01	1·4 ± 0·5 × 10^{4} yr.	2·8 × 10^{5} yr.
$^{251}_{98}$Cf	3, 4	(α)	—	—	—	—
$^{252}_{98}$Cf	3, 4	α, spontaneous fission	2·1 ± 0·4 yr	6·12 ± 0·01	60 ± 12 yr.	8 × 10^{6} yr.
$^{253}_{98}$Cf	3, 4	β^-	18 ± 3 days	—	—	—
^{253}99	1, 2	α	19·3 ± 0·3 days	6·61 ± 0·01	> 10^{5} yr.	—
^{254}99	2	β^-	37 ± 1 hr.	—	> 10 yr.	—
^{254}100	1, 2	α, spontaneous fission	3·3 ± 0·2 hr.	7·17 ± 0·01	220 ± 40 days	70 yr.

gives a summary of the nuclear properties of several isotopes of these elements.

The measured partial spontaneous fission half-lives of californium-246 and -248[6] agree reasonably well with the values predicted for even-Z even-A nuclides from the graphs of Seaborg[7] and Whitehouse and Galbraith[8], who plotted the logarithms of the spontaneous fission half-lives of several nuclides as a function of their Z^2/A values. The measured spontaneous fission half-lives of the heavier even-A californium isotopes, however, deviate seriously from the Z^2/A relationship. The spontaneous fission half-lives of the californium isotopes, given in Table 1 and plotted in Fig. 1, support the idea that the even-A isotopes of each even-Z element go through a maximum stability for spontaneous fission as A increases[9].

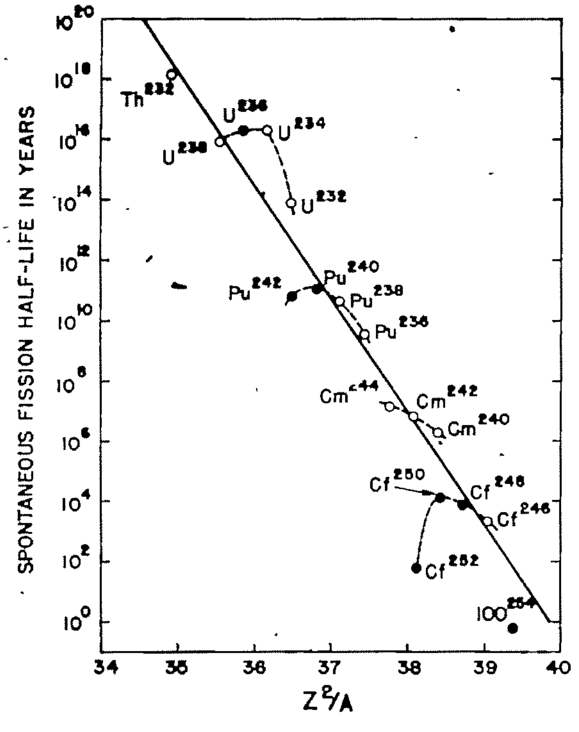

Fig. 1. Spontaneous fission half-lives as a function of Z^2/A. Open circles represent the early spontaneous fission data through which the straight line was drawn (ref. 7). Solid circles are recent spontaneous fission half-lives. The broken lines illustrate the maximum stability toward spontaneous fission (ref. 9) for each element

As a consequence of this spontaneous fission half-life relationship, one has to revise previous ideas of nuclear stability. For a given even value of Z, spontaneous fission decay competes more favourably with alpha-decay as the even-A masses are increased; and as a result, spontaneous fission becomes a competing mode of decay at lower values of Z than previously expected. In fact, the heavier even-A beta-stable isotopes of even-Z elements (Z = 98, 100, etc.) may decay principally by spontaneous fission.

The spontaneous fission decay-rates of the heavy odd-nucleon isotopes given in Table 1 are several factors of ten slower than corresponding even–even nuclides, in agreement with the spontaneous fission half-lives[7] of other odd-nucleon isotopes.

The observed yields of californium-252 in neutron bombardments of plutonium in the Materials Testing Reactor (MTR) in association with the high specific spontaneous fission activity of this isotope makes it attractive as an experimental neutron source.

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Inelastic Scattering of 14-MeV. Neutrons by Lithium-7

THE nuclear-level scheme for lithium-7 given in he review article on light nuclei by Ajzenberg and Lauritsen[1] indicates levels at 0·478, 4·61, 6·56 and 7·46 MeV. excitation. The level at 7·46 MeV. corresponds to a resonance in the ^{6}Li(n,^{3}H$_1$)^{4}He reaction at a neutron energy[2] of 0·25 MeV., but neither (p,p'), nor (d,d'), nor (α,α') scattering experiments have revealed inelastically scattered particle groups corresponding to this level[3].

We have studied the inelastic scattering of fast neutrons by lithium-7, using a photographic plate loaded with natural lithium. In this work advantage was taken of the fact that the levels of interest are unstable with respect to alpha-particle and triton emission. The loaded plates (Ilford 200 μ E_1 with 52 mgm. per c.c. loading) were exposed to 14·1-MeV. neutrons produced by the ^{3}H$_1$(d,n)^{4}He reaction, and the plates were searched for the occurrence of alpha-particle and triton pairs of tracks produced by the reaction :

$$^7\text{Li}(n,n')^{7*}\text{Li}(t)^4\text{He}\,; \quad Q = -2{\cdot}465 \text{ MeV.} \qquad \text{(i)}$$

The scattered neutron was not detected in this experiment. The only measurements made were of he energy released to the alpha-particle and triton when the recoiling and excited lithium-7 nucleus decayed within the emulsion. By suitable processing of the plates, good discrimination was obtained between the alpha-particle and triton tracks. The events appeared as a thick and a thin pair of tracks having a common point of origin, and were easily ecognized against a background of recoil protons and single alpha-particles arising from other emulsion constituents. Measurements were made on the ranges and angles of emission of the alpha-particle and triton tracks with respect to the incoming neutron direction.

Provided that the interpretation of the event is correct, these data are sufficient for the calculation of the excitation energy $\epsilon(^7\text{Li})$ of the states of ithium-7 involved in the reaction and, in addition, he energy E_N of the incoming neutron. The expressions obtained for both these quantities involve the same factors, and the value of E_N deduced provided a sensitive test of the accuracy of the individual measurements and of the correctness of the identification of each event. Only those events which inferred an incoming neutron energy within prescribed limits on either side of 14·1 MeV. were accepted.

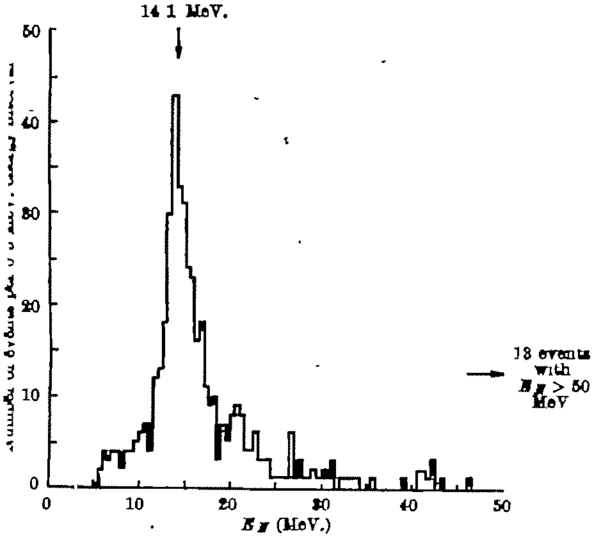

Fig. 1

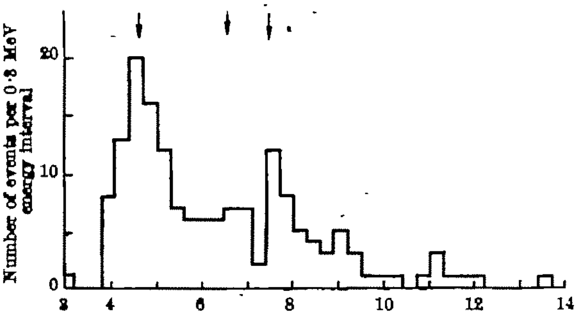

Fig. 2

The frequency distribution of E_N values calculated from the data obtained from measurements on 427 events is given in Fig. 1. The peak occurs at an energy of 14·0 ± 0·25 MeV. and has a half-width at half-height of 1·5 MeV.

Fig. 2 gives the distribution obtained for $\epsilon(^7\text{Li})$ measured in MeV. above the ground-state, assuming the Q value given for reaction (i). Only events satisfying the acceptance limits for E_N (11–18 MeV.) have been included, and this has eliminated many events due to reactions other than (i) which produce heavily ionizing and lightly ionizing particle-pairs of the type measured. Suitable corrections have been applied to remove the background of such events which could have produced E_N values within these limits. In particular, Fig. 2 has been corrected for a considerable background of events due to the reaction :

$$^7\text{Li}(n,t)^5\text{He}(n)^4\text{He}\,; \quad Q = -2{\cdot}465 \text{ MeV.} \qquad \text{(ii)}$$

The background corrections applied made little difference to the shape and position of the groups in the $\epsilon(^7\text{Li})$ distribution in the range 0–9 MeV., although the fully corrected distribution given has been reduced to a total of only 167 events. Most of the events removed appeared in the uncorrected $\epsilon(^7\text{Li})$ distribution in the range 9·2–13·5 MeV., and these events, when recalculated according to reaction (ii), fell into two groups representing helium-5 excitation energies of 0 ± 0·3 MeV. and 2·4 ± 0·6 MeV. A distribution of $\epsilon(^7\text{Li})$ values corrected on the assumption that only the ground-state of helium-5 is involved in reaction (ii) shows a prominent peak at 9·25 ± 0·25 MeV. which may represent a new level in lithium-7.

In Fig. 2 the prominent group at 4·6 ± 0·25 MeV. is identified with the level in lithium-7 at 4·61 MeV. (see ref. 1). The smaller group at 7·5 ± 0·25 MeV. is identified with the expected level at 7·46 MeV., and the group of events between 6 and 7 MeV. is presumably due to the broad level reported[3,4] at 6·56 MeV.

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Dielectric Properties of Tellurite Glasses

In a previous communication, Stanworth has described the properties of glasses containing a high percentage of tellurium dioxide[1]. Some data were presented on the optical and dielectric properties of several of such glasses. The purpose of this communication is to record the results of further dielectric measurements on tellurite glasses, carried out at the Physical Laboratory of the National Defence Research Council of the Netherlands (The Hague), in close co-operation with Mr. Stanworth of the British Thomson-Houston Co., Ltd., Rugby, where the samples for this investigation were prepared.

Table 1

	Resonance measurement								Coaxial line	Rectangular wave-guide
Frequency (Mc./s.)	0·07	0·2	0·7	1·5	4	9	20	68·5	1,000 2,000 1,200 3,000 4,590 1,500 4,000 5,190	7,520 9,375 24,000
ε′	26·0	25·9	25·9	26·0	26·0	25·9	26·2	26·2	25·5	25·5
ε″	0·06	0·06	0·06	0·05	0·06	0·05	0·06	0·05		
tan δ	0·002	0·002	0·002	0·002	0·002	0·002	0·002	0·002	<0·01	<0·01

Precision measurements of the dielectric constant and loss angle were made on a glass of molecular composition $BaO.5TeO_2$. The measurements between 0·07 and 68·5 Mc./s. were made with an accuracy of 1 per cent, using the resonance method of Hartshorn and Ward; the measurements between 1,000 Mc./s. and 5,190 Mc./s. were made to an accuracy of about 1½ per cent by impedance measurements on coaxial line equipment, and those between 7,520 and 24,000 Mc./s. to an accuracy of about 1½ per cent using impedance measurement in rectangular wave-guides. The results are shown in Table 1.

The results are similar to those reported for tellurite glass of somewhat different composition in Mr. Stanworth's communication. It appears that the tellurite glasses can have high dielectric constant and low loss-angle up to very high frequencies, showing no frequency dependence, indicating the absence of relaxation up to 24,000 Mc./s. Thus tellurite glass constitutes material of high dielectric constant with very good microwave properties.

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May 12.

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Cataphoresis of Crystal Nuclei

From his investigation of crystal formation in supersaturated electrolytic solution and the analysis of the electric behaviour of the crystal solution interface, Ubbelohde[1] has suggested that charged microcrystals which act as crystallization nuclei might exist in the solution. In the course of work on the mechanism of crystal formation, I have observed some phenomena which seem to support Ubbelohde's views.

(1) *Electrolytic crystal formation.* A saturated solution (at 25° C.) of sodium nitrate was electrolysed between two platinum electrodes for 10 hr., at a constant temperature of 15° C., 0·4–0·5 V./cm., current density 2–5 × 10^{-4} amp./cm.[2]. Solute crystals appear first only on the cathode and in its neighbourhood; the initial crystallization is never found in the anodal region (Fig. 1*a*). Fig. 1*b* shows the sam phenomenon on a small scale under the microscope In both cases, crystal formation occurs selectivel only on the cathode side. Considering that th mobility of the sodium ion is greater than that o the nitrate ion in this case, and that the concentratio polarization owing to transport phenomena may b assumed to be negligibly small[3], it is plausible t assume that the phenomenon is due to cataphoresi of the charged crystal nuclei toward the cathode.

(2) *The creeping of salt solution and the interfacia potential.* If it is really the case that the crysta nuclei move electro-cataphoretically toward th cathode, a glass surface[3], being negatively charge with respect to the electrolytic solution, shoul behave like a cathode and cause the occurrence o cataphoresis and crystal formation. This is the well known creeping phenomenon[4]. I find that the creep ing never occurs when the glass container has bee previously treated with (1) silver nitrate solution[5] o (2) aluminium ion[6], both of which cause reversal of the potential at the glass-solution interface. Silica glass, which has no ionic structure, has also failed to show the creeping. These observations are indirect evidence of the electro-cataphoretic nature of crysta nuclei.

(3) *Accelerating effects of the very high-frequenc field on the crystallization process.* It has bee observed that very high frequency (λ = 30–40 cm. accelerates the deposition of crystals in super saturated electrolytic solution[6] (for example, pot assium chloride, potassium nitrate and lead nitrate) but it shows no effect on a non-electrolytic solution (for example, urea). This supports the idea of th existence of charged nuclei in the solution, becaus the chance of collision between the nuclei or betwee a nucleus and an ion should be increased by th effect of the alternating field, resulting in the accelera tion of crystal formation.

(4) *Deviation of sedimentation path of crystallit by the electric field.* Each of the observations men tioned above suggests that there exist charged crysta

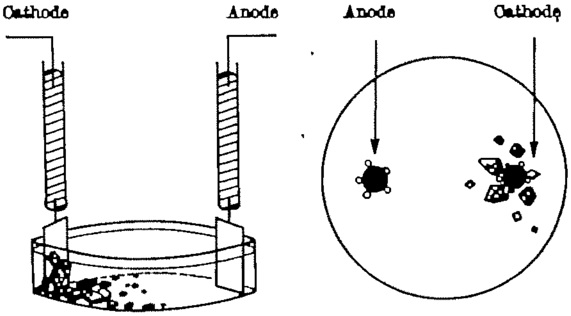

Fig. 1. Electrolytic crystal formation of sodium nitrate; (*a*) large scale; (*b*) on a microscope stage (×16)

uclei and that they move electro-cataphoretically, he size of a nucleus[9] being less than 10^{-6} cm., the atio charge to mass being sufficiently large. Even f the particle size were larger than in the above ase, it may still be expected that cataphoresis will ccur if their surfaces are fresh and the electric field s strong enough. In order to test this expectation, reshly deposited potassium chloride crystallites were llowed to sediment in the supersaturated solution. An external electric field was applied momentarily o the solution (between two carbon rods in the ontainer, 150 V./cm.) immediately after the appearance of the crystallites. The sedimentation paths were deflected a little to the cathode, though the ituation was somewhat blurred, probably by the heterogeneity in the dimensions and forms of rystallites and also by the thermal convection ccompanying the change of phase.

In short, all these observations support the view put forward by Ubbelohde.

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RECENT observations on the crystallization of lithium sulphate by Helen Rae and A. E. Robinson may possibly provide a further example of the formation of crystallization nuclei bearing a net charge with regard to the solution[1]. Attention may be directed to the interest of this mechanism of migration of nuclei of ionic crystals. With reference to the deposition of crystalline masses at controlled places in animal systems, it is conceivable that the formation of bones and teeth, for example, are controlled by the direction of nuclei from supersaturated solutions through the intervention of the appropriate electric fields in the surrounding system. The deposition of crystals associated with certain diseases may also be related with the phenomenon under discussion.

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A Modified Differential Refractometer

THE light-scattering method of molecular weight determination involves the measurement of the difference in refractive indices of a solution and its solvent. To this end special differential refractometers of high precision have been constructed with[1] or without autocollimation[2,3]. A hollow glass prism is placed within a rectangular glass cell filled with the solvent, and the inner prismatic cell is filled with solution. A beam of parallel light traversing this double cell is deflected by an angle proportional to the difference of refractive indices of the two fluids.

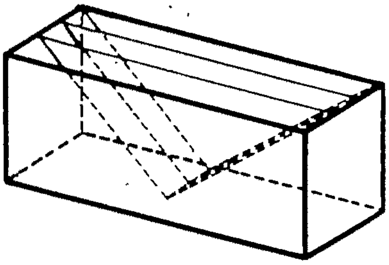

Fig. 1

I have modified this double cell in such a way that part of the parallel beam traverses only the outer cell, passing beside or under the hollow prism. I have thus obtained simultaneously the undeflected and the deflected image of the slit in the measuring microscope; the difference may be read directly in a single measurement without having to change the contents of the hollow glass prism. Errors caused by mechanical derangement or variation of temperature during the change are thus avoided.

A further modification operates with a horizontal slit instead of the usual vertical one, and the rectangular cell contains two hollow prisms instead of one, resting with their apex edge on the bottom of the cell (Fig. 1). Each prism occupies a third of the vertical transverse section of the rectangular cells, leaving a third free for the light beam to bypass them. The rectangular cell is filled with solvent, one of the hollow prisms with the solution to be measured and the other one with a solution of known refractive index for calibration. Thus the difference to be measured and the calibration value may be read simultaneously in one measurement. The fact that the hollow prisms stand on their apex edges makes it possible to use them with a small volume of solution, solely at the cost of light intensity owing to the reduced aperture available.

Solutions may be made up in this refractometer to a given value of difference in refractive indices by filling an appropriate solution into the calibration prism and diluting the other one with solvent from, for example, a burette until the lines—now horizontal—coincide in the microscope.

I wish to acknowledge the help of Mr. F. Dullion and Mr. J. Szántó in the construction of the new cell.

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Structure of Collagen

A DETAILED X-ray study of collagen fibres obtained from different sources (namely, shark ray, rat tail tendon and kangaroo tail tendon) and a re-examination of the published wide-angle patterns indicate that the unit cell of collagen is hexagonal with $a = 12–16$ A. and $c = 9·5–9$ A., the actual values depending on the moisture content. The essential difference of this indexing from those reported earlier[1-3] is that the 2·86-A. meridional arc is here interpreted not as a true meridional reflexion, but as arising from the superposition of two close non-

Table 1

Indices	Dry $a = 13 \cdot 3$, $c = 9 \cdot 55$ A obs.	calc.	Wet $a = 15 \cdot 0$, $c = 9 \cdot 20$ A. obs.	calc.
100	11·4	11·5	12·9	13·0
200	5·75	5·75	6·5	6·5
210	4·3	4·34	4·8	4·92
101	7·4	7·35	7·6	7·50
201	4·8	4·92	—	4·46
112	3·9	3·87	3·95	3·93
212	3·3	3·22	3·4	3·36
113	2·86	2·87	2·82	2·84
001	—	9·55	9·2	9·20

meridional reflexions. A calculation of the angular spread of the arc, using the tilt of the c-axis deduced from the spread of the equatorial reflexions, confirms this interpretation. Table 1 shows the good agreement between the calculated and observed spacings of an air-dried and a wet specimen from kangaroo tail tendon.

A structure has been obtained (Fig. 1) which fits the above unit cell and which appears to be in good agreement with infra-red, X-ray and chemical data for collagen. It consists of nine amino-acid residues per unit cell, which corresponds to the observed density. These are linked together to form cylindrical rods, which occur in a hexagonal array. All the residues have the *trans* configuration, and the latest values of Corey and Pauling[4] for the dimensions of the amide group were used for the calculations. The residues are arranged in the form of three helical chains, each of pitch 9·5 A. (= c) and containing three residues per turn, with the symmetry 3_1. The three helixes are also arranged with a 3_1 symmetry about the c-axis, and they are held together by means of hydrogen bonds to form the cylindrical rods. Two of the three NH groups in each turn of a chain are linked by hydrogen bonds to an oxygen of each of the other two chains, the NH . . . O distance being 2·80 A. The third NH group points outward from the cylinder, and the nitrogen atom forms part of a proline ring. Of the three α-carbon atoms per turn, a hydrogen attached to one of them (R, Fig. 1) could be replaced by a general R group to form an amino-acid residue such as arginine or lysine another (P) takes part in forming the proline ring while the third (G) is in such a position that there i no space for either of its hydrogens to be replace by any other group, so that it could only form par of a glycine residue. These features of the structur could explain the observed range of amino-acid composition for collagen.

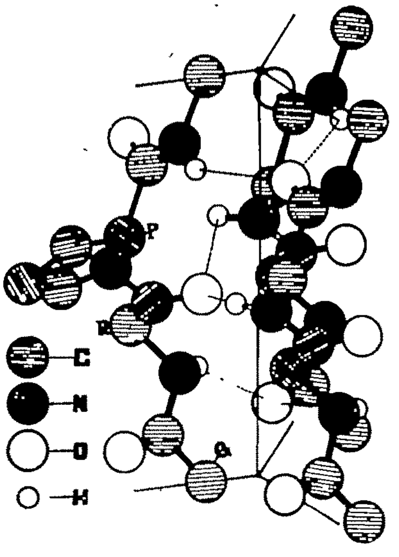

Fig. 1. Diagram showing one of the three-chain cylindrical rods of the structure. The dotted lines indicate the positions of the hydrogen bridges. Only one proline ring is shown, and all hydrogen atoms except those in the NH groups are omitted. The thin lines indicate the directions of the crystal axes

The NH- and CO-bonds are almost exactly perpendicular to the fibre axis, the angle made wit the c-axis being about 85° in both cases. This agree with the observed large infra-red dichroism[5]. Structure-factor calculations show fairly good agreemen with observation. The individual helixes are unstable, and the stability of the cylindrical rods arise from the hydrogen bonds between the helixes. I these are broken, for example, by heating, th structure would crumble down, which would explai the thermal contraction of collagen. The structur could, however, re-form on cooling, as the chain o amino-acid residues in a single helix need not b ruptured in this process.

It may be mentioned that this structure is essentially different from the three-chain structure o Pauling and Corey[2]. The value $c = 9 \cdot 5$ A. is no critical, and a variation of about 15 per cent i permissible without affecting the main features o the structure.

A detailed paper, containing also a discussion o other features of this structure and a critical comparison with previously proposed structures, will be published elsewhere.

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Unbiased Ratio Estimators

RATIO estimators are frequently employed in sample surveys when estimating the population mean $\bar{Y}$ of a variate y with the help of the known population mean $\bar{X}$ of a correlated variable x. Confining ourselves to the case of a simple random sample of n pairs y_i, x_i from a population of N pairs, various ratio estimators of $\bar{Y}$ can be formed of which the most important ones are $\hat{y} = \bar{X}\bar{y}/\bar{x}$ and $\tilde{y} = \bar{X}\bar{r}$, where $\bar{y}$, $\bar{x}$ and $\bar{r}$ are the arithmetic means of the sample of y_i, x_i and y_i/x_i, respectively.

One well-known defect of these estimators is the fact that they are usually biased by amounts for which only approximate formulæ are offered in the literature, and, to our knowledge, no general methods are available for the elimination of this bias. It is of some interest, therefore, that quite elementary and exact formulæ for these biases can be obtained which frequently permit the construction of unbiased ratio estimators.

We must confine ourselves here to the simplest cases. It is obvious that

$$E(\tilde{y}) = \bar{Y} - \mathrm{Cov}\left(\frac{y}{x}, x\right) \text{ and } E(\hat{y}) = \bar{Y} - \mathrm{Cov}\left(\frac{\bar{y}}{\bar{x}}, \bar{x}\right)$$

which give the exact formulæ for the bias.

An immediate consequence of these equations are he upper bounds for the biases

$$|\text{Bias in } \hat{y}| \leqslant \sigma_{y/x}\,\sigma_{\bar{x}} \text{ and } |\text{Bias in } \bar{y}| \leqslant \sigma_{\bar{y}/\bar{x}}\,\sigma_{\bar{x}} \qquad (3)$$

which are proved (but only as large-sample approximations) in most text-books. Next, we may try to estimate the exact bias in $\hat{y}$ from the sample. This eads to the unbiased ratio estimate

$$y' = \bar{X}\bar{r} + \frac{n(N-1)}{(n-1)N}\,(\bar{y} - \bar{r}\bar{x}). \qquad (4)$$

If variance formulæ are derived by the customary xpansions in powers of $\Delta y_i = (y_i - \bar{Y})/\bar{Y}$ and $\Delta x_i = (x_i - \bar{X})/\bar{X}$, it can be shown that (for $N \to \infty$) up to and including cubic terms

$$\text{Var } y' = n^{-1}\bar{Y}^2(\sigma_y^2/\bar{Y}^2 + \sigma_x^2/\bar{X}^2 - 2\,\text{Cov}(x,y)/\bar{X}\bar{Y}),$$

which is also the approximate formula for Var $\hat{y}$ and Var $\bar{y}$ if terms up to and including the quadratic are considered. The cubic terms in Var $\hat{y}$ or Var $\bar{y}$ may be positive or negative (depending on certain product moments of the y, x distribution) and are 0 in Var y'. Within the framework of this approximate variance theory, therefore, no large price in variance increment is paid for bias elimination; indeed, for certain populations Var y' is less than Var $\hat{y}$ or Var $\bar{y}$. Similar results are available for bias elimination in $\bar{y}$, and exact variance formulæ have been derived. Since the approximate variance formula depends on the fact that the coefficients of variation of y and x are small, a useful modification consists of the device of splitting the sample of n $y_i x_i$ into (say) K subsamples with means $\bar{y}_j \bar{x}_j$ and computing the unbiased ratio estimate $y' = \bar{r}\bar{X} + \frac{K}{K-1}\,(\bar{y} - \bar{r}\bar{x})$, where $\bar{r} = \frac{1}{K}\Sigma\bar{y}_j/\bar{x}_j$ and N is assumed large.

Adaptations to stratified and multistage sampling have been developed, and it is hoped to publish applications of these estimators shortly.

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Solubility of Uroporphyrin I in Ethyl Acetate

ACCORDING to Waldenström, Fink and Hoerburger[1], uroporphyrin I does not pass from aqueous solutions into ethyl acetate at any pH, thus differing from uroporphyrin III, which is readily extracted by ethyl acetate around pH 3·1. This statement has been widely accepted in the literature. We have found, however, that uroporphyrin I in the concentrations studied is readily extracted into ethyl acetate from aqueous solutions at pH 3·0–3·2, and, provided these are strongly buffered, quantitative recoveries can be obtained.

The results of some recovery experiments with uroporphyrin I and 'Waldenström porphyrin' are illustrated in Table 1. The experimental technique was as follows: a solution of the free porphyrin in 0·1 N sodium bicarbonate was added to 50 ml. of 10 per cent (w/v) hydrochloric acid, followed by 150 ml. saturated sodium acetate. The solution was rapidly brought to a pH between 3·0 and 3·2 with concentrated hydrochloric acid and the final volume of solution made up to 250 ml. The order of adding the reagents appeared to affect the recovery materially, and is therefore given in full. The buffered solution was extracted exhaustively with 100-ml. portions of ethyl acetate, readjusting the pH with concentrated hydrochloric acid and saturated sodium acetate between extractions. The last few ethyl acetate extracts are usually non-fluorescent; but extractions were continued until such ethyl acetate layers gave non-fluorescent aqueous layers when shaken with 2 per cent hydrochloric acid. The combined ethyl acetate extracts were then extracted to completion with 2 per cent hydrochloric acid, and this extract determined spectrophotometrically, using the correction factor of Rimington and Sveinsson[2]. It was found that the number of extractions required at each stage was not significantly different for the two isomers; in both cases about 50 per cent of the porphyrin present in the aqueous phase passed into the ethyl acetate during each extraction. The results in Table 1 show clearly that the recovery of uroporphyrin I is not appreciably less than that of 'Waldenström porphyrin'.

Table 1

μgm. Porphyrin added (range)	Percentage recoveries	
	Uroporphyrin I	'Waldenström porphyrin'
46–49	94, 95, 94, 100, 102	99
22–24	99, 99, 102, 99 100	
9–10	100, 89, 94, 95, 97, 97, 101, 99, 101	92, 93
4–5	90, 91, 89, 89 91, 91	95, 86

A suitable method for comparable extraction of both isomers is of value with respect to recent investigations of the porphyrins formed by tissues *in vitro* from precursors such as porphobilinogen and δ-amino-lævulinic acid[3]. A detailed investigation, which we hope to report elsewhere, has led us to conclude that equivalent recovery of each isomer from tissue preparations should also be possible.

The uroporphyrin I used in this investigation was a hydrolysed sample of fraction A(i) shown in Fig. 1 of the paper by Rimington and Miles[4]. 'Waldenström porphyrin' was taken from a bulked sample of Waldenström ester (m.p. 260°, corr.), which, when tested by the paper chromatographic method of Falk and Benson[5], behaved as uroporphyrin III only. Hydrolyses were carried out in 25 per cent hydrochloric acid at room temperature for 36 hr.

We thank Prof. C. Rimington for his support of this work and Miss H. James for technical assistance.

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Fractionation of Serum Proteins by Zone Electrophoresis in Glass Powder

In connexion with recent electrophoretic studies of ox serum[1], it became necessary to establish a reliable method for the fractionation of serum proteins which would allow numerous samples to be separated into distinct fractions of sufficient volume and concentration for subsequent physico-chemical and biological characterization. Zone electrophoresis[2] appeared to be the method of choice, and the apparatus here described is a development of that of Svensson and Brattsten[3], whose work should be consulted for the principles involved. The present modifications were introduced to overcome certain difficulties associated with their apparatus, notably the complexity of the feed arrangements and the lack of control of adverse *p*H and electrolytic changes.

The glass-powder bed is supported in a double-walled 'Perspex' trough 27 cm. long, 18 cm. deep and 2 cm. wide. The top of the trough is completely open. 'Perspex' nipples of 1 mm. bore are fitted to the base of the trough at 1 cm. intervals and a strip of closely-woven calico, 27 cm. × 2 cm., is placed inside the trough over the nipple openings to prevent blocking by glass powder. The double walls of the trough form two flat cooling chambers through which is pumped refrigerated water at 2° C. At the ends of the trough are 'Perspex' flanges to which are bolted ion-permeable partitions, electrode chambers and soft-rubber sealing gaskets. The ion-permeable partitions, which have an open area of 16 cm. × 2 cm., constitute the vertical end-walls of the trough and isolate the glass powder bed from the free-flowing buffer solution in the electrode chambers. A typical arrangement consists of a porous ceramic plate at the cathode and a 'Cellophane' membrane at the anode. The electrodes are flat spirals of platinum wire, 1·5 cm. × 15 cm., mounted parallel to and about 1 cm. behind the ion-permeable partitions. Each electrode chamber is sealed, apart from a lower inlet and upper outlet through which buffer solution is pumped continuously at the rate of about 1 litre/min. The return flows of buffer solution from the electrode chambers are mixed in a single 5-litre aspirator bottle prior to recirculation by a centrifugal pump. By this means drifts of *p*H and unstable electrical characteristics arising from accumulations of the products of electrolysis may be completely controlled. This arrangement also overcomes the limitation of current set by the use of reversible electrode systems. The leakage current which by-passes the glass-powder bed is negligible if the rubber connexions of the system are of 1 cm. bore and about 200 cm. long.

The assembly of trough and electrode chambers is fitted to a special rack which may be levelled accurately. This rack also supports a finely adjustable horizontal bar to which are clamped twenty-seven capillary tubes of about 1 mm. bore and 30 cm. length each bent to the form of a J. The longer limbs are connected by fine-bore rubber pressure-tubing to the twenty-seven outlet nipples at the base of the trough. The shorter limbs of the J-capillaries, directed downwards into collecting tubes, terminate at a common level which is about 1–2 cm. below that of the free surface of the buffer solution above the glass-powder bed. The rate of flow of buffer solution through the bed and from the outlet capillaries is determined by the height of the horizontal clamping bar. Regularity of flow from the outlet capillaries is achieved by individual adjustment of the length of each in a preliminary rate-of-flow calibration, and by grinding each tip to an accurate square and smooth finish. The buffer supply to the bed of glass powder is provided by a simple constant-head system. Since the top of the trough is completely open, the multiple syphon system of Svensson and Brattsten[3] is unnecessary.

The protein sample to be fractionated is injected directly into the glass-powder bed at a depth of 3 cm. below its surface. For this purpose a 20–50 ml. glass syringe, provided with a 10 cm. needle bent in the middle at right angles, is mounted horizontally and the plunger advanced by a geared drive from a 1 r.p.m. synchronous motor. A range of protein sample feeds of 0·8–8 ml./hr. may thus be obtained with great regularity.

The completed assembly may be operated in two ways. In the continuous-flow method, following Svensson and Brattsten[3], the buffer solution and protein sample flow continuously while current is passed, and components of distinct mobility follow paths down the glass-powder bed which diverge from the point of injection. This method demands constancy of flow of buffer solution, protein sample and current, but is not seriously influenced by geometrical irregularities of flow density. In the second method, the method of 'no-flow', 5–10 ml. of the protein sample to be fractionated are injected to form a vertical band about 1 cm. wide in the glass-powder bed. The flow of buffer solution and of protein sample are now discontinued and the current switched on. The initial vertical band separates horizontally to form a spectrum of vertical bands spaced across the bed. When the current is switched off, the bands are washed out of the glass-powder bed by a relatively rapid flow of buffer solution equivalent to about 15 ml./hr. at each capillary outlet. Up to twenty-seven fractions each of about 7 ml. are then collected within 30 min. following a separation lasting about 5 hr. This method does not depend upon the constancy of flow of buffer solution or current, but is more sensitive than the first to geometrical irregularities of flow density. The 'no-flow' method is faster than the continuous flow method, since equal resolution may be achieved without lengthy periods at low rates of flow.

With veronal and phosphate buffer systems of *p*H 7·5–9, ionic strength 0·04, and a maximum bed temperature of 30° C., it is possible to maintain a total current of up to 300 m.amp., equivalent to a current density of 10 m.amp./sq. cm., and a voltage between electrode chambers of 300 V., equivalent to a voltage gradient of 10 V./cm. Under these conditions, bovine albumin and γ-globulin separate in the 'no-flow' method at the rate of 3–4 cm./hr. Electrophoretic analyses by the Tiselius method of collected fractions indicate that an almost linear gradient of mobility develops across the glass-powder bed. The mobility-resolution following a separation lasting 5 hr. is about 0·5 $\text{cm.}^2\ \text{V.}^{-1}\ \text{sec.}^{-1} \times 10^{-5}$. The albumin and γ-globulin components of ox serum are separated cleanly. The intermediate α- and β-globulin, however, when collected at the appropriate outlets, may be contaminated with small proportions of the adjacent components. This is probably a consequence of adverse spreading effects and of the poly-dispersity of the protein mixture.

It is hoped to publish shortly further details of suitable ion-permeable partitions and of the separations achieved with ox serum in beds of glass powder and of starch. The significant advantages of the present apparatus in facility of control and in rapidity of separation of components over the entire length of the bed have been demonstrated also in preliminary studies of the fractionation of the sera of cattle infected with the virus of foot-and-mouth disease.

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Phosphorus Linkages in α-Casein

RECENTLY, an investigation on the nature of phosphorus bonds in proteins has been initiated in this laboratory. This was stimulated by the observation that a variety of phosphatases will dephosphorylate phosphorus-containing proteins without proteolysis occurring simultaneously. Dephosphorylation, however, takes place only if the phosphate groups are present as monoesters with two ionizable hydroxyls[1,2]. In addition, the occurrence, in phosphoproteins, of linkages such as those of pyrophosphates, —O—P—O—P—O—, phosphodiesters, —O—P—O— or —N—P—O—, and the presence of these bonds in cyclic arrangements, had to be anticipated. Thus, it should be possible to demonstrate such structural units with the aid of specific enzymes which bring about their transformation into monoesters that are then readily hydrolysed by the action of phosphomonoesterases. The work described here was designed to test these assumptions, and supplies the first experimental evidence for the existence of pyrophosphate bonds in a protein. Moreover, it is shown that α-casein, in addition to phosphomonoesters, also contains some of its phosphorus as pyrophosphate and phosphodiesters.

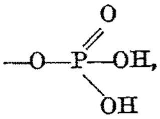
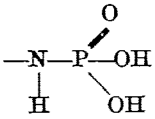
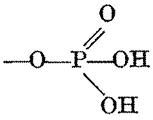
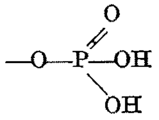
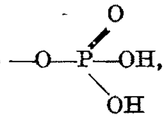
As reported in 1952[3], prostate phosphatase[4], an enzyme specific for the hydrolysis of  $\mathrm{-O-P(=O)(OH)-OH}$, at pH 5·8–6·0 removes 40 per cent of the α-casein phosphorus. If a 1 per cent solution of α-casein in 0·05 N sodium bicarbonate containing 0·01 M magnesium ions is treated at 37° C. with a purified phosphodiesterase from rattle snake venom (*Crotalus adamanteus*)[5], no inorganic phosphorus is liberated. As shown in line 2 of Table 1, the pH of the reaction mixture, however, had shifted from 8·5 to 7·8, indicating the exposure of acidic groups. Subsequent incubation of the protein with prostate phosphatase in cacodylate buffer of pH 6·0 and 0·1 ionic strength results in the appearance of 41·5 per cent of inorganic phosphorus (line 3), an amount corresponding to that liberated by the prostate enzyme from untreated α-casein (line 1). If, however, the α-casein pretreated with diesterase is incubated with both prostate and intestinal phosphatase[6], 78·0 per cent inorganic phosphorus appears (line 4). Since the intestinal enzyme used in this investigation is found to act at pH 6·0 on low molecular-weight substrates of the type  $\mathrm{-N(H)-P(=O)(OH)-OH}$ but not on  $\mathrm{-O-P(=O)(OH)-OH}$[6], and the

Table 1. STEPWISE ENZYMATIC DEPHOSPHORYLATION OF α-CASEIN

Reaction mixture	pH of the reaction mixture	Maximal amount of phosphorus released (per cent of total)	Conclusions	Distribution of phosphorus (per cent of total) as		
				$\mathrm{-O-P(=O)(OH)-OH}$	$\mathrm{-N(H)-P(=O)(OH)-O-}$	$\mathrm{-O-P(=O)(OH)-O-P(=O)(OH)-O-}$
1. α-Casein + prostate phosphatase	6·0	39·6	2/5 of phosphorus present as $\mathrm{-O-P(=O)(OH)-OH}$	40		
2. α-Casein + phosphodiesterase	8·5 → 7·8	0	O—P of diester bond broken			
3. α-Casein (pretreated with diesterase) + prostate phosphatase	6·0	41·5	Same as in line 1	40		
4. α-Casein (pretreated with diesterase) + prostate and intestinal phosphatase	6·0	78·0	2/5 of phosphorus present as $\mathrm{-O-P(=O)(OH)-OH}$ and 2/5 derived from N—P—O	40	40	
5. α-Casein + pyrophosphatase	7·2	0				
6. α-Casein (pretreated with pyrophosphatase) + prostate phosphatase	6·0	59·5	2/5 of phosphorus present as $\mathrm{-O-P(=O)(OH)-OH}$ and 1/5 derived from O—P—O—P—O	40		20
7. α-Casein (diesterase + pyrophosphatase pretreated) + prostate and intestinal phosphatase	6·0	100		40	40	20

snake venom diesterase hydrolyses the —O—P— bond of a diester, it can be inferred that the diester linkage in α-casein is of the —N—P—O— type, in contrast to the —O—P—O— recently found in β-casein[7].

An identification of the remaining phosphorus is then achieved as follows: on incubation of a 1 per cent solution of α-casein in veronal–carbonate buffer of *p*H 7·2[8] containing 0·001 *M* magnesium ions with crystalline yeast pyrophosphatase[9], no inorganic phosphorus is set free (line 5). Subsequent treatment of the protein with the prostate phosphatase at *p*H 6·0 in sodium cacodylate buffer results in the appearance of 59·5 per cent inorganic phosphorus (line 6). Thus the increase of 20 per cent liberated by the prostate enzyme from the α-casein pretreated with pyrophosphatase must originate from monoesters of the type  $-\mathrm{O}-\mathrm{P}(=\mathrm{O})(\mathrm{OH})-\mathrm{OH}$ derived from a pyrophosphate bond, —O—P—O—P—O—. In line 7 of Table 1 the results of an experiment are listed, showing that if α-casein is treated with the phosphodiesterase at *p*H 8·2, followed by incubation with the pyrophosphatase at *p*H 7·2, the intestinal and prostate enzymes at *p*H 6·0 will liberate the entire phosphorus of this protein. These results thus demonstrate that α-casein contains 40 per cent of its phosphorus as monoesters of the type  $-\mathrm{O}-\mathrm{P}(=\mathrm{O})(\mathrm{OH})-\mathrm{OH}$, 20 per cent as pyrophosphates, —O—P—O—P—O—, and 40 per cent as diesters, —N—P—O—.

Complete removal of the phosphorus is accompanied by a disintegration of the protein into smaller units, indicating that the phosphorus links relatively small polypeptides which are soluble in 10 per cent trichloroacetic acid. These fragments can be separated chromatographically by passage through a column of 4 per cent cross-linked 'Dowex 50'.

The presence of the pyrophosphate bond in α-casein, a protein with 0·99 per cent phosphorus[10], can be used for the estimation of the molecular weight. If one-fifth of the phosphorus is present as a pyrophosphate, a linkage involving two atoms of this element, the total number per mole must be ten or a multiple thereof. Since the atomic weight of phosphorus is 31·02, it would give a minimum molecular weight of 31,000, in good agreement with that of 30,000 reported for casein in the literature[11].

I wish to thank Drs. G. Schmidt and M. Kunitz for some of the phosphatase preparations used in this research, and Dr. T. L. McMeekin for supplying the α-casein.

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Rockefeller Institute for Medical Research,
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Catalysis of Olefin Autoxidation by Heavy Metal Ions in Non-Polar Media

THE catalysis of autoxidation by heavy metals ha wide ramifications in the fields of biochemistry an chemical industry and is of considerable academ interest. In spite of this, relatively little fundament work has been undertaken except with polar solvents[1].

The special case of the autoxidation of natur and certain synthetic rubbers takes place unde conditions which are essentially non-polar. The marked differences in behaviour might occur a between polar and non-polar media has prompte this investigation. We have studied the autoxidatio of *cyclo*-hexene at 60·0° C. catalysed by the *n*-heptoates of metals in the presence and absence of 10 part by weight of *n*-heptoic acid per 100 parts by weigh of *cyclo*-hexene. An aliphatic carboxylic acid wa chosen as the polar compound in view of the published work using glacial acetic acid[1]. Table 1 show that a very different ranking order for catalyti efficiency is obtained in the presence of *n*-heptoi acid, making it clear that mechanisms deduced fron work in polar media cannot be transferred *a prior* to non-polar media.

Table 1
(Po_2 = 760 mm./mercury)

Metal, initial valency state and concentration	Extent of oxidation after 60 min. reaction (gm. O_2/kgm. *cyclo*-hexene)	
	cyclo-Hexene as medium	*cyclo*-Hexene + heptoic acid as medium
Co^{++} (49·1 p.p.m.)	27	85
Mn^{++} (49·5 p.p.m.)	21*	28
Cu^{++} (50·0 p.p.m.)	13	0·33
Fe^{+++} (500 p.p.m.)	1·3	3·4
Metals absent	0·13	0·34

* The duration of this reaction is taken as 60 min. from the termination of the induction period

The marked difference in behaviour between pola and non-polar media is further emphasized by th kinetic characters of the various systems. Thes differences are shown simply in Table 2.

Table 2

Metal and initial valency state	Variation in rate of oxygen absorption as the total extent of absorption increases	
	cyclo-Hexene as medium	*cyclo*-Hexene + heptoic acid as medium
Co^{++}	rate decreases	rate decreases
Mn^{++}	rate decreases*	rate increases from very low value
Cu^{++}	rate decreases	no catalysis
Fe^{+++}	rate increases from very low value	rate increases from very low value

* With manganese there is a marked induction period followed by the sudden appearance of a well-defined rate.

The induction period for manganese, which is of very variable duration, is eliminated by the addition of a small amount of *tert*-butyl hydroperoxide, indicating that the free radicals required to start reaction chains are derived from the interaction of manganese and hydroperoxide, not by interaction of the manganese and *cyclo*-hexene, and that, therefore, the induction period is determined by the rate at which a threshold value of hydroperoxide concentration is built up independently of the manganese. The same hypothesis may apply to cobalt and copper, although an induction period has not been observed with these metals.

With copper at 50 p.p.m. concentration in the absence of *n*-heptoic acid, the consumption ratio

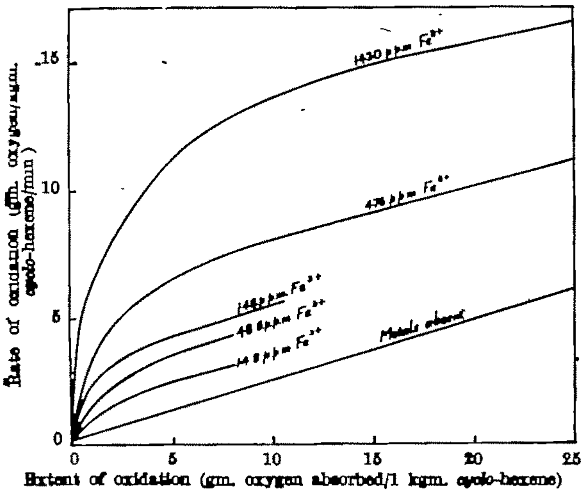

Fig. 1

$d(O_2 \text{ absorbed})/d[ROOH]$ has been accurately determined and found initially equal to unity but increasing somewhat as the reaction proceeds. A similar consumption ratio appears to exist for the reaction catalysed by ferric iron.

We reserve suggestions regarding the mechanism of catalysis in non-polar media except for the ferric iron catalysed autoxidation. The interpretation of this reaction is most readily seen by plotting the rate of oxygen absorption against the amount of oxygen already absorbed, when the graphs shown in Fig. 1 are obtained.

Thus, provided due allowance is made for the simultaneous uncatalysed autoxidation, there is an initially marked dependence of the rate on hydroperoxide concentration, which eventually degenerates into a complete independence as the reaction proceeds.

If we assume a reaction scheme for ferric iron analogous to that postulated for cobalt in glacial acetic acid[1], namely:

$$\begin{array}{llcl}
\text{Initiation} & \left\{\begin{array}{l} ROOH + Fe^{3+} \\ ROOH + Fe^{2+} \end{array}\right. & \begin{array}{c}\rightarrow\\ \rightarrow\end{array} & \begin{array}{l} ROO. + H^{+} + Fe^{2+} \\ RO. + OH^{-} + Fe^{3+} \end{array} \\
\text{Propagation} & \left\{\begin{array}{l} ROO. + RH \\ RO. + RH \\ R. + O_2 \end{array}\right. & \begin{array}{c}\rightarrow\\ \rightarrow\\ \rightarrow\end{array} & \begin{array}{l} ROOH + R. \\ ROH + R. \\ RO_2. \end{array} \\
\text{Main termination} & RO_2. + RO_2. & \rightarrow & \text{Inactive products}
\end{array}$$

then the scheme must be erroneous in at least one respect as it predicts a rate dependent on $[ROOH]$ as well as $[Fe^{3+}]$ until a very advanced stage of oxidation is reached. This discrepancy can be removed by postulating that the rate-determining step in chain initiation is the formation of free radicals by the decomposition of an iron (III) – hydroperoxide complex.

The maximum rate of oxygen absorption is not attained until the molar ratio $[ROOH]/[Fe]$ reaches a high value. Therefore, either there is an equilibrium of the type

$$\text{(Iron (III) – hydroperoxide complex)} \rightleftharpoons \text{iron (III)} + \text{hydroperoxide},$$

or the formation of the complex is a relatively slow process. Experiments are in hand to distinguish between these possibilities.

The apparent differences in kinetic behaviour of the other metals may result partly from the possibilities of the corresponding equilibria being farther to the left and the complexes being formed more rapidly. These factors would result in the maximum rate of oxidation being reached at a very early stage of the reaction, and since these metals are more efficient catalysts than iron, this maximum rate would be developed in such a short time as to escape experimental observation. Work is in hand to study the initial periods of oxidation more accurately. Such measurements may also provide evidence regarding an alternative chain-initiation process, namely, a direct interaction between metal and olefin to give free radicals.

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Atoxopyrimidine Action of Vitamins of the B_6 Group

In a previous communication, we recorded that pyridoxamine has a strong atoxopyrimidine action[1]. We now find that, besides pyridoxamine, pyridoxine and pyridoxal also have strong atoxopyrimidine action.

Mice were fed at first for five days on a synthetic diet consisting of purified casein, starch, lard and McCollum salt mixture, supplemented with known B-group vitamins except B_6. Then for five days 0·1 or 2·0 mgm. respectively of pyridoxamine or pyridoxine was given in addition to the above diet, and finally 0·125 mgm. of 2-methyl-6-amino-5-hydroxymethylpyrimidine per gm. body-weight was injected into the test mice. While all the controls to which no additional B_6 was supplied died from severe convulsions, all the test animals were saved from these attacks. (Inhibiting activity, that is, number of survivals/number of test animals multiplied by 100, is 100 per cent.) A daily supplement of 0·05 mgm. of pyridoxine for 5 days gave an inhibiting activity of 75 per cent, and 0·025 mgm. for 5 days gave an inhibition of 50 per cent. With injection of 0·125 mgm. of 2-methyl-6-amino-5-hydroxymethylpyrimidine per gm. body-weight, all mice fed for 7–15 days on the basic diet died, whereas all mice injected with pyridoxamine in amounts of a half to one-fifth of the dose of the simultaneously injected 2-methyl-6-amino-5-hydroxymethylpyrimidine were saved from the attack of convulsions (inhibition, 100 per cent). The simultaneous injection of pyridoxamine in amounts of one-tenth to one-twentieth of the dosage of 2-methyl-6-amino-5-hydroxymethylpyrimidine showed an atoxopyrimidine effect of 50–80 per cent. The simultaneous injection of pyridoxine in dosages of from one-tenth to one-twentieth of the amount of 2-methyl-6-amino-5-hydroxymethylpyrimidine showed an inhibition of

100 per cent. Injection of pyridoxine in a dose of one-fortieth caused an inhibition of 80 per cent.

In the case of feeding with ordinary diet, even the injection of 0·5 mgm. of 2-methyl-6-amino-5-hydroxymethylpyrimidine per gm. of body-weight was not sufficient to bring on convulsions of all test mice. So little as 1·0 mgm. of 2-methyl-6-amino-5-hydroxymethylpyrimidine caused the death of all test animals. In the latter case the simultaneous injection of pyridoxamine in dosages of a half to one-fifth of the amount of 2-methyl-6-amino-5-hydroxymethylpyrimidine saved all the test animals from convulsions and death (100 per cent inhibition). In the case of pyridoxine, injection of a fifth to a tenth of the amount of the pyrimidine compound gave 100 per cent inhibition, and one-twentieth to one-fiftieth gave 80 per cent inhibition. In the case of pyridoxal, a tenth to a two-hundredth of the dosage of 2-methyl-6-amino-5-hydroxymethylpyrimidine gave 100 per cent inhibition, but in dosages of from a four-hundredth to a five-hundredth the effect fell to 50 per cent. The toxicity of pyridoxal itself appeared at more than a fifth of the dose of 2-methyl-6-amino-5-hydroxymethylpyrimidine, and therefore the inhibiting effect upon the convulsions caused by the pyrimidine compound could not be estimated.

We are indebted to Dr. T. Matsukawa for supplying a sample of 2-methyl-6-amino-5-hydroxymethylpyrimidine.

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Colchicine-Induced Heteroploidy in Early Mouse Embryos

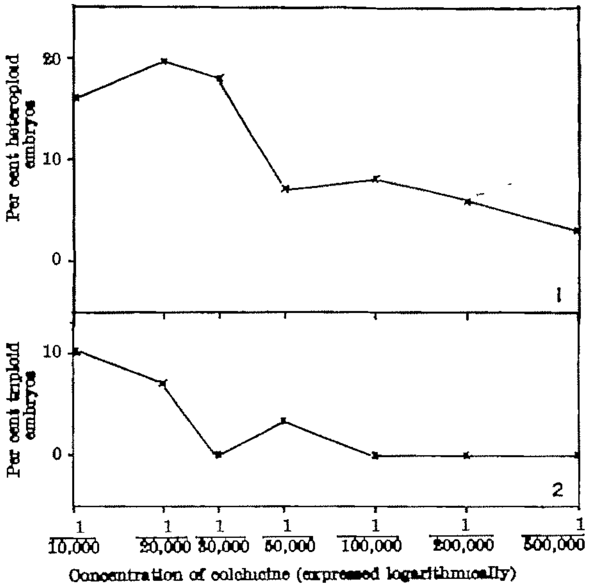
THE induction of heteroploid development in the mouse (*Mus musculus*) has been obtained by the method of temperature treatment of eggs in the Fallopian tube[1,2]. As an alternative method, colchicine, the classical polyploidogenic agent in plants, has been used in mammals other than the mouse. Pincus and Waddington[3] reported a number of one-celled tetraploid rabbit eggs after treatment *in vitro*. Chang[4] and Häggqvist and Bane[5] artificially inseminated rabbits with sperm suspended in a dilute solution of colchicine and observed a proportion of abnormal young at term. In the experiment of Häggqvist and Bane, of those abnormal offspring which came to maturity one was apparently not diploid[6]. Similar experiments with the pig gave one adult boar claimed to be triploid[7]. The heteroploid status of the mature rabbit and boar has, however, been disputed by several workers, for example, Beatty and Fischberg[8].

The following experiment was undertaken to investigate the possibility of obtaining colchicine-induced heteroploidy in the mouse, and if it was obtained, to elucidate the optimal conditions fo treatment. The mice used were of heterogeneou origin. To reduce the level of spontaneous heteroploidy[1,2], mice carrying the silver factor were no used.

By artificial insemination with semen containin colchicine, Chang[4] and Häggqvist and Bane[5] created conditions which probably led to fertilizatio in the presence of the chemical. Colchicine may ente the egg either by general absorption or, more directly by accompanying the fertilizing sperm; and onc in the egg, the colchicine might inhibit the secon meiotic spindle and induce triploidy by retention o the second polar body. But colchicine is also a toxi substance. To reduce toxic effects on the sperm direct treatment of the sperm was abandoned an the following procedure adopted. Œstrous females selected by the vaginal smear technique, were injecte with about 0·1 ml. of colchicine solution through th cervix into each horn of the uterus. They were then paired with males for natural mating. In this way, the sperm was not exposed to colchicine until the mating occurred.

Three and a half days after mating, the females were killed, and the developing embryos washed from the uterus, fixed in aceto-carmine, and made into squash preparations. Chromosome counts were made as accurately as possible (with a maximum error of ±5 per cent of the total chromosome number) on all the clear mitotic figures found, and the embryo was classified on these counts.

By the use of various concentrations of colchicine dissolved in 0·75 per cent sodium chloride, the highest concentration compatible with fertilization and development was found to be 1/9,000 by weight. At higher concentrations no eggs had developed apart from four under-developed embryos taken from two females. At lower concentrations the number of females with developing embryos was always more than 62 per cent and averaged 79 per cent. Examination of the embryos showed that a large number



Relation between colchicine concentration and the percentage of: (1) induced heteroploid embryos (the figures for concentration 1/9,000 have been included in concentration 1/10,000); (2) induced triploid embryos (these figures are also included in 1) were developing as heteroploids, and that these were of various kinds—haploids, hypo-diploids, hyper-iploids, triploids, tetraploids and various mosaics. The heteroploids were produced over a range of oncentrations as shown in Fig. 1. The numbers nvolved in the graph between concentrations 1/9,000 and 1/30,000 are 191 diploid and 44 heteroploid mbryos. Low concentrations of colchicine were used n order to find the lower threshold of activity. Few mbryos were examined at concentrations 1/100,000 nd 1/200,000, the occurrence of heteroploids at these concentrations merely being used as an indication of the continuing action of the chemical. At 1/500,000, however, the effect of the colchicine appeared to be slight, only one embryo being possibly heteroploid out of thirty-one classified. The control figures, obtained by injecting the same quantity of 0·75 per ent sodium chloride solution into the uterus, were 03 diploids and no heteroploids.

The time of mating following injection affected the uccess of the method. If mating was delayed, the percentage of heteroploids resulting was low; if mating was rapid, many heteroploids were found, the difference between the two categories of mating time being statistically significant at the higher con-centrations. The decreased effectiveness of delayed matings is probably due to the absorption of the colchicine by the uterine tissues, or to the inactivation of it by the uterine fluids, or to leakage through the cervix of the injected solution, all of which lead to a ess effective treatment of the egg.

If embryos with mitotic figures of between 55 and 60 chromosomes are classified as triploid (the diploid number of chromosomes in *Mus musculus* being 40), their distribution is given in Fig. 2. The number of triploids is highest at the strongest concentrations and declines to none at 1/30,000 and below, except for a single one found at 1/50,000. A high concentration appears necessary, therefore, to include all the polar body chromosomes within the egg at fertiliz-ation.

Experiments designed to induce tetraploids were made using the same techniques of colchicine injection and embryo recovery. The injections were made about eighteen hours after mating, which is immediately prior to the formation of the first cleavage spindle; and the ntention of the treatment was to suppress the separa-tion of the two diploid chromosome sets on this spindle. Examination of the squashed three and a half day embryos showed that, at concentrations of 1/2,000 to 1/4,000, in addition to many diploids, five tetraploid or diploid-tetraploid mosaics were developing. Presum-ably the tetraploids arose by the action of the colchicine on the first cleavage spindle, and the mosaics by an effect on one of the blastomeres of the two-celled or later stages; in both cases the colchicine having been absorbed on the surface of the embryo.

These results show that colchicine can be used to induce heteroploid development in the mouse, and suggest a wider use for the chemical in the domestic-ated animals[7]. Variation in the time of treatment produces triploids or tetraploids, though various other chromosomal abnormalities are produced. Many of the triploids showed no effect of the chemical cyto-logically, and had cell numbers only slightly less than their diploid sibs. The tetraploids showed some effects of the chemical by the presence of contracted mitoses, and had low cell numbers.

This work has been carried out under the super-vision of Dr. R. A. Beatty. I wish to thank the University of Edinburgh for the receipt of a post-graduate studentship which made the work possible.

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Relationship between Maternal Liver Fat and Fœtal Weight in Ovine Pregnancy

It has been shown by Ferguson[1] that there is a considerable rise in total liver fat in healthy sheep at the 135th–140th day of pregnancy, when their food consumption is severely restricted from the 100th day, but that the livers of ewes which are maintained on a high plane of nutrition from the 100th day contain the same small amount of fat towards the end of term as do non-pregnant animals. Dryerre and Robertson[2] did not investigate the effect of plane of nutrition on liver fat during preg-nancy; but in well-nourished ewes they found no difference in liver fat between animals bearing a single and those bearing more than one fœtus, and that there appeared to be no correlation between the lipide content of the liver of the ewe and the growth of the fœtus.

For the first 100 days of pregnancy in the present study, ewes were fed a high-plane diet of swedes, hay and concentrates (crushed oats 30, dried brewers' grains 20, bran 20, linseed cake 10, white fish meal 10, dried molassed sugar beet pulp 8, minerals 2 parts by weight) and showed satisfactory gains in weight. Thereafter a high-plane group of these was maintained on the same diet and continued to increase in weight, while the remainder (low-plane group) received only swedes and oat straw, on which they declined severely in weight.

The weights of the fœtuses and the total liver fat of the ewes which were slaughtered at the end of the pregnancy period are shown in Table 1. Liver fat was estimated gravimetrically as the total ether-soluble fractions. The liver was homogenized with ethanol and then submitted to continuous hot ex-traction for four hours with 97 per cent ethanol. The tissue residues and alcoholic extract were treated to hot continuous extraction with ether for two hours. The ether extract was dried to constant weight.

There is a significant positive correlation ($r = +0{\cdot}99$) at $P = 0{\cdot}05$ between fat in the ewes' liver and the weight of her fœtuses in the case of

Table 1. MEAN VALUES FOR LIVER FAT IN EWES ON HIGH AND LOW DIETARY PLANES, AND WEIGHTS OF THEIR FŒTUSES

Group	No. of ewes	Fœtuses		Total maternal liver fat (gm. per cent fresh liver weight)
		Number	Weight (lb.) per ewe	
High-plane (128th–143rd day of pregnancy)	8	12 (incl. 4 twins)	19·7 ± 1·54	8·87 ± 0·34
Low-plane (135th–140th day of pregnancy)	6	12 (6 twins)	14·4 ± 1·74	26·7 ± 1·90

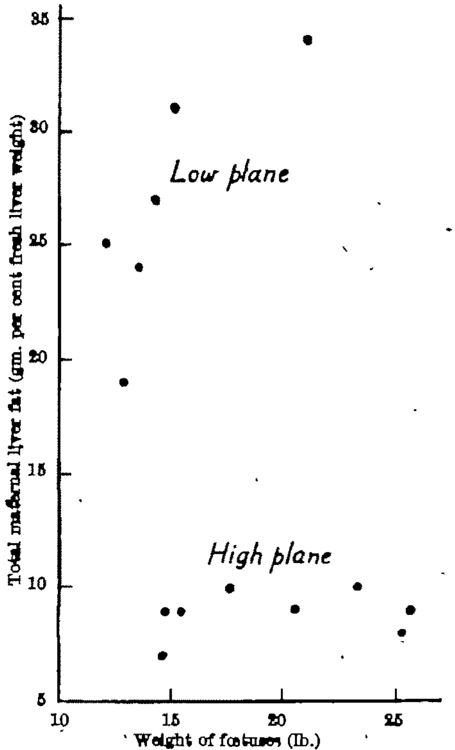

Fig. 1. Relation between total liver fat in ewes on high- and low-dietary planes at the end of pregnancy, and the weight of their foetuses

the low-plane animals, as is suggested by the scatter of points in Fig. 1. The correlation between these two variables in the case of the high-plane ewes ($r = + 0{\cdot}07$) is not significant at $P = 0{\cdot}05$. In the case of these high-plane animals, body reserves never seem to have been drawn on, the carcasses being well furnished with fat. These findings, however, require further investigation with a larger number of animals.

The experiment was made possible by financial assistance from the Agricultural Research Council. Acknowledgment is made of help received from P. S. Pugh, who undertook the analysis for fat.

N. L. Ferguson

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April 15.

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Wilt of Shisham (*Dalbergia sissoo* Roxb.) due to *Fusarium solani* sensu Snyder and Hansen

Shisham, an important timber species of North India, has been found to suffer from wilt disease in the Dehra Dun and Saharanpur districts in western Uttar Pradesh. The disease occurs both in natural forests and in taungyas which are artificially regenerated with field crops in admixture with other economic species like semul (*Bombax malabaricum*), babul (*Acacia arabica*), khair (*Acacia catechu*), bamboo (*Dendrocalamus strictus*), etc. Only trees of about 15–25 years old suffer from this disease, and wilting has not been observed in the seedling, sapling and pole stages of the plant. The symptoms of wilt in shisham are systemic and are characterized by drooping leaves and branches due to loss of turgor. The leaflets gradually turn yellow, and eventually drop off. The entire tree becomes 'thin' and light coloured, and stands out sharply in contrast to adjoining densely clothed green healthy trees. The nodules and slender branches on roots which characterize healthy shisham are absent on the roots of wilted trees. On splitting the diseased roots, the bark and the outer sapwood exhibit a well-defined pinkish-brown (sorghum brown, army brown, light seal brown, according to Ridgway[1]) stain, and though the stain is restricted in this region, it may rarely penetrate into the inner sapwood. The heartwood is free from the stain. The stain also progresses along the outer sapwood from the roots to the stem and, in the late stage of wilt, it may extend up the stem to about ten feet from the ground.

The wilt disease of shisham was reported by Bagchee[2] to be due to ***Fusarium*** sp. The organism, which is identified as ***Fusarium solani***, has been proved to be soil-borne. The fungus invades the tree through the roots, usually the laterals, whence it travels into the tap root and then proceeds along the stem. Within the wood, the hyphæ of ***F. solani*** are abundant in all the tissues, particularly the vessels. Due to clogging of vessels and adjoining tissues in the sapwood, especially in its outer region through which the sap mainly flows, the water supply to the crown is stopped, or at any rate considerably reduced, as a result of which the crown wilts. Wilting of the crown in shisham starts only when a certain proportion of the roots of a tree is invaded by the fungus. Wilt of leaves and branches thus indicates a late stage in the development of the disease. Death of affected trees is rapid and may occur within a few months after the symptoms in the crown become evident. ***Fusarium solani*** is constantly associated with wilted shisham, from the infected roots and stems of which the organism is consistently isolated in culture. Healthy but dead roots of shisham are quickly infected by ***F. solani*** when such roots are buried in a soil naturally infected by the fungus. These artificially infected pieces of root develop a pink stain in the wood from which ***F. solani*** can be re-isolated, proving that the fungus is responsible for the pinkish-brown stain present in the wood of wilted trees. Thus it is concluded that wilt and sudden death of shisham is due to attack by ***F. solani***.

The behaviour of ***F. solani*** in the soil has been studied in detail. Colonies of the fungus appear frequently in isolations made from the soil by the 'dilution plate' method described by Waksman[3]. 1 gm. of soil is found to contain about 10,000 colonies of ***F. solani***, based on an average of thirty soil samples, and the maximum number of colonies in one sample has been recorded as 40,000 per gm. of soil. The fungus occurs in soils bearing both healthy and wilted shisham and also in soils which support vegetation other than shisham, so that the occurrence of the fungus is independent of the presence or absence of the host species. In the soil, ***F. solani*** is usually present in the form of mycelium, though the possibility of its occurrence in the form of conidia and chlamydospores also exists. The fungus has been proved to possess quick and wide powers of saprophytic colonization by its ability to colonize healthy but dead shisham roots buried in wilt-infected soil. From these observations, it is concluded that ***F. solani*** belongs to the 'soil-inhabitant' group as assified by Garrett[4]. Detailed results will be pub- hed elsewhere. Studies are in progress regarding e relationship between the host plant, the parasite d the general soil microflora under varying con- tions of soil texture, soil moisture, soil reaction, vailable soil nutrients and the influence of cover ops, with the view of evolving methods for the ntrol of wilt.

Seedlings of shisham are immune to the attack of *usarium solani*, saplings are resistant, while the adults fter the trees bloom and bear fruit) are susceptible, hen growing in close proximity in the tarai land here shisham grows naturally. In the pure planta- ons in the taungyas of Uttar Pradesh also there is o wilt of seedlings. The fungus is present throughout he soil in this region and has been described as a il inhabitant. It also causes systemic infection on he stems of siris (*Albizzia procera*) by the air-borne pores[5]. The problem of the lowering of the resistance f the host at the transition from the juvenile to the dult stage is now under investigation. Control epends on the factors which predispose the trees to he attack of the pathogen at this stage.

I am grateful to Mr. C. R. Ranganathan, president f the Institute, for suggesting the problem and ffering helpful criticism in the work. Thanks are ue to Dr. K. Bagchee, mycologist, for his advice nd interest in the work, and to Dr. W. L. Gordon, lant pathologist, University of Manitoba, Manitoba, anada, for identifying the cultures of *Fusarium olani* sent to him.

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"The Case for Natural Selection"

ON my return from eight months travelling, my ttention was directed to the review of my book "Evolution in Action" by Sir James Gray (*Nature*, 173, 227; 1954). I feel I must comment on some of his statements, since they are of major concern to general biological theory.

At the outset he writes: "Darwinian orthodoxy demands implicit faith in the efficacy of natural selection operating on chance mutations. Subscribe to this and all doubts and hesitations disappear; question it and be forever lost". After saying that I state "the case for orthodoxy", he continues: "A few readers, perhaps rather pagan in their outlook, may think it a little strange that, if the case is quite so strong as they are asked to believe, it should still be necessary to argue the merits of natural selection with almost evangelistic fervour". Later, he states, "No amount of argument, or clever epigram, can disguise the inherent improbability of orthodox theory; . . . there will always be a few [biologists] who feel in their bones a sneaking sympathy with Samuel Butler's scepticism".

These allegations from one of our leading biologists demand an answer. First, I repudiate (and I am sure that other biologists will agree) the idea that there is any such thing as a "Darwinian orthodoxy" which "demands implicit faith in natural selection"—or in anything else. I venture to remind Sir James Gray of Sir Ronald Fisher's "Genetical Theory of Natural Selection". In that remarkable book, Fisher demonstrated conclusively: (1) that gradual evolutionary change, as postulated by Darwin and later established by the palæontologists, could have been brought about by selection acting on small mutations, on the basis of a particulate (Mendelian) mechanism of inheritance; but could not have been brought about on the basis of a mechanism of blending inheritance; (2) that, given the observed facts concerning heritable variations and their origin, neither orthogenesis (in the sense of inherently determined and directional variation) nor Lamarckism in any of its forms could have played any but the most trivial part in effecting evolutionary change; (3) that selection, acting upon small mutations and their recombinations, is capable of producing an extremely high degree of *apparent* improbability; and (4) that natural selection does not have to await the precise mutations needed to produce desirable adaptation, but operates on the stored variance made possible by the particulate mechanism of heredity, eliciting from it the required recombinations. (Gray's statement about selection "operating on chance mutations" obscures this essential point, and neglects the fact that the *effects* of genes are gradually adjusted by selection operating on the gene-complex.)

These are not dogmatic statements, but scientific conclusions; and the resultant neo-Darwinian or selectionist theory of evolution is no more an 'orthodoxy' than is the atomic theory of matter or the Mendelian theory of inheritance. Evolutionary biologists support it, not because they would be "forever lost" and excluded from an orthodox fold if they questioned it, but because it—and so far, it alone—is able to account for the facts.

Finally, the reason why it is still necessary, especially in a semi-popular book, to argue the case for natural selection so vigorously is that, unfortunately, a certain number of prominent biologists still publicly evince "a sneaking sympathy", to use Gray's own words, with Samuel Butler, or other vitalists or Lamarckians.

JULIAN HUXLEY

Athenæum Club,
London, S.W.1.

THAT my review of Dr. Huxley's book should be regarded as a matter of "major concern to general biological theory" is a sobering thought. It just shows how careful one must be in approaching the preserves of evolutionary genetics.

I can only say that none of the works to which Prof. Huxley refers, or appears to have in mind, gives me reason to believe that a 'conclusive demonstration' of the fact that certain things *can* happen is necessarily proof that they *have* happened. A demonstration that Dr. Huxley might conceivably make a mistake is no proof that he has, in fact, done so. Nor does a feeling of disappointment in natural selection as a working hypothesis during the past hundred years prove that biologists—prominent or otherwise—are either vitalists or Lamarckian fellow-travellers.

J. GRAY

Department of Zoology,
University, Cambridge.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

MANAGER (graded as Senior Experimental Officer) (with H.S.C. (science) or equivalent, and with experience in nuclear or reactor physics, and technical administration) OF THE REACTOR SCHOOL, to take responsibility for the day-to-day running of the school and act as secretary to the Management Board, arrange the course syllabus in conjunction with the lecturers and the Board, assist the physics lecturer in tutorial work and supervise the practical class associated with the school—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/22 (August 13).

ASSISTANT LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, University College of Wales, Aberystwyth (August 14).

LECTURER (grade 2) IN PHYSICAL METALLURGY—The Secretary, The University, Birmingham 15 (August 14).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY—The Registrar, The University, Hull (August 14).

ASSISTANT LECTURER or LECTURER IN METALLURGY—The Registrar, The University, Leeds 2 (August 17).

SENIOR LECTURER IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (August 20).

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SENIOR LECTURER IN PATHOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, August 21).

SENIOR LECTURER IN THE POSTGRADUATE SCHOOL OF MINING—The Registrar, The University, Sheffield (August 21).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, hydro (or aero) dynamics and/or physics, or equivalent qualifications) IN THE MARINE LABORATORY of the Scottish Home Department, Aberdeen, to work in conjunction with the fisheries biologists in studying the effects of modifications of commercial fishing gear and in devising new types of modifications of gear to increase fishing efficiency, and be prepared to go to sea in the Department's research vessels or in commercial vessels—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (August 27)

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in science or civil engineering and a knowledge of applied mathematics and physics) with the Air Ministry, for work on soil mechanics, at Wellesbourne Mountford, Warwickshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.41/54/A (August 28).

ASSISTANT IN BOTANY—The Secretary of University Court, The University, Glasgow (August 31).

RESEARCH FELLOWS IN EXPERIMENTAL NUCLEAR AND ELEMENTARY PARTICLE PHYSICS—The Professor of Natural Philosophy, The University, Glasgow (August 31).

LECTURER (honours graduate, with a knowledge of advanced physical metallurgy, and an interest in X-ray metallography) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Liverpool (September 1).

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ANGLO-IRANIAN OIL COMPANY STUDENT, for the study of gaseous reactions in the Chemistry Department—The Registrar, Imperial College, London, S W 7.

ASSISTANT EXPERIMENTAL OFFICER (with a qualification in physics, preferably to pass degree standard) with a research unit of the Anti-Locust Research Centre (accommodated at a Ministry of Supply establishment in Wiltshire), to assist in laboratory investigations of problems connected with the application of insecticides to flying locust swarms—The Director, Anti-Locust Research Centre, c/o British Museum (Natural History) Cromwell Road, South Kensington, London S.W.7.

ASSISTANT, Grade B (with a good honours degree in chemistry) to teach mainly physical chemistry to degree and A.R.I.C.A. standard—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham.

ASSISTANT PROFESSOR IN CHEMISTRY—Head, Department of Chemistry, Dalhousie University, Halifax, Nova Scotia, Canada.

ENGINEERS and PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree, or equivalent high professional attainments), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A246/52A.

GEOLOGIST (with a second-class honours degree (upper division) in geology) with H.M. Colonial Service in Cyprus, for detailed geological mapping, more particularly of the igneous area and petrologic examination of such rock and of mineral deposits—The Director Recruitment, Colonial Office, Great Smith Street, London, S.W. quoting BCD.105/17/02.

INDEPENDENT FORECASTER (with a degree in physics or mathematics, and experience of independent forecasting, and the gener work of a city meteorological office) IN THE METEOROLOGICAL DEPART MENT, Bermuda, for duties which include forecasting for the gener public and shipping, investigation of meteorological problems, routin climatological returns and checking the work of assistant staff—T Director of Recruitment, Colonial Office, Great Smith Street, Londo S.W.1, quoting BCD.57/29/01.

READER IN THE DESIGN AND ANALYSIS OF SCIENTIFIC EXPERIMEN at the University of Oxford—The Registrar, University Regist Oxford.

SENIOR TECHNICIAN IN THE DEPARTMENT OF BOTANY—The Secr tary, Bedford College (University of London), Regent's Park, Londo N.W.1.

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THE CIVIL SERVANT IN BRITAIN

THE famous report on the organization of the permanent Civil Service signed by Stafford H. Northcote and C. E. Trevelyan was presented to Parliament just over a hundred years ago at the end of February. The anniversary has been marked by numerous articles in the Press, as well as by the publication by H.M. Stationery Office of a booklet reviewing the growth and organization of the Civil Service during a hundred years and by a commemorative lecture before the University of London on February 16, 1954[*]. In that lecture Prof. K. C. Wheare dealt with the Civil Service in the constitution, with the way in which the reforms recommended in the Northcote–Trevelyan report were effected and some of their implications to-day. Prof. Wheare points out that the centenary of a modern Civil Service recruited and organized on the lines advocated in that report will not be celebrated before 1970, though with the establishment of the Civil Service Commission in 1855 there came into existence a permanent institution with a vested interest in the discovery of merit through competitive examination as a means of entry into the Service. Prof. Wheare is concerned, however, chiefly with the consequences of the adoption of these reforms; he looks upon them from outside the Civil Service and from the point of view of their effect upon the practice and efficiency of government.

The first point to which Prof. Wheare directs attention is one the importance of which has been strikingly emphasized during the past few years. The greatest change in the position of the Civil Service in the constitution since the publication of the Northcote–Trevelyan report does not consist in the removal of patronage or the establishment of permanence. Britain already had a permanent Civil Service, and the Northcote–Trevelyan reforms were aimed at ensuring that those appointed were fit to hold office. The greatest change consists in the increase in the authority of the Civil Service, and this would probably have occurred whether it was recruited by patronage, by qualifying examination or by competitive examination.

Prof. Wheare argues that, whereas a hundred years ago the principal influence in government lay with an aristocracy acting through a cabinet with the advice and consent of Parliament, nowadays the principal influence lies with a bureaucracy acting through a cabinet with the advice and consent of Parliament. This change is due largely to the growth in the extent and intensity of the State's activity and consequent increase in the powers of the Civil Service. So far as the Northcote–Trevelyan reforms have contributed, it is because when increased authority was given to the executive branch, those reforms had provided officers ready and capable of exercising power. Northcote and Trevelyan saw the Civil Service as an efficient body of permanent officers occupying a position duly subordinate to that of the Ministers who are directly responsible to the Crown and to Parliament, yet possessing sufficient independence, character, ability and experience to be able to advise, assist and, to some extent, influence those who are from time to time set over them. They saw, in fact, exactly the kind of man that, on one hand, Sir Edward Bridge depicts in his "Portrait of a Civil Servant", and Mr. Herbert Morrison, on the other, in his "Government and Parliament: a Survey from the Inside"*.

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[*] The Civil Service in the Constitution. By Prof. K. C. Wheare (A lecture delivered before the University of London, on 16 February 1954, to commemorate the centenary of the Northcote–Trevelyan Report.) Pp. ii+34. (London: The Athlone Press, 1954. Distributed by Constable and Co., Ltd.) 2s. 6d. net.

Mr. Morrison writes frankly and with understanding about the relations between Civil servants and Ministers, and concludes with an unqualified tribute to the energy, ability, resourcefulness and incorruptibility of the Civil Service, as well as its loyalty to the Government of the day; but he fails to recognize the change to which Prof. Wheare directs attention, and the danger implicit in that change. That may well be because, although Mr. Morrison is expressing an inside view, it is one from the Ministerial angle. He recognizes fairly enough the danger to the public interest that lies in overworking the higher Civil servant and that, like other senior professional men and women, senior Civil servants, though loyal, may not be quick enough in accepting or adapting themselves to new ideas. He has not quite recognized the 'statesman in disguise' of Sir James Stephen; the latter, admitting the evils of patronage and the need for a better-educated Civil servant, nevertheless thought that the man at the top of the examination list would be too good for the Civil Service.

Prof. Wheare puts besides Sir James Stephen's comment of a hundred years earlier the official description, by the Civil Service Commission, of what it expects to-day of a successful candidate for the Administrative Class, and of what he may expect of the Civil Service. He is "concerned with the formulation of policy, with the co-ordination and improvement of government machinery, and with the general administration and control of Departments. The ideal candidate would possess intellectual ability of a high order, and the ability to discern and analyse the essentials of complicated questions, and to express himself with lucidity in speech and writing. He would be able to get on well with all kinds of people, be adaptable, far-sighted and persevering, and have enough strength of character and leadership to hold his own, take decisions and exercise responsibility. He would have enough practical imagination to enable him to devise, in broad outline, workable plans for dealing with an unprecedented situation. Above all, he would need judgment and commonsense".

Before we consider the implications for to-day of a Parliamentary bureaucracy, which has in fact, contrary to some predictions, attracted a high proportion of the ablest young people of successive generations, and perhaps an excessive proportion, one consideration emphasized by Prof. Wheare should be noted. He believes that an important factor in attracting so many of the ablest young people from the schools and universities has been the persistence of the tradition that service to the State is an honourable profession. Prof. Wheare wonders whether that tradition is now as strong as it was. Certainly the tendency of a certain section of the Press to denigrate the Civil Service on any possible pretext, though not countenanced either by Parliament or Ministers, does not help to maintain the tradition. None, however, who is concerned to see that the task of government is well and efficiently discharged can be indifferent to the firm maintenance of the great tradition that has made the Civil Service a pre-eminent profession in Britain.

Prof. Wheare has no hesitation in affirming that to-day we need (and in large measure we get) in the higher Civil Service not only skill in the management of public affairs but also the wisdom, vision and imagination which are the mark of statesmanship, and that it should be the constant anxiety of those responsible for recruitment to see that our methods of selection, training and promotion attract and retain persons possessing such qualities. But he adds two qualifications. First, although in one sense it is true that adoption of the principles of the Northcote–Trevelyan report both took party politics out of the Civil Service and the Civil Service out of politics, a Civil servant's work is carried out in the midst of party politics. Everything he does is done in the name and upon the responsibility of a Minister who belongs to a party, and anything he does may have party consequences for his Minister and, at times, for the Ministry as a whole. In formulating policy, for example, a higher Civil servant is advising and assisting a Minister not only to carry through a policy which is that of a political party with a majority in the House of Commons, but also to defend that policy against the criticisms and attacks of the Opposition.

Accordingly, as Prof. Wheare points out, a higher Civil servant requires a political sense; and in saying this he has put his finger on one of the causes of the mismanagement which has aroused such widespread concern over the Crichel Down report. The essential question in that unhappy episode is what is the public interest, and how and by whom it should be determined. Those questions cannot be answered even by men of the most impeccable integrity or intellectual ability without political sense. Lacking that sense, the extreme delicacy of the position of the Civil servant, of which Prof. Wheare reminds us, is fatally disturbed; but it is equally true that the maintenance of that delicate position depends as much or more upon a correct attitude on the part of Ministers and Members of Parliament towards Civil servants as it does upon the attitude of Civil servants towards them.

On this question of the relations between a Minister and his Department and between Parliament and the Civil Service, one would have welcomed much more comment from one writing from inside, like Mr. Morrison, particularly from one who possesses such a sense of the rights of the House of Commons as a whole and of the responsibility of the Government to the House rather than to a political party, and who recognizes the danger that party discipline may be overdone. A concrete episode like that of Crichel Down throws a more searching light on the weaknesses of our Parliamentary institutions and the changes required to adapt them effectively to the needs of to-day than Mr. Morrison's generalizations. Indeed, Prof. Wheare's second proviso is more relevant to the Crichel Down episode than any passage in Mr. Morrison's book. "Civil servants," he writes, "may be statesmen in disguise, but they must not be Ministers in disguise."

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* Government and Parliament: a Survey from the Inside. By Herbert Morrison. Pp. v+363. (London: Oxford University Press, 1954.) 21s.

Prof. Wheare recognizes that it is possible that Civil servants accustomed to act on behalf of or in the name of Ministers may be tempted at times to think and act as if they were Ministers. He is, however, convinced that it is still an axiom in the Civil Service that no matter how much a Civil servant may act on behalf of his Minister, he must never forget that his Minister bears the responsibility, and for justification of that confidence Prof. Wheare points to the evidence of 'question time' in the House of Commons. The remedy for arbitrariness and errors of judgment such as the Crichel Down report has exposed lies, in Prof. Wheare's view, in stronger Ministers and a more independent and vigilant House of Commons rather than in weaker Civil servants.

Now, although the position of the scientific Civil servant or of the scientific expert in general is nowhere specifically discussed by Prof. Wheare or even by Mr. Morrison, in spite of a brief recapitulation of steps he took, as Lord President of the Council, to improve the arrangements for scientific advice, the nature of the relations between Ministers and their advisers is of vital importance to the participation of the man of science in the task of government. The first condition for effective relations is mutual confidence, and here the question of the relations between Government and Parliament and the dominance of a political majority are more important than Mr. Morrison suggests. Civil liberty depends on Parliament never becoming the instrument of a single class. It also depends on Ministers seeking to further primarily the public interest, and not simply that of a political party which may or may not even represent the majority of an electorate, however much the Ministerial conception of the public interest may be influenced by political ideas. The expert must at least have some assurance that the advice he renders in his particular field will be fairly considered by those competent to appreciate its significance, and that it will be evaluated objectively along with the other factors involved in the situation.

It is because there have been frequent indications in recent years of the plain disregard of facts and of deteriorating standards of Ministerial conduct that the situation cannot be regarded with the satisfaction that Mr. Morrison's book implies. Some five years ago, we commented on two instances which seriously prejudiced the self-respecting association of the scientific and technical expert in the task of government (see *Nature*, 164, 1103; 1949). Others are to be found since in such matters as fuel policy, broadcasting and television, national parks, and in scientific and industrial research as well as in technological education.

The first step to establish full confidence and proper relations between Ministers and their Departments and advisers, whether scientific or otherwise, is firmly to re-establish the rule affirmed by the Newton National Civil Aviation Consultative Committee in 1948, that no man should be judge in his own case. That indeed is the first thing that should have come out of the discussion in Parliament of the Crichel Down report if any public confidence is to be felt that there will be an end to departmental high-handedness. Failure to elicit such an assurance would have dealt a fatal blow to the essential spirit of the British constitution as well appears from Sir Alfred Denning's lectures, "The Changing Law" (Pp. 122. (London: Stevens and Sons, Ltd., 1953.) 10*s.* 6*d.*). Nor will confidence be restored by an investigation by the Civil Service Committee under Sir Edward Bridge's chairmanship—a Committee which *ipso facto* infringes that principle.

Next, it has to be admitted that the efficiency and possibility of government depend upon removing a great many decisions from the range of popular choice. When the size of a Department compels extensive delegation of power, responsibility must go with it; otherwise petty tyranny and bureaucracy will replace democracy and government by consent. The doctrine of Ministerial responsibility requires re-examination in the context of situations in which it is clear that advice has not been tendered and considered at anywhere near Ministerial level.

This, then, and the indication of the right and force of public criticism were the first things required of Parliament in the Crichel Down debate: they transcend in public importance even any steps taken to rectify an injustice. But of equal importance are the questions what is the public interest, and how and by whom should it be determined. Manifestly, the assumption that every public servant has a primary concern for the public interest and can be trusted without inquiry to pursue it can no longer be accepted. It never has been accepted for the scientific or technical expert, and it is perhaps all to the good that it should now be shown so plainly that the administrator stands on the same level.

It is no longer possible to ignore the evidence which has accumulated since the War, especially over land for the Services and other government departments or public corporations, that a government department is not necessarily any sounder judge of the public interest than anyone else. Decision as to what is the public interest can only be made at ministerial- or even at cabinet-level. If the cabinet fails to formulate the broad lines of policy and it is impracticable or impossible for a Minister to master all the facts and details in the multitude of cases in which this principle would reserve to him the final decision, we have to evolve some further practical means, as Sir Alfred Denning indicates, of providing that the issues are surveyed impartially at some stage by a competent but wholly independent person.

That is the vital principle at stake and Parliament has no greater responsibility than to insist on seeing that the means necessary to serve it are implemented without delay. It affects almost every aspect not only of the impact of government and of the Civil Service on the lives of the individual citizen, but also of the participation of the man of science and the technical expert in the task of government. To them it would offer the assurance, not yet wholly theirs, that the advice they tender within their own particular field of competence and knowledge would be considered intelligently and impartially along with that given by other experts concerned, and evaluated in the light of the situation as a whole. More they are not entitled, nor do they wish, to claim. But such measures for terminating the power of a government department or any other body to judge its own cause, and giving the assurance of impartial consideration of all issues and fair treatment of individuals, would have as one further consequence the placing of the scientific and technical expert more nearly on an equality with the administrator. Their importance justifies the hope that they will be formulated in no party spirit, but with full appreciation of how much is at stake—no less than the stability of our Parliamentary institutions.

In the debate in the House of Commons on July 20, the doctrine of ministerial responsibility was supported not only by the resignation of Sir Thomas Dugdale but also on all sides of the House. There was some general appreciation of the complexities that arise in applying that doctrine to-day. More might have been said on the question of the public interest; but the swiftness with which Sir John Woods's Committee has reported to the Prime Minister and the forthrightness of the report on this point warrant the hope that these issues will receive ample and urgent attention. "In the present times," says the report, "the interests of the private citizen are affected to a great extent by the actions of Civil Servants. It is the more necessary that the Civil Servant should bear constantly in mind that the private citizen has a right to expect, not only that his affairs will be dealt with effectively and expeditiously, but also that his personal feelings, no less than his rights as an individual, will be sympathetically and fairly considered." It is a prime responsibility of Parliament to see that that doctrine is never forgotten or ignored.

EXPERIMENT IN THE POPULARIZATION OF SCIENCE

Die Welt der ungewohnten Dimensionen

Versuch einer gemeinverständlichen Darstellung der modernen Physik und ihrer philosophischen Folgerungen. Von Prof. Arnold Hildesheimer. Pp. 368. (Leiden: A. W. Sijthoff's Uitgeversmaatschappij N.V., 1953.) 17.90 Dutch florins.

TRANSLATED into English, the title of this four-hundred-page volume by Prof. Arnold Hildesheimer is "The World of Unaccustomed Dimensions". Its scope is, however, more closely defined by the sub-title: 'Versuch' of a popular presentation of modern physics and its philosophical implications. 'Versuch' could mean one of two things: 'attempt' or 'experiment'. Regarding the work as an attempt, the reader is immediately captivated by the enthusiastic earnestness of the author's endeavour to raze the mathematical fortifications separating the 'expert' from the interested layman, in order to open for him a view into the fundamental concepts of physics and all their enjoyable or threatening technical consequences with which modern man has to live. The author points correctly to the abyss which isolates the scientist from the masses. Any attempt to bridge this gap will be greatly appreciated by anyone living on either side of the fence, and throughout the book the honesty of this attempt can be recognized.

In four main parts, the author tries to encompass the essential ideas in physics as they have evolved during the past five centuries. In the first part, dealing with "The World of Medium Dimensions", we get a rapid treatment of classical mechanics, the field concept, matter, gravitation, energy, causality, statistics, entropy, the atom, optics and Maxwell's theory of electromagnetism. The theory of relativity is introduced in the second part: "The Macrocosm". Both special and general relativity are discussed, and the author tries to familiarize the reader with four-dimensional geometry and Riemann spaces. Part 3 turns to "The Microcosm". Quantum and wave mechanics are described in terms of the work of the great leaders, Planck, Bohr, de Broglie, Schrödinger and Heisenberg, and the duality wave-particle is pointed out. In the fourth and final part, "Consequences for the Theory of Knowledge", the author summarizes and integrates the concepts presented and speculates about the significance of these thoughts for the ultimate issues like fate, free will, *existentia et essentia*. A bibliography of more than sixty popular and scientific books on these subjects and eight appendixes plus a complete index conclude the book. On every page the author's admiration for the giants is evident, and wherever it is feasible he allows the great men of science to speak in their own words.

No doubt this work represents an honest attempt to relieve the layman from his 'sacred awe' when he is exposed to the innermost of the magic circles of science. But the question is: What is the result of the work as an experiment? In other words, how successful has the author been in explaining to the layman the essential pillars of scientific thought? How much does he contribute to the clarification of complex ideas like curvature of space, entropy and probability, the uncertainty principle and similar concepts? This brings us to the method the author uses throughout the whole book: the method of comparison.

Almost every page contains one or more examples in which a physical situation is 'explained' by a comparison with simple everyday-life experiences. If some of these comparisons contain words which perhaps are not in the vocabulary of the reader, the first-order comparison is explained by a second-order comparison with an even more simple everyday-life experience—and so on. This leads to a hotchpotch of armchairs, gravitational fields, pregnant mammals, cosmologies, twirling sticks, cannons, Maxwells, horse carriages, Jacks and Jills, red shifts of spectral lines, flying bullets, pilots jumping off planes, potential barriers, Riemann spaces and people invited to parties. It finally becomes so complicated that not only does the reader lose completely the thread of what had to be explained in the first place, but the author is also deeply lost in an ocean of n-th order explanations. Furthermore, it is doubtful whether an everyday experience can suffice to serve as an analogy to atomic or cosmic situations. If that were the case, quantum mechanics and general relativity could be reduced to classical mechanics. The poetic comparison of a beautiful girl with a rosebud is perfectly legitimate if one knows both. But it is doubtful whether somebody who has never seen a girl would recognize one as such, if he only knows that they are like rosebuds.

It can be argued that the interested layman may suddenly grasp the idea of the metric tensor if he is told that if one invites people (stars) to a party (universe) and they have to bring chairs (gravitational fields) along, it may eventually become so crowded that a newcomer may indirectly cause a distant guest to move his chair (the distribution of the masses in the universe defines the geometry of the universe—pp. 175 and 185). But it cannot be argued that the author's statement "... the formula $v = \lambda\nu$ tells you, as you know, that the velocity of a wave is solely dependent upon the medium in which it is propagated. ..." is wrong (p. 99). Another example: "... If one observes the light of a body in its spectrum and recognizes that this spectrum has shifted to the red, one has proof that the frequency of the light is reduced, i.e., the motion of the body has been retarded. And indeed that is observed if one views in the spectrum the β-rays emitted from a rapidly moving radium atom.... This redshift of the spectrum is one of the proofs of Einstein's theory of light" (p. 149). This statement is not only wrong, it is nonsensical, like "the causal law of gravitation" (p. 305). Misinterpretations of the type of 'near-truths' occur frequently in the book. This is a consequence of the hopeless attempt to describe the rules of chess by those of noughts and crosses. Readers who may look for some hints in the field of nuclear physics will be disappointed. The word meson is mentioned only once, and the all-out effort of modern physicists to determine the structure of the nucleus is not mentioned once.

If this honest attempt at a popular presentation of modern physics and its philosophical implications is regarded as an experiment in popularization, I must regretfully conclude that it is a failure. But the question remains: Can science be popularized at all?

Heinz Von Foerster

MODERN FOOD HYGIENE

Food Poisoning and Food Hygiene

By Dr. Betty C. Hobbs. Pp. x+174. (London: Edward Arnold and Co., 1953.) 14s. net.

This book by Dr. Betty C. Hobbs should be read by all those interested or engaged in the production and handling of food. It will also be found of great use to those who are engaged in the administration of the new Food and Drugs Act in its present and anticipated amplified form.

At any time the contents of the book would be a valuable contribution to the literature of the subject; but its publication now enhances its value. As its title implies, it deals with the subject in two sections—food poisoning and food hygiene—and it is written in a manner which makes it easily understood by others than specialists. There is a tendency to deal with the subjects rather more from the academic than the practical aspects, and only those who have experienced the great difficulties of administering the simple rules of food hygiene will grasp how practically impossible it will be to carry out *in toto* the recommendations in Dr. Hobbs's book, admirable as they are.

The simple explanations and clear illustrations in the section dealing with food poisoning should convey to the reader something of the complexity of the subject, and the manner in which these micro-organisms form the toxins. Until very recently, *Clostridium welchii* were not regarded as falling into the class of food-poisoning bacteria, but, according to the table on p. 36, they were the cause of the outbreak of twenty cases out of a total of thirty-three. In the pages following these tables, explanations are given of the history of these cases, and these need to be read in the light of the second section of the book, dealing with hygiene. In this, there is sound advice, which, if it can be followed, should do much to minimize these outbreaks; but it is not all easy to carry out.

The female's head-covering, illustrated on p. 85, is not effective; experience has shown that the hair must be completely covered. The idea of regular educational talks on personal hygiene, although by no means new, is an excellent one; but it will be found that, in order to secure a full audience, such lectures have to be delivered during working hours and, therefore, interfere with production. It is a pity that Dr. Hobbs fails to direct attention to the hazards attached to the cafeterias of the help-yourself type, in which the unwrapped food is exposed to fingering, coughing and sneezing by hundreds of persons every day. Perhaps greater attention could be focused upon the cause of contamination of foods in retail shops, due to exposure, unclean knives, soiled aprons, etc., and the fly menace.

Dr. Hobbs is to be congratulated upon the excellence of her book. It should certainly enjoy a wide circulation, and it will doubtless prove of great use to the food industry.

Osman Jones

EXPERIMENTAL PLANT MORPHOLOGY

Entwicklungs- und Bewegungsphysiologie der Pflanze

Von Dr. Erwin Bünning. Dritte auflage. (Lehrbuch der Pflanzenphysiologie, Zweiter und Dritter Band.) Pp. xii+539. (Berlin: Springer Verlag, 1953.) 49.60 D. marks.

Experimental plant morphology has recently undergone a revival, especially in Germany, and there are flourishing research schools under Richard Harder in Göttingen and Erwin Bünning in Tübingen. Indeed, Bunning's monograph, which is here under review in its third edition, is a monumental summary of the subject, and a valuable source-book of facts and ideas.

Particularly ideas. For if there is one criticism of this book it is that the documentation of facts is inadequate and the distinction between established facts and illuminating speculation is not always clear. The expression "dass wird man so und so erklären können" is admirable when the speaker can be cross-questioned about the authenticity of his facts: it is exasperating when the reader has to guess whether this *is* the explanation, or only whether it *might well be* the explanation. A symptom of this failing is the paucity of references (though there are many more than there were in the second edition) and the absence of an author index.

The book has been enlarged by some seventy-five pages, mostly by the interpolation of new paragraphs. Its scope remains as it was: chapters on growth and cell division, differentiation (with a considerable amount of new material), plant movements, and the effects of external stimuli on movement and development. Bünning's own views on photoperiodism and endogenous rhythms are well summarized, together with recent experiments which appear to corroborate his hypothesis.

In a book which covers such a wide sweep of knowledge any critic can find omissions; a few of them are mentioned here only in the hope that they may be repaired in a fourth edition. The discussion of the relation between respiration and growth (pp. 84–91) is not convincing, and needs fuller and more critical treatment. The section on weed killers (p. 132) might well be expanded, for it omits so much that it is not easy to understand the residue. The section on stomatal movement (p. 429) is not up to date. Vernalization (p. 473) receives a scant three and a half pages, which seem inadequate in a book which specializes in developmental physiology. Finally, one is bound to say that the style suffers from a Teutonic turgidity, and the index is not nearly full enough for an important work of reference of this kind.

However, these are criticisms of detail, and they do not detract seriously from the massive erudition of the book and the fecundity of its ideas. It cannot be denied that the most powerful weapons in plant physiology are the techniques of physics and chemistry, and that sooner or later every physiological problem needs these weapons for its solution. But as more mature physiological problems reach the stage which requires the chemist's technique, new problems emerge from the experience of naturalists and gardeners and agriculturists; and these can be tackled by the techniques of biology. Anyone who doubts such an assertion as this has only to read Bünning's book. For the English student, who is likely to hear all too little of this fascinating field of physiology, the book has a great deal to offer, and it is to be hoped that sooner or later an English translation will be available.

E. Ashby

THE RARER METAL, ZIRCONIUM

Zirconium

By Dr. G. L. Miller. (Metallurgy of the Rarer Metals No. 2.) Pp. xviii+382. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1954.) 45s. net.

This book is the outcome of its author's desire to collate the information on zirconium which has been accumulating so rapidly during the past few years. Dr. G. L. Miller has been in an advantageous position to do this by reason of his own wide experience and also because of his visits to workers in the same field in the United States. As a result of his work, he has written this text-book and reference volume which will appeal to every chemist and metallurgist interested in zirconium. There are eighteen chapters, the first of which opens with the history and the occurrence of zirconium, its consumption and uses both as metal and alloys and, naturally as a refractory material. The treatment in all cases is as thorough as the available data will permit, and the very carefully assembled bibliography at the end of each chapter is up to date and of notable dimensions. Methods of extracting the metal and the preparation of pure zirconium compounds are discussed in some detail, in particular the separation of hafnium and zirconium from one another. Earlier and more recent production methods are described, notably the van Arkel or iodide process and the Kroll processes in which purification and reduction are combined. Reduction of the tetra-chlorides of titanium and zirconium and the arc-dissociation of halides, and also methods of electrodeposition from fused salts as well as from aqueous and non-aqueous solutions, receive attention.

Following a general account of the structure, crystallographic, atomic and nuclear characteristics, attention is given to physical properties. Thermal, electrical, optical, thermionic and magnetic properties are reviewed and illustrated by graphs. There are two chapters on the mechanical properties of zirconium metal, and on zirconium alloys at room and at elevated temperatures. In this latter chapter, alloys of some twenty-four elements are included, not counting the zirconium alloys with oxygen and nitrogen which receive separate treatment in the following chapter. The chemical and corrosion resisting properties of the metal and its alloys and their resistance to the action of liquids in general and to some of the concentrated mineral acids as well as a range of organic acids is illustrated by a series of useful tables. Probably the most valuable and generally useful chapter in the book is that on alloys of zirconium, in which first the alloying theory and its application to zirconium is discussed on a theoretical basis and then the practical results of comparatively recent investigations of binary systems involving zirconium are reported with phase diagrams of many of the binary alloys. This chapter has a bibliography involving more than eighty references and covering all the contemporary useful contributions to the subject. The chapter on melting practices discusses those types of furnace that can be applied to zirconium and is followed by an account of fabricating the metal by rolling, extrusion and other techniques, in which brazing and soldering are not lost sight of and attention is directed to the fact that zirconium has superior wetting and very good bonding qualities.

The powder metallurgy of zirconium has its own chapter in which the conclusions of H. A. Hausner and his colleagues at Sylvania Electric Products, Inc., Bayside, Long Island, New York, that zirconium is readily fabricated by powder methods are confirmed. The most important part of the chapter deals with the preparation of zirconium powder. The last chapter covers special compounds such as the nitride, the carbide, the boride and the silicide, but there is a valuable appendix dealing with some eleven methods of preparing material for metallographic examinations.

The usefulness of the chapter bibliographies is increased by the addition of a final black numeral or numerals to each reference denoting the page upon which the reference is cited, a distinct advantage to the busy worker who quickly wants to find where the reference appears and its specific terms.

H. W. Greenwood

Introduction to Solid State Physics

By Prof. Charles Kittel. Pp. xiii+396. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 56s. net.

THIS book forms a valuable addition to the literature on solid-state physics, and can be strongly recommended to those engaged in the preparation of university honours degree courses in this subject. The range of subjects included is wide: the sixteen chapters deal with crystallography, elastic, thermal, electric and magnetic properties, the electron theory of metals, and crystal imperfections, problems for the student being suggested at the end of each chapter. Prominence is given to relatively new subjects such as ferroelectricity and antiferromagnetism.

The emphasis is almost entirely on theory; experimental methods are referred to only briefly. A high standard of theoretical ability is expected of the reader, and occasionally the author seems to have taken a delight in starting from unnecessarily general premises. For example, he defines the unit cell of a crystal as a polyhedron, whereas it is always taken to be a parallelepiped; and in equation 1.12 is it fair to the student to allow the same symbol—i—to have two different meanings, clear as these may be to the expert?

In fact, the first chapter, on X-ray crystallography, is the weakest in the book, and contains several statements that would not be accepted in crystallographic circles. For example, on p. 9 symmetry elements called rotation-reflexion axes are introduced; they should be rotation-inversion axes. It is hoped that in future editions of the book, Chapter 1 will either be largely rewritten or will consist mainly of references to standard crystallographic text-books.

Yale University Publications in Anthropology

No. 49: Excavations at Wari, Ayacucho, Peru. By Wendell C. Bennett. Pp. 126+12 plates. No. 50: On the Excavation of a Shell Mound at Palo Seco, Trinidad, B.W.I. By J. A. Bullbrook. Pp. 114. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1953.) 3 dollars.

THIS volume is made up of two papers, each dealing with a particular aspect of American archæology. The first is a posthumous publication of Prof. Wendell C. Bennett, whose premature death last summer deprived South American archæology of one of its most notable scholars. It describes his excavations, in 1950, at an extensive habitation site, spelt variously Wari and Huari, in the little-known but important highland basin of Mantaro, which lies just north-west of the Cuzco basin. The chief remains at Wari are contemporary with the Classic Period at the well-known ceremonial site of Tiahuanaco in Bolivia, with which they have many features in common; but they include a pottery style more closely related than any at Tiahuanaco itself to the Coastal Tiahuanaco style which has such a wide distribution on the coast. Prof. Bennett discusses fully the relationships between the various Tiahuanacoid sites and makes suggestions as to the nature of the contacts between them.

In 1919, Mr. J. A. Bullbrook excavated a shell mound in southern Trinidad with official support, and the resulting material and the report went to the British Museum. Mr. Bullbrook is a geologist with considerable archæological experience, and his work was done very carefully; for various reasons it was not published at the time, and for many years afterwards he got little encouragement. He continued to live in Trinidad, and when members of Yale University began to work on the West Indies about fifteen years ago, his researches came to their notice. Subsequent work, mainly by Dr. Irving Rouse of Yale, has confirmed his results, and Dr. Rouse has considered it worth while to edit the report and publish it in spite of the long interval since it was written. The Palo Seco mound was inhabited at two periods in Pre-Columbian times, separated by a short interval, by people who lived on shell-fish, fish and game, probably with some cultivated plants, although there is no direct evidence of agriculture. There are few artefacts other than pottery, which forms the basis for the definition of one stage, the Palo Seco style, in a succession of rather similar types established by Dr. Rouse. The British West Indies have been very much neglected by archæologists until recently, and most of the modern work has been done by Americans. Mr. Bullbrook's pioneer work, which satisfied the exacting standards of the school at Yale, is much to his credit.

G. H. S. BUSHNELL

Advances in Electronics

Edited by L. Marton. Vol. 5. Pp. xii+420. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 9.50 dollars.

ENGINEERS and physicists will again be indebted to Dr. L. Marton for bringing together further review articles in this Vol. 5 of "Advances in Electronics". A wide field of specialization is represented, the most topical of which are colour television and junction transistor applications. Other subjects include thoria emitters, solid-state luminescence, detectors for visible and infra-red radiation, β-ray spectroscopy and modern vacuum pumps. The articles are authoritative, clear, well illustrated and contain abundant references; the cumulative index includes earlier volumes. This book is to be highly recommended.

L. JACOB

Explorers of the Pacific

European and American Discoveries in Polynesia. By Te Rangi Hiroa (Peter H. Buck). (Bernice P. Bishop Museum Special Publication 43.) Pp. viii+126. (Honolulu: Bernice P. Bishop Museum, 1953.) 1.75 dollars.

THIS is a posthumous work which arose apparently out of Sir Peter Buck's monograph, "An Introduction to Polynesian Anthropology". It purports to be an important anthropological document, "for it describes the early contacts of Polynesians with Europeans and Americans, hence provides a picture of the setting in which the culture change of modern times had its origin". What it does is to give a brief account of voyages in the Pacific between 1486 and 1849 in chronological order and without any real attempt to estimate their importance. Some of the brief judgments on the explorers give a wrong impression: for example, that Drake "fooled" the Spaniards by not returning via Magellan's Strait, or that Cook, on his third voyage, "dispelled the theory of a northern passage into the Atlantic". The list of "literature cited" is incomplete as a bibliography, and, although a great many islands are mentioned in the text, there is only one small map on which the main groups of islands are marked. This book has its use as a brief guide to voyages in the Pacific; but is too brief to make any serious contribution to our understanding of any of them.

J. N. L. BAKER

NATURE PROTECTION IN THE NEAR AND MIDDLE EAST

DURING June 3–9 a conference on the conservation of Nature in the Near and Middle East was held at Beirut, organized by Prof. F. Ghosn, president of the Lebanese Society of the Friends of the Trees, and Mr. W. E. Purnell, director of the Unesco Middle East Scientific Co-operation Office. The conference was attended by scientists and others from Cyprus, Egypt, Greece, Iraq, Jordan, Lebanon, Syria and Turkey. Dr. E. H. Graham, director of plant ecology, Soil Conservation Service, United States Department of Agriculture, attended from Washington, D.C., and Lieutenant-Colonel C. L. Boyle went from London on behalf of the Society for the Promotion of Nature Reserves and the Fauna Preservation Society. Many of the participants are actively engaged in conservation problems in their own countries and, at the conference, had an opportunity to exchange opinions and discuss experiments. After a short general discussion, study groups were formed to consider separately soil, flora, fauna and education.

The discussions of the soil and flora groups showed that, although great damage had been done to the forests of the Near and Middle East, they had not been utterly destroyed. M. P. Ballot, head of the French Agricultural Mission to the Lebanon, said that they had only just realized the continued existence in the Anti-Lebanon mountains of a juniper forest of perhaps a million trees; furthermore, experiments had shown how extraordinarily quickly vegetation could re-establish itself when it was protected from grazing. A distinction can be drawn between the damage done by the grazing of sheep and of goats; whereas trees can grow fairly quickly beyond the reach of browsing sheep, goats, as was shown by a photograph of them feeding high in an oak tree, can reach almost anything.

The flora group pointed out that in much of the area the climate is not sufficiently arid to explain the lack of vegetation; but even where the rainfall is adequate, the destruction of the plant cover has resulted in the water being lost by immediate run-off, deep percolation and evaporation. Moreover, it is not only the quantity of plants which matters. Where grazing is heavy, perennial grasses with spreading root systems, which bind together the soil, build up humus beneath the surface and retain moisture, are replaced by annual grasses which do nothing to resist erosion. Similarly, forests are replaced by thorny shrubs with tapering roots, which do little to conserve the soil. The annuals and the thorny shrubs survive because they can resist grazing.

It is fully understood that complete elimination of goats is not possible, for they play an important part in the economy of the area; but their number must be radically reduced. Mr. Y. Salti, director of forests, Jordan, explained how goat control is effected in his country. When a considerable majority in a village vote against goats, they are restricted to three tethered goats per family. In practice, the reduction in goat population is not easy, for it is the shepherds who own not only the goats but also the village rifles.

The chief factor in the destruction of the forests has been the demand for fuel; but preservation is linked with the economic betterment of the people. A man blamed for cutting good, bearing olive trees said, "What am I to do? I have a large family and absolutely nothing with which to provide them with food, but the immediate value of these trees".

Wood is cut for many purposes besides domestic burning—for charcoal burning, for firing of bakeries and lime kilns. That these can be brought under control has been shown by the example of Cyprus. Oil is the alternative to wood, but for domestic use oil alone is of little value. The production of a really cheap crude-oil stove would be a major step towards the prevention of soil erosion. The solar stove, which cooks by the sun's rays, is considered to be a possible answer to the problem, but so far its cost has been prohibitive.

The fauna study group, working under the chairmanship of Prof. C. Kosswig, of Istanbul, were told how the recent killing of pelicans on Lake Marmara has resulted in such competition for food among young carp that their growth has been retarded and none has reached full size. A very interesting report came from Cyprus, where natural regeneration of the forests of *Pinus nigra*, confined to altitudes above four thousand feet, has failed. In spring, when the warm khamsin wind blows, the cones open and discharge their seeds, which, clearly visible on the snow, are eaten by hordes of migratory finches. Possibly destruction of hawks, which controlled the number of finches, has led to the failure of the natural regeneration of the pines.

Egyptian scientists directed attention to the dangers inherent in the excessive use of poison sprays and insisted that nature reserves should contain as many kinds of habitat as possible, including ponds for the protection of water insects. They recommended special protection for the desert monitor and the four large lizards of the genus *Uromastix*, the only herbivorous lizards; these are in danger of extermination because they are being used in laboratory work, for which smaller lizards would do equally well. Stress was laid on the importance of instruction in the mosques, for the fellaheen are very responsive and have great faith in their religious teachers.

Among the recommendations of the fauna group was that a questionnaire should be sent to appropriate schools in Turkey, to discover the status of the rare monk seal, which still appears every year on the coasts. Similar methods in other cases have produced good results. An investigation into the status of the rock hyrax in Lebanon, with the view of its preservation, was also suggested. Many mammals were recommended for protection—for example, the leopard, lynx and jungle cat in Turkey and the wild ass and addax in Egypt, where they still exist on the Sudan border. Reserves for wild life were recommended at Kammouha in the Lebanon, in the province of Lattakia in Syria and at Wadi-el-Natroun and Wadi-el-Assioti in Egypt.

All governments were advised to safeguard rivers against pollution. Though rivers in this part of the world may not yet have been affected, it is a danger to be guarded against as industrialization progresses. Destruction of fish by poison and explosives will ever be stopped until fish wardens are appointed nd the public instructed in conservation.

During a visit to the best-known group of cedars in ebanon, it appears that grazing in their vicinity has een stopped; nevertheless, there was little sign of egeneration, prevented perhaps by human trampling. The conference was shown research work at the ranco-Lebanese agricultural college at Ryak and, n the coast, research into the fixation of sand-dunes y grasses backed by plantation of the umbrella pine, *Pinus pinea*.

A full report of the conference will be prepared by he Unesco Middle East Science Co-operation Office, nd suggestions for the implementation of the esolutions sent to appropriate bodies.

C. L. BOYLE

PROGRESS OF CANCER RESEARCH

THE investigations under way at the research centres financed by the British Empire Cancer Campaign are described in its thirty-first annual report*; incidentally, it may be remarked that the Campaign's income in 1953 was £350,000, which is about the cost of one air liner.

The different lines of work surveyed in the report can be grouped into those dealing with: (*a*) carcinogenesis, cytotoxins, nucleoproteins (in the laboratory light-heartedly referred to as 'secret-of-life studies'), tissue culture and immunology; (*b*) radiotherapeutics and radiobiology; (*c*) clinico-pathology.

The explanation for the ominous increase in lung cancer in the past two or three decades continues to be the principal theme of general interest in cancer research.

Emphasis has now shifted slightly from cigarette smoking as a very important factor in the causation of the disease to the influence of atmospheric pollution. This does not mean that experiments on the tobacco factor have ceased; far from it, for at several laboratories mechanical smoking installations have been set up with the aim of obtaining in quantity the components of tobacco smoke and testing them on animals. One of the main problems is, of course, to find an experimental tissue with the same sensitivity as human lung.

Tobacco extracts reinforced by croton oil have failed to induce tumours when applied to mouse skin. The complementary experiment when the extracts were tested as possible co-carcinogen for dimethylbenzanthracene also gave negative results.

The inhalation of carcinogen-loaded charcoal has not induced lung cancer in a single mouse of eighty-five which survived a minimum of six months, although the same charcoal suspension was actively tumour inducing when injected subcutaneously. It is suggested that the negative result is due to the carcinogen not reaching the parenchyma but being rapidly removed from the bronchial tree. This explanation could be confirmed by the fluorescence microscopy of frozen sections.

At the Glasgow centre it was found that application of crude oxidized nicotine to the skin of fourteen mixed-stock mice gave adenomata of the lung in seven of the animals. This remarkable result seems to have induced a hypercritical state in the investigators, Schontal and Head, for they say, "However, these results may not be significant, and should be repeated using a different strain of mice as well as other species of animal".

The part played by industrial and domestic smoke in the causation of lung cancer is discussed in Sir Ernest Kennaway's review of atmospheric pollution in Iceland, Britain and Norway.

"Great Britain has stores of coal and iron which have been the source of vast wealth, and of many other consequences. Iceland, which has no such resources, and has not even abundance of any kind of fuel except peat, has a history, and a degree of civilization which all other countries must admire, without industrialization or poverty as we understand these things in many countries of Europe and America. Hence data from a country such as Iceland are of great value for comparative purposes. The Industrial Revolution which in the earlier part of the 19th century converted England, by the utilization of coal and iron, from an agricultural to an industrial country, caused an enormous increase in atmospheric pollution. Obviously this factor cannot, by itself, account for the sudden increase of deaths attributed to cancer of the lungs which occurred a century later, in the 1920's, when the output of smoke was declining. Recently the greater part of this increase, and the higher incidence of this form of cancer in towns, has been ascribed to tobacco, but a possible contributory effect of the suspended matter of town air cannot yet be excluded finally. Iceland provides the example of a country where bronchial cancer is rare, the general consumption of tobacco small, and atmospheric pollution quite unlike that in England, though the history of Reykjavik is rather confused in this respect, as was pointed out above. In the course of years such comparative studies may enable one to assess the importance of these two factors."

For comparison Sir Ernest quotes figures for smoke estimations in the three countries.

COMPARATIVE MEASUREMENTS OF ATMOSPHERIC POLLUTION

	Smoke, mean mgm. in 100 m.^{3} air
Sheffield	
February 1948: 3 foggy days	173
" " 25 other days	40
" 1949	44
Salford (Manchester)	
November 1952 to January 1953	76
Leicester	
Whole year	21·5
Oslo	
1953, February, March November	5·5
" April to July	1·7
Reykjavik	
1953, August, September	1·0
" October, November	1·6

The report goes on to say: "In the smoke papers from Salford the following polynuclear hydrocarbons have been identified, and some of these have been estimated quantitatively: anthracene, pyrene, fluoranthene, perylene, 1 : 2-benzpyrene, 3 : 4-benzpyrene, 1 : 12-benzperylene, anthanthrene and possibly an alkyl pyrene and 1 : 2-benzanthracene. The relative proportions of these hydrocarbons, e.g., the ratio pyrene : 3 : 4-benzpyrene, differ in various products of combustion and such comparisons provide an interesting subject for study".

Research at the London Hospital has given some startling results. Croton oil, the best-known cocarcinogen (or promotor), can induce tumours when it is painted on mouse skin, provided the skin has been pretreated by a sub-threshold painting with a carcinogen. It has now been shown that urethane, which is a potent inducer of lung tumour, but is ineffective on skin, can act as an initiator for this tissue, for if croton oil is applied to urethane-treated skin, tumours do in fact arise. These findings have important possibilities, for there is no obvious reason why the urethane–croton oil combination should be unique.

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* British Empire Cancer Campaign. Thirty-first Annual Report covering the Year 1953. Pp. xxxiv+468. (London: British Empire Cancer Campaign, 1954.)

At Leeds, Dmochowsky has found that the C_{57} black strain of mouse which is reputed to be non-susceptible to mammary cancer (incidence of the order of 1 per cent) has now developed a sub-line, the females of which are liable to this disease to the extent of 14 per cent; moreover, these mice now carry the viral milk factor.

The application of physics in the study of the cause and cure of cancer covers each year an ever-widening field, and while the same basic problems remain, they are being considered from an increasing number of directions. The varied use now being made of the fundamental principles involved in scintillation counting is a very good example of the application of new techniques to old problems. Dosimetry, which remains one of the perennial problems facing the medical physicist, is studied by means of probe-type scintillation dosimeters which are now in routine use for the measurement of the γ-radiation dosage-rate, and which are being modified at various centres for use with β-radiation sources and for the measurement of X-radiation. Various improvements in scintillation counters themselves are also reported, such as the increased sensitivity obtained in a collimated system with the use of a long, narrow crystal, the use of a double-probe unit coupled to a pen-recorder for measuring the rate of blood flow after the injection of sodium-24, and the technique of mixing the substance to be assayed with a liquid phosphor, such as one of the terphenyl-in-benzene type.

Radioactive isotopes have become an everyday aid in the study of a very large variety of problems, as well as a standard therapeutic procedure for many malignant conditions. The use of thulium-170 in radiographic work has been continued and a detailed study made of the physical characteristics of this isotope. The possibility of providing a method for the measurement of blood volume based on erythrocytes labelled with chromium-51 has been considered and work is proceeding on the estimation of the chromium-51 by means of its soft X-ray. Therapeutic procedures with radioactive isotopes still continue to receive careful attention as improvements and modifications of techniques are reported from various centres. The increasing use of cobalt-60 beam therapy units has led to studies of the quality of the radiation from the beam in water phantoms and also of the effects due to the presence of bone in the field being irradiated. Comparisons are made of the calculated and measured doses obtained in a model in which bones were embedded in tissue-equivalent wax when irradiated with rays from a cobalt-60 source and with X-rays of half-value layer 1·5 mm. copper and 50 cm. focal skin distance. The question of protection from these and other sources of high-energy radiation is one of particular urgency, and studies are reported of the measurements of both the quantity and quality of the radiation dosage liable to be received by workers in these departments. Education of technical and nursing staff is of importance in this respect, and efforts are being made to reduce the dosage-levels received, by nursing staff in particular, by means of lectures and demonstrations.

Reports on studies of plant interphase nuclei by means of interference microscopy, of the study of the electrophoresis of non-spherical particles, and of the ionophoresis of radioactive phosphate ions, are examples of some of the more unusual applications of physics to biological problems.

The pathological contributions to the report are, as usual, very mixed, whether considered from the point of view of subject, mode of presentation, or value; but they include—also as usual—a number of items of more than ephemeral interest.

The systematic accumulation of data at Great Ormond Street Hospital, London, on the tumours of childhood continues its ponderous but invaluable course. Dr. M. Bodian writes something more like a section of a text-book than a report, but at least the text-book is a good one and one that needs writing. This year's chapters deal with the teratomata, the lymphomata, and the adrenal, cervical and vaginal carcinomata. A discussion of the pathology of sacral teratomata from the point of view of their management in practice, and the identification of the relatively benign paragranuloma in three of seventeen children with Hodgkin's disease are of particular interest. Apart from this, there is a most interesting account from the same centre of the use of vitamin B_{12} in the treatment of neuroblastoma. This was originally used on the hypothesis that it might promote the maturation of neuroblasts to ganglion cells, a process which occasionally results in the spontaneous arrest of these tumours. No direct support for the truth of this hypothesis has been obtained, but in four of eight cases remissions have been seen, and three of the children are alive and free from symptoms after substantial periods—three years in one case. Because of the occasional occurrence of the spontaneous arrest already referred to, these results must be accepted with some caution; but if they fulfil their promise they offer hope of cure of a rare but deadly tumour. Suggesting as they do also a completely new line of tumour chemotherapy, their theoretical interest is perhaps even greater than their practical value.

The demonstration of a significantly high frequency of group *A* blood among patients with cancer of the stomach by workers at the Postgraduate Medical School, London, has been put on a firmer basis by the inclusion of statistics from several other centres, data on some thousands of cases being now available. It has been found that peptic ulcer presents an opposite effect: among patients with that diagnosis, group *A* is significantly less common, and group *O* more common than in the general population. It is cogently suggested that both these effects may be related to the high content of polysaccharides specific for blood groups in the gastric mucins. No other tumours of those investigated (Sheffield workers contribute a negative study of carcinoma of the breast on these lines) has shown any comparable effect.

The subject of the diagnosis of cervical carcinoma by cytological examination of the vaginal fluid has become the field of much partisan argument. It has become necessary to determine, not so much whether the method is of value, as whether the very large expenditure of skilled man-hours which it calls for is justified by the results in any given circumstances. Two correlated attempts at evaluation, sponsored by the Royal College of Obstetricians and Gynæcologists, are here reported from Birmingham and Newcastle. Though both are in their early stages, they have provided some useful data and provoked some valuable comments. The experiment in Birmingham of leaving not only the work but also the whole responsibility of cytological diagnosis in the hands of a specially trained technician will be watched with special interest.

There is a brief account of a visit paid by Prof. J. W. Orr to Makerere College in Uganda and of the tumour material he saw there. The observations he was able to make in the time at his disposal on Kaposi sarcoma and primary carcinoma of the liver were not spectacular; but the pattern of visitation is one which should be more widely followed, and which the British Empire Cancer Campaign is in a uniquely favourable position to foster.

SEVENTEENTH-CENTURY CHEMISTRY, THE PHLOGISTON THEORY AND DALTON'S ATOMIC THEORY*

By Prof. J. R. PARTINGTON, M.B.E.

SOME important aspects of seventeenth-century chemistry are exemplified by the work of Van Helmont (1579–1644), Boyle (1627–91) and Mayow (1641–79). Van Helmont, a physician, held views on education in advance of his time, thinking that young men in universities should learn mathematics and the sciences, including chemistry with practical work. He criticized the theory of the four elements and also the alchemical three elements, salt, sulphur and mercury, believing that air and water are the true elements; fire never forms part of a material body and earth can be formed from water, as he tried to prove by experiment. He made chemical experiments using the balance, and showed that a metal dissolved in an acid or converted into a compound is not destroyed but can be recovered again with the same weight and properties as before. The products of distillation do not exist as such in bodies, but are formed by the action of heat. Van Helmont coined the name 'gas' and recognized the existence of different gases, such as carbon dioxide ("gas sylvestre"), nitric oxide and sulphur dioxide. He thought that a gas cannot be retained in a vessel, since a sealed vessel containing materials generating gas is burst. Although a gas as such is not retainable by bodies, some bodies contain gas in a fixed form, and it can be separated from them by heat, fermentation or acids. Van Helmont represents the transition from alchemy to chemistry, and used the quantitative method.

Boyle was well acquainted with the writings of Van Helmont, whom he greatly respected. Like him, he retained some old ideas on superstitious remedies, comparing their action with that of a magnet on iron. In his "Sceptical Chymist" (1661) Boyle repeated and extended Van Helmont's criticism of the four elements and three principles, and confirmed many of his experiments. Both believed in the possibility of the transmutation of metals. Boyle was the first (1660) to collect gases (hydrogen and nitric oxide); he investigated the effect of pressure on air, discovering Boyle's law, and made many experiments in the vacuum of an air-pump. His experiments on combustion and respiration were made in dry vessels; he found little or no change of pressure or "elasticity" of air, taking this to be its most distinctive property.

Boyle attempted to rid chemistry of mysticism by using the ideas of rational mechanics in explaining chemical phenomena, and by the use of the atomic (or "corpuscular") hypothesis, which he took from Gassend, and of the ideas of Descartes, he interpreted physical and chemical changes in terms of the shapes and motions of the particles of bodies; acids have pointed particles, and air particles behave towards pressure like coiled springs.

In experiments on combustion Boyle found that gunpowder will burn under water or (with difficulty) in a vacuum, and hence he suspected that air contains some vital substance which may be a volatile nitre and which supports combustion and respiration. He thought nitre crystals might contain admixed air, although he admitted that, on heating, nitre may evolve vapours which "emulate air". Since combustion and respiration cause very little change of pressure of air in dry vessels, Boyle thought there was very little of this "fine subject" in the air.

In his experiments on the calcination of metals in air in sealed retorts (1673), Boyle was misled by his method of working, since he opened the retort before weighing (when air enters to take the place of that absorbed by the metal), and he concluded that the increase in weight is due to the fixation of ponderable fire particles in the metal. From his experiments on respiration (1672), he concluded that the burning of flames and the breathing of animals might remove the same substance from the air, but he gave other alternatives: they might remove different substances, since a flame is extinguished while an animal is still alive. His conclusions were (as usual with him) presented with great caution.

More definite conclusions were drawn from such experiments by Hooke and Mayow. Hooke ("Micrographia", 1665) suggested, without any new experiments, that air and nitre contain a common constituent, nitre more plentifully, and that a burning body dissolves in air, producing heat, as when metals dissolve in acids. It was not until 1682 that Hooke called the common constituent of air and nitre "nitrous air" (a name used by John French in 1651), and proposed a theory of combustion similar to that given by Mayow in 1674. Hooke, who otherwise claimed discoveries published by others which he thought belonged to him, did not feel that Mayow had taken anything from him, and the two were friends. It seems, in fact, that the theories of Hooke and Mayow were different, Hooke regarding combustion as a passive solution of a body in air, and Mayow as a violent collision and interaction of combustible particles and particles in the air which he called "igneo-aerial particles", "nitro-aerial particles" or "nitro-aerial spirit" (a name used by Scaliger in 1557). These particles, Mayow suggested, are contained in the nitric acid part of nitre, which derived them from the air.

Mayow was a highly ingenious experimenter, devising new apparatus for manipulating gases and in studying combustion and respiration, which he investigated in the presence of water and hence found a decrease in volume or pressure, not noticed by Boyle. He supposed that air contains two kinds of particles, one (the nitro-aerial particles) removed in combustion and respiration, and he explained the change of volume or pressure by an ingenious theory based on the views of Descartes and Boyle of the corpuscular structure of air. He explained the increase in weight of antimony on calcination as due to the fixation in the metal of nitro-aerial particles from the atmosphere. In respiration, he assumed, these particles enter the blood from air in the lungs, and animal heat is due to their interaction with combustible particles in the blood, this taking place in part in the muscles and being the cause of muscular motion. In these three processes, the nitro-aerial spirit plays the part of oxygen. Mayow's explanations were often artificial, since they were conceived in terms of the prevailing views of Descartes, which were also used by Boyle. Newton's "Principia" was not published until thirteen years after Mayow's "Tractatus quinque" (Oxford, 1674). Newton's chemical ideas in his "Optiks" (1717) are similar to Mayow's. Mayow's views on chemical affinity are very correct and anticipated those of Geoffroy (1718) and Berthollet (1801). The very severe criticism of Mayow by T. S. Patterson (1931) was exaggerated and incorrect in detail. Mayow's dependence on Descartes was overlooked, the originality of his experiments was not appreciated, and Mayow's supposed dependence on Boyle, Hooke, Lower and Thruston was based on ignorance of earlier work. The correct parts of Patterson's criticisms had been, unknown to him, anticipated by Jonathan Stokes in 1800. Indeed, a new study of Mayow, having due regard to the facts, is needed.

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* Substance of a course of three lectures delivered in the University of London on May 5, 7 and 10.

The phlogiston theory is a complicated and difficult subject. The name "phlogiston" for a supposed material constituent of combustibles was used by Hapelius (1606), Van Helmont, Sennert and Boyle before Stahl, starting from some ideas of Becher (1669), proposed (first in 1697) what is called the old phlogiston theory. This was soon accepted and, combined with the replacement of Descartes's ideas by those of Newton, caused neglect of the more correct views of Boyle, Hooke and Mayow. The theory assumed that phlogiston is the material of fire, not fire itself; it is a dry earthy substance, soot being nearly pure phlogiston, although phlogiston was also supposed to escape in invisible particles from a burning body. It exists in animal, vegetable and mineral bodies, is the same in all, and can be transferred from one body to another. A metal is a compound of its ash (or "calx") and phlogiston; on heating in air the metal loses phlogiston, and on heating the calx with a body rich in phlogiston the metal is formed again. Sulphur is a compound of sulphuric acid and phlogiston; and all acids are modifications of sulphuric acid, the universal acid. Phlogiston is the cause of odour and colour.

Stahl's theory inverted the true theory of combustion and calcination and neglected quantitative aspects; although Stahl knew that the calx weighed more than the metal, he did not explain this, beyond saying that phlogiston is a weightless matter which when it enters bodies makes them lighter. The theory combined many isolated facts into a comprehensive body of false doctrine, made them easier to remember, and was very popular until towards the end of the eighteenth century.

As new facts accumulated the phlogiston theory underwent many modifications, including the views that phlogiston is hydrogen (Cavendish, 1766) or the matter of light (Macquer, 1749). The theory suggested new experiments: Scheele's discovery of oxygen 1772) was based on it, and Cavendish explained the synthesis of water (1784) in terms of it. Attempts to explain the increase in weight on calcination of a metal included the assumptions that phlogiston was lighter than air, or even that it had an absolute negative weight.

Lavoisier's theory of combustion was that oxygen gas is a compound of a base and the matter of heat or "caloric", an imponderable fluid which in some respects played the part of phlogiston. A burning body combines with the oxygen base and sets free the caloric as heat and light. This theory was seen to be unsatisfactory, since heat and light are evolved in the combination of solids as well as gases, and several modifications of it were proposed. In one, the combustible was assumed to be a compound of a base and phlogiston, and oxygen gas a compound of a base and caloric. The two bases combine to form an oxide, and the phlogiston and caloric combine to form light. It was only after the introduction of the theory of energy, about 1850, that a chemical explanation of the formation of heat and light in combustion was felt to be unnecessary, and the process was interpreted in a manner reminiscent of Mayow's theory—namely, as due to the collision of particles of the combustible and of oxygen.

Dalton's atomic theory was the first to make successful use of the old Greek theory of atoms in chemistry. The old theory had been used quite extensively in the seventeenth and eighteenth centuries by Gassend, Sennert, Magnenus, Boyle, Mayow and Newton. Newton's treatment of the physical nature of air, as consisting of particles repelling each other with a force inversely proportional to the distance (which gave Boyle's law), needed modification when air was recognized (as Mayow had seen) as containing two kinds of particles, and when different gases were discovered late in the eighteenth century and it was shown that two gases (ammonia and hydrochloric acid) combine to form a solid. Bryan Higgins (1776) supposed that gaseous particles are surrounded by mutually repelling atmospheres of caloric, and explained the formation of compounds $A+B$ of the atoms of two different gases. William Higgins, in his "A Comparative View of the Phlogistic and Antiphlogistic Theories" (1789), explained the formation of compounds of one atom of A with one, two, three, four or five atoms of B in terms of a force of attraction which divided itself among the combining particles. Although the law of multiple proportions may be read into his speculations, if Higgins supposed that the atoms of different elements have different weights, he expressed it so obscurely that authorities cannot agree on the matter.

John Dalton (1766–1844), born in Cumberland of a Quaker family and almost self-taught, became a schoolmaster in Kendal, where he wrote his "Meteorological Observations and Essays" (1793), containing the germs of his later discoveries. In 1793 he moved to New College, Manchester, as tutor, resigning in 1799, and thereafter supported himself by private tuition and consulting work. In his book, Dalton had proposed the new view that water vapour in the atmosphere is not chemically combined but mixed with the other gases. In developing this idea in 1801, he discovered his law of partial pressures, which he expressed in terms of Newton's theory by saying that particles of any one gas in a mixture repel one another but not the particles of other gases. He regarded the gaseous particles as surrounded by repelling atmospheres of caloric, and to explain gaseous diffusion he supposed that the atmospheres differed in size in different gases. From this view, in the autumn of

1803, he came upon the idea that atoms of different elements have different weights, and he probably presented the first table of atomic weights in a lecture in 1803 to the Manchester Literary and Philosophical Society, which was published in 1805. All the details of Dalton's chemical atomic theory are given, explicitly or implicitly, in an entry in his note-book on September 6, 1803 (his birthday), and he held these unchanged until the end of his life. Dalton calculated the atomic weights from the quantitative compositions of compounds and assumptions about the numbers of atoms of the elements in a particle of a compound. The numbers were not accurate, but they were based on analyses by well-known contemporary chemists, not by Dalton. He later said that he would publish only what he had confirmed, since he had often been misled, a statement which has erroneously been said to imply conceit on his part; there are, in fact, many assertions about Dalton based largely on ignorance.

The first printed statement of Dalton's atomic theory is that in the "System of Chemistry" (1807) of Thomas Thomson, who visited Dalton in 1804 and found him analysing marsh gas and ethylene, and Thomson afterwards said that Dalton's atomic theory was evolved to explain the results, which indicated a law of multiple proportions. The theory had, in fact, been arrived at in 1803. In 1808 Dalton gave a brief account of the theory in his "New System of Chemical Philosophy", with a table of atomic weights and plates of chemical symbols. He also gave some "general rules" for arriving at the numbers of the atoms of the elements A and B in a "compound atom" of a compound. If only one compound is known, it is $A+B$; if there are two compounds they are $A+B$ and $2A+B$ or $A+2B$, etc. Dalton had concluded from the combining volumes that equal volumes of gases cannot contain the same number of atoms (which is correct); but he did not consider the possibility that the particles of elementary gases may contain two or more atoms, and Avogadro's hypothesis (1811) was not used by chemists until Cannizzaro (1858) directed attention to it—it enables the numbers of atoms in a molecule of a compound to be found, and hence the atomic weights may be determined without ambiguity.

Dalton's atomic theory, it will be seen, differed in important respects from the modern theory, but it laid an enduring foundation for future progress. In addition to it, Dalton made important discoveries in chemistry and physics both before and after announcing his atomic theory. His work on the uniform expansion of gases by heat, on vapour pressures, on the law of partial pressures, and on gaseous diffusion was done in an early period (1800–04); later, important work was on the incomplete combustion of hydrocarbons (1805), on the volumes of solutions, and on the composition of the atmosphere at high altitudes, which he found nearly the same as at sea-level, explaining the result as due to convection (a theory proposed again in recent times). He was a skilful and accurate gas analyst.

Dalton became internationally famous after his publications in 1801. He was a *correspondant* member of the Paris Academy of Sciences in 1816 and one of the eight foreign associates in 1830, a Fellow of the Royal Society in 1826, a D.C.L. of Oxford in 1832 and in the same year an LL.D. of Edinburgh. In 1833 he began to receive a Civil List pension. He died suddenly in his room in 1844 and was buried in Manchester with civic honours. Dalton was greatly liked and respected by his contemporaries, his two main characteristics being his constant truthfulness and his great originality, both of which are quite incompatible with the assertion of Higgins in 1814 that Dalton arrived at his atomic theory by reading Higgins's book of 1789. There is no evidence that Dalton owed anything to his predecessors except Newton; this charge originated with Higgins alone, and if it has afterwards been repeated, it has always been withdrawn.

OBITUARIES

Prof. F. E. Fritsch, F.R.S.

F. E. Fritsch, emeritus professor of botany in the University of London, died on May 23 at the age of seventy-five. Of German descent, but born in London, he became truly English, though in his remarkable thoroughness and the solidity of his literary work he betrayed mental features held to be characteristic of German scholars. Asked how he managed to make fewer mistakes in his quotations and references than almost anybody else, he answered: "I am very slow though". This reply indicates how much time and trouble he devoted to every task he undertook.

Prof. Fritsch was head of the Department of Botany in Queen Mary College (University of London) during 1911–48. He began his academic career as assistant in the Botanical Department of the University of Munich during 1899–1901, then lectured in University, Birkbeck and East London (Queen Mary) Colleges of the University of London before taking the chair at Queen Mary College. He was president of Section K (Botany) of the British Association in 1927, president of the Linnean Society during 1949–52 and chairman of the Council of the Freshwater Biological Association of the British Empire.

Fritsch's inclination and gifts were more like those of a philologist commenting on ancient texts, and drawing careful conclusions from them, than those of a biologist who puts, by experimental means, his questions to Nature itself. But in his own investigations he was as painstaking and accurate as possible.

Since he came to be interested in morphology, the immense variation in the shaping of the Algae became, in his later years, his main attraction. There was scarcely ever a person who knew so much about them, and his life's work, "The Structure and Reproduction of the Algae", could not have been written by anybody else with the same degree of comprehension and authority.

Frail in body but strong in mind, Fritsch was a personality not to be overlooked in any assembly, and it is not surprising that he was often made a chairman by his colleagues. People used to look up to him, although he was small in stature.

Fritsch was asked for advice by numerous people who knew of his reputation as a most reliable man, and he did not spare himself, but he always kept his superiority. So long as this remained untouched, he could be the friendliest, most considerate and helpful man. He was a great talker, critical but benevolent, and resourceful in council.

Since his teaching, literary work and many dignities, combined with travelling—sleeping away from home and working in the train—eventually took most of his time and energy, gardening and music which had been his favourite spare-time occupations were gradually given up, but he did not rest much until near the end of his long life.

Fritsch's publications will remain standard works for some time to come. He himself will be missed by many as a strong supporter of order, prudence and loyalty. E. G. Pringsheim

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The botanical world, and more especially the phycological section of it, has suffered grievous loss in the passing of Prof. Fritsch. Few men have attained the degree of eminence to which, despite physical frailty, his intellectual power, human wisdom and qualities of leadership raised him.

His primary interest was in the freshwater algae, in the study of which he made notable contributions to knowledge; but his interests were wide, and in the related field of marine phycology, his encyclopædic knowledge and sound judgment made him one to whom research workers in Great Britain and overseas turned inevitably for opinion and guidance. Help was always given freely and generously. He had that faculty of detached consideration of other people's problems that is not only invaluable but is also heart-warming and stimulating.

Prof. Fritsch's work, whether designed for the needs of elementary students or research workers, was always characterized by meticulous accuracy and a wealth of detailed information. The two volumes, "The Structure and Reproduction of the Algae", must remain as classic for all time; the completeness of the bibliography would alone ensure their permanent value, and that, coupled with the breadth and precision of the text, establishes the volumes as a *vade mecum* for all phycologists.

Though valuable scientific contributions, remarkable both in quantity and quality, earned for Prof. Fritsch both respect and admiration, his delightful human qualities also drew forth affection. It was a privilege to be associated with him for more than thirty-five years, and to have received from him an early training in university examining, in which his breadth of scholarship, fair-mindedness—especially to those less gifted than himself in graceful expression—provided an example to be remembered and followed.

Prof. Fritsch found great relaxation in music, and many of his friends will cherish memories of delightful week-ends at his home in Surrey where he and Mrs. Fritsch dispensed gracious hospitality. At the outbreak of the Second World War, Prof. Fritsch moved to Cambridge, where his home became again a social centre and focal point for botanists, from Great Britain and overseas. He faced the problems of war, as indeed he faced all other difficulties, with calmness, merely taking every possible precaution to safeguard scientific material and then going on quietly with his work, adding still further to scientific knowledge. It is regrettable that he himself will not see the publication of his current work on the calcareous algae.

Those who were privileged to be admitted to the friendship of Prof. Fritsch will be glad to express personal gratitude for unstinted and generous encouragement and to join with vast numbers of those who knew him in extending their sympathy to Mrs. Fritsch and her son. She must surely find some measure of comfort and pride in the knowledge of the sincere esteem and affection in which her husband was held by scientists all over the world.

Margery Knight
Lily Newton

Dr. Malcolm Burr

Dr. Malcolm Burr, whose death at the age of seventy-six, due to an accident, occurred on July 13 in Istanbul, was a most colourful figure. A mining engineer by training, he took part in the development of the Kent coalfield at the beginning of this century, prospected for coal in Angola and visited the Lena goldfields and manganese mines in the Caucasus between the two World Wars, not to mention many other professional tasks. His main scientific interest in life, however, was entomology, and even as a schoolboy he specialized in Orthoptera and Dermaptera. When only twenty years old, he visited Vienna and, under the stimulus of Dr. Brunner von Wattenwyl, produced a revision of the genus *Acrida*. A long series of articles on the systematics of other Orthoptera followed, as well as a monograph of the family Eumasticidae, the first of this group. His principal contribution was to the study of the Dermaptera, which he was the first to classify on the basis of the structure of the copulatory organs, and on which he published a classical revision in Wytsman's "Genera Insectorum", as well as a volume in the "Fauna of British India", apart from very numerous journal papers. Dr. Burr's valuable collection of world Dermaptera, containing many type-specimens, has been presented by him to the British Museum and his rich collection of European Orthoptera, including many collected by himself, to the Hope Museum, University of Oxford.

Financial misfortunes and a restless character made it impossible for Burr to settle down, and in his old age he became a journalist, author of delightful travel and natural history books and finally professor of English at Istanbul. One of his most remarkable abilities was the gift of learning languages—he spoke fluently all the European ones, including several Slavonic. His last letter to me, dated July 2, 1954, full of entomological inquiries, was written in a vivid, if not strictly grammatical, Russian, a language which he never attempted to learn, but merely 'picked up' during his visits to Russia more than thirty years ago and never forgot.

The Royal Entomological Society of London has lost in Dr. Burr one of its oldest Fellows, elected in 1896. Apart from his many publications, he rendered an important service to entomology by having been one of the active group which founded the International Entomological Congresses and the honorary secretary of their permanent executive committee until 1920. B. P. Uvarov

Dr. R. W. Pocock

Dr. Roy Woodhouse Pocock, formerly a district geologist of the Geological Survey of Great Britain and a member of its staff for thirty-six years, died suddenly on June 22, while on holiday in Brussels.

Pocock was born in 1887 and, after leaving school, he became an assistant in the Geological Department of the British Museum (Natural History), in the meanwhile working for an honours B.Sc. degree at evening classes at Birkbeck College, London. During this time he began an investigation of the Silurian inlier of Woolhope, Herefordshire, and discovered there a thin limestone largely composed of the remains of the crinoid *Petalocrinus*, previously known only from the Niagara Limestone of North America and the Silurian beds of Gotland. He presented specimens from Woolhope to the British Museum

(Natural History) in 1911; but his work on the "*Petalocrinus* Limestone" was not published until 1930, in the *Quarterly Journal of the Geological Society of London*.

Pocock was appointed to the Geological Survey in 1912 and for about two years was assigned to work in Hertfordshire. During the First World War he was one of three members of the Geological Survey staff selected to go to the Eastern Mediterranean to advise on problems of water supply for the Army. On his return to England he received a commission in the Royal Garrison Artillery.

After the First World War, until his promotion to be district geologist in 1937, Pocock took part in the surveying of six one-inch sheets covering areas in Shropshire, Staffordshire and Worcestershire, and was principal or part author of the corresponding memoirs. His work in the western part of the Coalbrookdale Coalfield led to his contributing to the "Summary of Progress of the Geological Survey" for 1925 a paper on "The Basalt of Little Wenlock", in which he demonstrated the rock to be a lava of Lower Carboniferous age. Pocock extended his investigations to basalts among Upper Carboniferous sediments in the Midlands and, in a paper published in the *Quarterly Journal of the Geological Society* in 1931, concluded that all of them are of Carboniferous age and most of them of extrusive origin. The latter contention has not in all cases met with general acceptance. For his work on "The Age of the Midland Basalts", his *Petalocrinus* paper and other writings on the geology of the Welsh Borderland, Pocock was in 1932 granted the D.Sc. degree of the University of London (not an 'honorary' degree as has been stated elsewhere). His official work in Shropshire resulted also in his collaborating with E. S. Cobbold in a paper on "The Cambrian Area of Rushton, Shropshire", published in the *Philosophical Transactions of the Royal Society* in 1934.

On his promotion to be district geologist, Pocock took charge of the Bristol and South Wales District, and himself carried out mapping of rocks of Silurian and Old Red Sandstone age in the Chepstow Sheet. He retired from the Geological Survey in 1948.

Pocock was awarded the Lyell Fund of the Geological Society in 1932. He served on that Society's Council during 1937–42 and was a vice-president in 1941 and 1942. He was treasurer of the Geologists' Association during 1950–52.

T. H. WHITEHEAD

NEWS and VIEWS

Mathematics at the Imperial College of Science and Technology: Prof. H. Levy

PROF. H. LEVY joined the staff of the Mathematics Department of the Imperial College of Science and Technology, London, in 1920 from the Aerodynamics Division of the National Physical Laboratory. He was appointed professor in 1923, succeeded Prof. S. Chapman as head of the Department in 1946, and was also dean of the Royal College of Science from 1946 until 1952; he is due to retire this year after thirty-four years continuous service in South Kensington. In that time he has achieved much distinction; academically he has been the inspiration of a gradual and forceful revolution in the content and quality of the mathematics instruction and research at the College. He has never allowed himself to rest contented with his achievements, and continues still to work to keep the Department abreast of the rapidly changing demands of present-day science and technology. In the College he has been well known to generations of students in all departments. With an unfailing sense of humour, and a human sympathy, he is one of the most approachable of men and is never too busy to talk with anyone who desires his help. He has preserved an independence of outlook and possesses a remarkable facility of spontaneous and sensible expression which, when he leaves, will be missed by his colleagues on many boards and committees. For the time being, however, they are fortunate in that Prof. Levy has agreed to delay his retirement for six months.

Geography at Edinburgh: Dr. J. W. Watson

DR. JAMES WREFORD WATSON, chief geographer of Canada, has been appointed to the chair of geography in the University of Edinburgh in succession to the late Prof. A. G. Ogilvie. Born of missionary parents in China in 1915, Dr. Watson spent his early years in the Far East, but went to Edinburgh at the age of twelve to be educated at George Watson's College and the University, where he graduated with first-class honours in geography in 1936. After two years as lecturer at the University of Sheffield, he was invited to introduce the teaching of geography to McMaster University, Ontario, first as lecturer and later as professor (1945–51). During this period he took his Ph.D. at Toronto and was for a time visiting professor at the University of Florida. In 1949—being 'lent' for a time from McMaster—he was appointed the first chief geographer of Canada and director of the Geographical Branch of the Federal Government. In this capacity he has initiated and organized a great variety of geographical surveys, many of them in the Canadian Arctic. He has also been responsible for compiling and editing the new "National Atlas of Canada", to be published in 1955. Besides extensive travel in North America, he has a first-hand knowledge of many parts of South America, Greenland and several European countries. Although so much of his working life has been spent in administration and travel, and in the supervision of the researches of others, Dr. Watson has found time for a good deal of personal research, recorded in twenty-five papers, some of which are substantial studies in sociological, economic and historical geography, marked throughout by originality of approach and method and by clarity of expression and illustration. Early this year he received an Award of Merit from the Association of American Geographers for his "distinguished services in the establishment of a geographical office in the Canadian Government and for original contributions to the historical geography of settlement".

Chemicals in Food

AT the eighth annual general meeting of the British Food Manufacturing Industries Research Association, held on June 3, Sir Frank Engledow, in his presidential address, surveyed the problem of chemicals in food against the background of the fourth annual report of the Advisory Council on Scientific Policy, 1950–51 (Cmd. 8299; H.M.S.O.). This report states "that the risk to life and health due to the presence of toxic substances in consumer goods is probably small, but the rapid growth of chemical industry, and the needs of the food-processing industries for substances to replace scarce materials or for chemical substances which have a claim to use on their own merits as improvers of appearance, palatability or texture of manufactured foods, are accelerating the pace at which new chemical substances are being introduced into consumer products, and the machinery which exists for testing the possible harmful effects of these substances is inadequate". Sir Frank suggested that the food industries should searchingly examine their own attitude with the view of the formulation of a policy "constructively, not merely defensively". It is completely indefensible, he said, to attempt to offset the seriousness of the problem by comparisons with other hazards to health, such as those arising from atmospheric pollution and other causes; but the time is opportune for the preparation by industry of a reasoned case demonstrating the necessity of various methods of food preservation for different purposes, to make full use of seasonal crops, to allow for necessary delays in manufacturing processes and to ensure the distribution of world or national food supplies over wide areas. Such a statement might constitute a valuable contribution to public understanding and would help the industries to make sure that they are fully meeting their responsibilities by thoroughly probing all the complex issues. It is essential, Sir Frank continued, that all food firms should make full use of the whole of existing knowledge and take a scientific attitude to it; the British Food Manufacturing Industries Research Association can play a very important part and warrants the support of all firms in the industries concerned.

Legal Protection of Laboratory Animals Overseas

Some time ago, two scientists working in another country asked the Universities Federation for Animal Welfare (Great Britain) to suggest a form of legislation for the protection of laboratory animals which they might urge their own Government to adopt. In order to clarify the legal requirements, the Federation has drafted a summary of the Cruelty to Animals Act, 1876, and of the practices which have gradually come to be based upon it.

In Britain, the preparation of biological therapeutic substances for medical and veterinary use is controlled by statutes other than the 1876 Act; the animals involved are subject to inspection, and the Universities Federation for Animal Welfare considers this legal control and inspection important. The relevant British statutes are the Therapeutic Substances Act, 1925, and subsequent rules and orders, administered by the Ministry of Health, and the Diseases of Animals Act, 1950, and Diseases of Animals (Therapeutic Substances) Order, 1952, administered by the Ministry of Agriculture. The protection of all other laboratory animals is in the hands of the Home Office, which is equivalent to the Ministry of the Interior in most countries. The Federation considers that this is a good arrangement, since the Home Office is in a position to give an unbiased opinion when the claims of science have to be weighed against the welfare of laboratory animals. The Federation also considers that special breeding of all laboratory animals is desirable. In Britain many institutions breed their own animals, and a list of accredited breeders has been compiled by the Laboratory Animals Bureau, Medical Research Council, Holly Hill, Hampstead, London, N.W.3.

Ten-Tola Primary Standard Weight for Karachi Mint, Pakistan

L. Oertling, Ltd., have completed the manufacture for the Karachi Mint, Pakistan, of what is believed to be the first primary standard weight manufactured commercially in Britain since before the War. The weight is of iridium–platinum alloy and is a cylinder having a diameter equal to its height with a mass of 10 tolas (1,800 grains or about 117 gm.). The billet from which the weight was manufactured was forged by Johnson Matthey and Co., Ltd., Hatton Garden, London, E.C.1, and the production of such a billet to very close specific gravity limits reflects great credit upon their skill. The certification of the specific gravity and the accuracy of adjustment was carried out by the National Physical Laboratory, Teddington. A special pair of forceps, container and carrying case are provided. The manufacture and adjustment of a weight in the form of a solid cylinder to an accuracy of two parts in one million represents a skill of a very high order. Since it is impossible to make any adjustment to the weight should it become too light, the weighing and counter-weighing of the mass becomes extremely critical as the limits of adjustment are approached; this work was carried out in the Weight Department of Messrs. Oertling.

The British Civil Service, 1854–1954

At the suggestion of the Civil Service National Whitley Council, Mr. Wyn Griffith has written an excellent concise account of "The British Civil Service, 1854–1954" (pp. 32+4 plates. London: H.M.S.O., 1954; 1s. net) which has been published "at the direction of H.M. Treasury" on the occasion of the centenary of the publication of the Northcote–Trevelyan Report. In the broad perspective of this commemorative booklet, though the change in character and responsibilities of the Service are noted, the treatment of these aspects of special interest to the professional man, and particularly the scientific worker or technologist, is slight; nevertheless, the growth of the Scientific Civil Service is described as the outstanding development of recent years. Read with intelligence and reflexion, the booklet gives a clear enough guide to the real problems of the Civil Service to-day and the factors which determine its strength and weakness (see also p. 281 of this issue).

New Technical Bulletins on Rubber Research

The first of a series of technical bulletins to give information on new materials and processes resulting from the research and development work of the British Rubber Producers Research Association has just been issued by the British Rubber Development Board (Market Buildings, Mark Lane, London, E.C.3). The object of the bulletins is to provide factual information, particularly for the industrial technologist, on subjects which have reached a stage of more practical interest. They will therefore supplement to some extent publication of the Association's work in technical and scientific journals. "B.R.P.R.A. Technical Bulletin No. 1: Heveaplus M" is a well-produced, illustrated booklet (pp. 20; 1954) which describes various products obtained by treatment of hevea rubber latex with methyl methacrylate. These products are of much interest since they represent successful attempts to improve natural rubber and to confer on it some of the various advantages which have been claimed for speciality synthetic rubbers. 'Heveaplus MG' is a graft polymer obtained by polymerizing methyl methacrylate in rubber latex, while 'Heveaplus MM' is prepared by mixing a dispersion of polymethyl methacrylate with concentrated ammonia-preserved rubber latex followed by coagulating, washing and drying. In both types, a final number indicates the percentage of (poly) methyl methacrylate present in the product. Details of the chemical and physical properties, processing, vulcanization, reinforcing power, etc., of these interesting new materials are also given.

Properties of Materials at Low Temperatures

ANNEXE 1954–2 of the Bulletin of the International Institute of Refrigeration (177 Boulevard Malesherbes, Paris 17^e) records the proceedings of the meetings of Commissions 1 and 2 of the Institute held at Zurich in September 1953; the publication has just become available. Nineteen papers were presented and some of the topics discussed are indicated below. A paper by Long and Simon describes a helium liquefier constructed with an elastic metallic bellows in place of the conventional cylinder and piston. Van Itterbeek describes an adaptation of the Collins liquid helium cryostat to a closed cycle so that the same quantity of helium gas is circulating and the loss reduced to a minimum. An apparatus which permits of the liquefaction of hydrogen and helium in the same unit is described by Spoendlin, and Myncke describes a liquid-air plant with propane precooling circuit. Wucherer reviews the development of expansion turbines for low temperatures and quotes figures for the high efficiency attainable. Heat-transfer calculations for a cross-flow regenerator are given by Hausen. Four papers deal with the low-temperature properties of metals: the mechanical properties of ferritic steels at −196° C., by Allen; the effects of low temperatures on some engineering properties of metals, by Oliver; the thermal conductivities of metals below room temperatures, by Powell; and strength of aluminium crystals at low temperatures, by Eder. Two papers deal with thermal insulation problems: one on the thermal conductivity of porous materials containing air under reduced pressure, by Paemel; and a note on the thermal conductivity of moist cork, by Hatton and Zaki. A survey of the field of work of Commission 2, which has for its terms of reference the study of heat transfer, insulating materials, instrumentation, and thermal properties of materials, was given by Griffiths. The next joint meetings of Commissions 1 and 2 will take place at Grenoble on September 24 and 25 of this year.

Constants of the Stellar Velocity Ellipsoid

WHEREAS previous derivations of the constants of the velocity ellipsoid of stars have been based on the radial velocities of the brighter stars, in a paper by D. G. Ewart (*Mon. Not. Roy. Astro. Soc.*, 113, 5; 1953) the derivation is based on the radial velocities of 820 stars the *HD* photographic magnitudes of which range from 8·5 to 8·6 and the spectral types of which are *F–M*. The calculations were simplified by using large regions of the sky, which was divided into thirty-four areas, according to galactic latitude, and antipodal areas were combined to give seventeen regions over one hemisphere. The final results for the solar motion were: $U = 20 \cdot 36$ km./sec.; $A = 275° \ 07'$; $D = + 40° \ 44'$; $G = 35° \ 53'$; $g = + 21° \ 18'$, with a K term of $- 0 \cdot 22$ km./sec. The mean results previously obtained by Moore and Paddock were: $U = 22 \cdot 44$ km./sec.; $A = 280°$; $D = + 44° \ 30'$, from which it appears that the high value of the declination of the solar apex obtained by Moore and Paddock is partly confirmed by Ewart's work. It is suggested, however, that as the stars used in earlier work on radial velocities were generally brighter than the sixth apparent magnitude—very much brighter than those used in the present investigation—there may be a magnitude variation in the solar motion.

The same division of the sky was used for the determination of the constants of the velocity ellipsoid, and a table shows the values obtained for $1/K$, $1/H$, K/H and G_s for the different zones; but it is pointed out that the only result to which any significance can be attached is that for all stars. In this case the values are 37·24, 25·80, 0·693 and 321° 44′ ± 3° 31′, respectively, one main feature of which is that the ratio $K/H = 0 \cdot 693$ is well defined and agrees closely with proper-motion results. Delhaye's figures, published in 1952, obtained by analysing the proper motions of faint stars in the Boss General Catalogue, indicated that the phenomenon of the deviation of the vertex is confined to the nearest stars and is not exhibited by the fainter and more distant stars, and it is significant that in Ewart's investigation the deviation of the vertex is barely evident. It is suggested that there should be further examination for a possible variation of the declination of the solar apex with apparent magnitude, and also for the dependence of the deviation of the vertex on the distances of the stars used in its determination.

Radioactive Tobacco Mosaic Virus

F. L. WYND has reported on the preparation of radioactive tobacco mosaic virus (*Lloydia*, 16, No. 4, 233; 1953) by growing young tobacco plants in hydroponic culture low in phosphate for three weeks. Radioactive phosphorus in the form of orthophosphoric acid was then added to the nutrient solutions and seven days later each plant was inoculated with the disease by rubbing the lower leaf with liquid obtained from macerated diseased leaves. Sixty-two days after inoculation, the plants were harvested and the virus recovered by differential ultracentrifugation. A purified virus suspension was obtained exhibiting a radioactivity of 2·54 μc./mgm. of virus phosphorus. This activity was significantly greater than those reported by previous investigators. The probable purity of the recovered virus was evidenced by electron photographs. The high radioactivity of the purified virus should permit its use in further studies of certain aspects of the physiology and biochemistry of this virus disease.

The Council for the Preservation of Rural England

THE twenty-eighth annual report of the Council for the Preservation of Rural England quotes an example from Sheffield to illustrate the need for constant vigilance in seeing that land scheduled as 'green belt' in local authorities' development plans is not used for other purposes. The Sheffield and Peak District Branch of the Council is very concerned about possible encroachments on the Sheffield 'green belt' as envisaged in the City's Development Plan. At a public inquiry in July 1953 the Branch lodged certain objections and received an assurance that various farm lands left uncoloured on the map and designated as agricultural areas would not be interfered with and would continue, as shown in the development plan, in their existing use. Before the decision of the Minister of Town and Country Planning could be promulgated, and within less than seven months from the inquiry, the Branch reports that Sheffield City Council has adopted a resolution to change certain provisions in it and to allocate portions of this land for building, without formal amendment or a public hearing. It would appear, therefore, that 'unallocated' land in a development plan can be developed at any time. If this is not the case an official assurance to the contrary would be welcomed.

Numbers of Man and Animals

THE Institute of Biology is organizing a symposium under the general title "The Numbers of Man and Animals", to be held at the Royal Geographical Society, London, during September 24–25. The symposium is to be opened by Sir Alexander Carr-Saunders, and the first session will be concerned with the varied approaches of the economist, demographer and anthropologist, papers being given by A. T. Peacock, E. Grebenik and Prof. I. Schapera. The second session (chairman, Prof. C. H. Waddington) will begin with a study of the mathematical approach to population dynamics by Mr. J. G. Skellam. Dr. D. S. Lack, D. H. Chitty and Prof. T. Park (Chicago) will then deal with various aspects of the study of animal populations. The third session (chairman, Prof. J. Z. Young) will be concerned with the effects of disease, fertility and nutrition on the structure of populations. Papers are to be given by Dr. A. S. Parkes, Prof. A. L. Banks and Dr. J. Hammond. In the final session (chairman, Prof. S. Zuckerman) Dr. Fraser-Darling is to speak from the point of view of the ecologist, Prof. L. S. Penrose will discuss changes in the quality of human populations and Lord Boyd-Orr will comment on the future outlook. Copies of the various papers will be available some weeks before the meeting. Further information can be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Ninth Electronics Course at Harwell

APPLICATIONS are invited by the Atomic Energy Research Establishment, Harwell, from physicists and electronic engineers holding a degree or equivalent qualification, who wish to attend the ninth electronics course. The course covers the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry, and in work with radio-isotopes. It is to be held at the Isotope School, Harwell, during November 1–5. Attendance at the course is limited to 12 students. The syllabus will include lectures and practical work concerned with counters, D.C. and pulse amplifiers, coincidence units, scalers and ratemeters, and the lecturers and demonstrators will be specialists from the Atomic Energy Research Establishment. The fee for the course is twelve guineas, and living accommodation can be arranged locally at a charge of five guineas approximately. Further information can be obtained from the Electronics Division, A.E.R.E., Harwell, Didcot, Berks. Application forms must be returned by October 15.

Announcements

THE Royal Society of Arts has awarded the R. B. Bennett Empire Prize of 100 guineas for 1954 to Dr. C. J. Mackenzie, president of the Atomic Energy Control Board, Canada. The Prize was founded in 1945 by the late Viscount Bennett, a former president and chairman of council of the Royal Society of Arts, and is awarded every three years "for the most outstanding contribution from the Dominions, India, Burma and the Colonies, to the promotion of the arts, agriculture, industries and commerce of the overseas empire during each intervening period".

DR. A. FRÖHLICH, lecturer in the University College of North Staffordshire, has been appointed to the University readership in pure mathematics tenable at King's College, University of London.

THE annual conference of the Society of Leather Trades' Chemists will be held in the Large Chemistry Lecture Theatre, University of Leeds, during September 24–25. On the afternoon of the first day, the sixth Procter Memorial Lecture of the Society will be delivered by Prof. J. T. Randall, Wheatstone professor of physics, King's College, University of London, his subject being "Observations on the Collagen System". Further information can be obtained from the honorary secretary, G. H. W. Humphreys, Forestal Central Laboratories, Harpenden, Herts.

FROM August 18 until the end of the year, the Science Museum will be showing some of the most important books on astronomy which were published between the fifteenth and the middle of the nineteenth centuries. The exhibition will include copies of Newton's "Principia", Copernicus's "De Revolutionibus Orbis", as well as works of Tycho Brahe, Kepler, Halley and Herschel. The exhibition will include photographs of many of the illustrations in the books. The Royal Astronomical Society has lent a number of books from its library to supplement the Science Museum's own collection.

A COURSE on the measurement of the particle-size characteristics of fine powders will be given by Dr. H. E. Rose in the Faculty of Engineering, King's College, University of London, during the week commencing September 27. The course is primarily intended for graduates engaged in industry and will consist of a series of lectures, tutorials and demonstrations in the more common techniques for the determination of the size-characteristics of powdered materials in the sub-sieve range. The fee is five guineas. Forms of application should be returned not later than September 10, and further information can be obtained from the Dean of the Faculty of Engineering, King's College, London, W.C.2.

THE X-ray Analysis Group of the Institute of Physics will be holding its autumn conference during October 22–23 at the Royal Institution, Albemarle Street, London, W.1. The subjects to be dealt with at the conference will be the structure and texture of metals. There will be an evening discourse on October 22 by Prof. A. H. Cottrell on dislocations. The conference is open to all, without charge, on completion of an application form, copies of which can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

WE regret that Sir Harold Hartley's signature was inadvertently omitted from the obituary notice of Dr. O. J. R. Howarth published in *Nature* of August 7, p. 249, although it appeared in the list of "Contents".

SCIENCE IN THE MODERN WORLD

In a paper entitled "The Task before Us", read before the American Academy of Arts and Sciences at Boston on April 14[*], Dr. P. W. Bridgman examined the philosophy of the founding fathers of American democracy in the light of the scientific thought of this century. He suggested that we have forgotten to regard democracy as a growing thing, evolving to meet our changing conceptions of ourselves and our place in Nature. Anti-intellectualism, he said, might be a symptom of something more deep-seated, and the emphasis on a return to humanistic attitudes requires a revitalization of the humanities themselves in the light of our recent intellectual experiences. We need to assimilate into our whole intellectual outlook, and in particular into our relation to social problems, the lessons implicit in scientific experience. Considering first the changes in intellectual attitude forced on us by such experience, Dr. Bridgman said that a necessary mark of a liberally educated man is the realization that our thinking and intellectual processes in general cannot be taken for granted. When we think, we use intellectual tools, and these tools have properties and limitations. In particular, recent experience shows that when we push the application of many of our concepts into new fields, limitations appear which we could not have anticipated from anything in our former more limited common-sense experience. We have now come to expect that a concept inherited from our ancestors will not be applicable when pushed into fields hitherto unentered. Analogy suggests that the presumption is that such concepts as human rights or duties or responsibilities require modification when the environment in which they arose is altered, as it now is, by technological advances that bring all men over the whole world into immediate mutal relations.

Dr. Bridgman suggested that it is not a common idea that there are still regions in which the man of science is groping his way and knows that he has not yet found the answers. Failure to realize this is one reason for the impatience of people with the scientific point of view and for the urge to return to a more humanistic outlook. Among such unsolved problems, Dr. Bridgman gave as examples that of the 'observer' in quantum physics and the growing concern with the basic problem of what sort of thing a brain is. One of the results which is beginning to emerge from cybernetics is a realization of the extent to which our conscious activities have to be selected from the overwhelming number of potentialities. The problem becomes not to find the absolute truth but to find how to do the best we can with what we have. Moreover, in psychology the new approach to the nature of perception is forcing on us the simple realization that all our conscious thinking is done in terms of perceptions, and we are now asking whether in the domain of ordinary experience the mould of space and time into which perception pours our world is a good mould. Dr. Bridgman believes that our task is to find the present status, in the light of all the insights now available to us, of such fundamental concepts as human rights, freedom, equality, duty and justice, and in the light of these insights to strengthen if possible, or to revise if necessary, the conceptual foundation of our social and political system. This task will demand a long campaign of education and the slow development of new intellectual techniques by a process involving much trial and error.

Reviewing more concrete aspects of the situation, Dr. Bridgman believes that analysis of the processes in a democratic society will in this way lead us to a society in which the relation between society and the individual is based on mutual advantage and service. Only exceptionally will it involve honouring minimum claims on the community whether or not any return is made; but it will also involve a revision in the philosophy underlying the system of taxation. Finally, it will place emphasis on two virtues: the repugnance of the individual to exercise force against his neighbour for his own advantage, and the imagination that can sense the significance of the simple underlying processes and relations so easily lost to sight under the complexities of modern life—or, in other words, intelligence.

[*] The Task before Us. By P. W. Bridgman. *Proc. Amer. Acad. Arts Sci.*, 83, No. 3, ii+95–112 (1954). 50 cents.

THE OIL INDUSTRY

The oil industry is one which could be said to be less than a hundred years old, or more than two thousand.

It seems probable that it was an ingenious Chinaman who first drilled a hole into the earth's surface. He was in search of salt water and natural gas which he could use as the fuel to evaporate the water to yield salt. In the process he or his successors at times bored down to three thousand feet and incidentally struck oil. They had no use for the oil except as a lubricant (*Esso Magazine*, 3, No. 11; Spring, 1954).

The rig these Chinese devised is basically not unlike the cable rig used to-day; it sometimes took them ten years to drill a deep hole with their rigs.

Drake used the cable rig method when drilling the world's first commercial oil well in 1859. It was fortunate that he made his attempt in Pennsylvania rather than in Texas, because when the drillers got to Texas they encountered softer rock formations in which the simple cable rig was useless; the sides of the holes caved in as fast as the bits pounded through. As a result the rotary rig came into being; with this a hole is drilled through rock instead of being pounded through. A length of piping with a 'bit' on its end is gripped and rotated like a carpenter's drill. Mud, forced down the pipe, comes to the surface again in the space between pipe and hole, thus sealing off loose formations as the hole is drilled and bringing the cuttings to the surface. Two-thirds of wells sunk to-day are drilled by rotary rigs.

The drill pipe has greater precision than the cable for deeper holes; it also goes down straighter. This is important to-day, when wells are being drilled deeper every year.

During the Second World War there was not enough easily located shallow oil to keep industry and machines operating. New sources had to be found. The drillers' bits now probed the rock formations of the Eocene and Oligocene ages; soon wells were being drilled to 12,000 ft. To-day, in the United States alone, ninety-seven wells are being operated at depths below 15,000 ft., of which twenty-two were drilled last year.

Difficulties increase, and costs multiply, with greater depths. (A 15,000-ft. well is three times as expensive as one of 10,000 ft. It may cost anything up to £400,000 to drill.) The strains imposed on rigs at a depth of two or three miles are vastly greater than with more shallow wells. Derricks have to be of much heavier construction to take the weight of the drill pipe and to hoist it up out of the hole. The heat at 15,000 ft. seriously interferes with the effectiveness of the normal drilling muds. Bits wear out more quickly owing to the greater density and hardness of the deep rock formations. Pipe that is fully adequate to drill to 5,000 ft. will twist at double that depth and drill crooked holes. The recent use of diamond bits for deep-hole drilling has eased the problem.

The world's deepest well had reached 21,482 ft. a little time ago when it was halted by a core stuck at the bottom and the drill pipe stuck at 12,000 ft. The core will reveal whether the well has reached formations of the Oligocene age. If it is still in shales of the lower Myocene age, drilling may be discontinued—with no oil found.

One of the most interesting of recent developments has been the adoption of directional drilling, the process whereby the direction taken by the bit can be changed while drilling is in progress—or the well can be drilled from the start at a chosen angle from the vertical. By this technique it is possible to deflect a hole from an unproductive to a productive part of an area and so save the time and cost of drilling again from the top; the hole can be deflected around particularly hard and difficult underground formations; a fire at a well can be brought under control by drilling a slanted relief well into it; by the same means one can drill under the sea from dry land.

The angle of drift is effected by means of a tool called a whipstock; this is a 'cone' which is lowered into the hole base first with its apex pointing upwards. A drilling bit will always follow the line of least resistance and, when it encounters the apex of the cone, it is naturally deflected from its vertical path at an angle, the angle being dictated by the shape of the whipstock used. Normally, the full angle to which it is intended to deflect a hole is made by a series of whipstock operations, the drift being increased 2–3° every hundred feet until an average angle of 10–45° has been obtained. Directional drilling programmes have been known to achieve a drift of 80° to a vertical depth of 8,000 ft.

Drilling practice is never static. The direction of advance has been and will be towards the automatic rig. The most difficult task has always been the racking of the drill pipe as it comes out of the hole in sections of ninety feet or more. Steel arms at various heights have now been evolved to do this automatically. Unscrewing the pipe joints also taxes the strength of the operators. Chains on winches have been used for twisting the pipe, but power-driven 'tongs' have done this by the push of a lever. To speed drilling a jet bit has been produced.

The greatest depth at which oil has been discovered is 17,895 ft. It is hoped that much more will be discovered below 20,000 ft.

SELECTION OF SUPERVISORS

In June 1948, the National Institute of Industrial Psychology's Foremanship Research Group conducted an experimental selection procedure in a large heavy-engineering works in Scotland. Two different selections for promotion to supervisory positions were made from a field of 110 candidates, obtained by advertisement within the firm. The first selection was made by management by their customary method of review and nomination; in the second, from the same field, systematic methods were used, including biographical history sheets, recommendation forms, intelligence tests, interviews, group discussion sessions, and a final selection panel. The latter procedure was carried out by members of the management with the advice and assistance of a member of the staff of the National Institute of Industrial Psychology.

After two years a check was made and gradings by the selection panel for the 44 men regarded as worth serious consideration for promotion correlated $0 \cdot 68 \pm 0 \cdot 08$ with assessments made on these men by their managers two years after the original selection. This was an encouraging result in comparison with the poor prediction, $0 \cdot 23 \pm 0 \cdot 14$, obtained by management's normal procedure. Another check has now been made by J. D. Handyside and D. C. Duncan some four years and five months after the original selection experiment*.

Two criteria were available against which to assess the efficiency of selection: first, ratings by managers who were in a position to assess the performance of the men concerned; and, secondly, whether the men had been promoted twice, once, or not at all during the four and a half year period.

Management's customary method of selection consisted of short interviews by the candidates' managers and discussion among managers who could be expected to know the men reasonably well. The results of the experimental evaluation of this method indicated that it was defective to a startling degree.

It appears from this experiment that a combination of existing, fairly elementary, selection techniques permits prediction of supervisory success—as measured by management criteria—just about as well as the uncertainties of the criteria allow. Nevertheless, there is a need to improve the economic efficiency of the selection methods.

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* *Occupational Psychology*, **28**, No. 1; January 1954.

GULMARG RESEARCH OBSERVATORY

By Prof. P. S. Gill

Director of the Observatory and Head of the Department of Physics, Aligarh Muslim University

With the development of the subject of cosmic radiation the need for stations at various heights and in different parts of the world has become increasingly important. Previously, the high-altitude research stations were used for astronomical, astrophysical, meteorological and terrestrial magnetic measurements; but during recent years these stations have become mainly associated with the work in cosmic rays. In the Americas, a number of high-altitude research stations have been established through the efforts of cosmic-ray investigators, some of which—Mount Evans, Echo Lake, Climax, Mexico

City and Huancayo—are well known; in Europe, too, there are a number of stations, the best-known being the Jungfraujoch in the Alps.

Within the past fifteen years, cosmic-ray studies in India have been initiated in a number of institutions, and naturally the need for establishing a station at a height where it is convenient to work throughout the year has been felt. The Meteorological Department has a station at Kodaikanal (about 7,000 ft.) in southern India, close to the geomagnetic equator. The geographical position of India for the study of cosmic rays is of special importance, because one can go from the geomagnetic equator to about 25° N. within a narrow range of longitude. The effects of the earth's magnetic field are strongly felt in this part of the world, for the intensity of cosmic rays varies rapidly with geomagnetic latitude within the intermediate latitudes.

Aligarh Muslim University was one of the institutions in India where work on cosmic rays was initiated in 1949. The cosmic-ray group thought it necessary to establish a station in the Himalayas at a convenient height, and, after considering various sites, it was finally decided that such a station should be located at Gulmarg in Kashmir. The Government of Jammu and Kashmir provided ample facilities for the opening of this laboratory, and a formal agreement was signed with the Government in the year 1951. The observatory was officially opened this year on April 4 by Prof. A. H. Compton, chancellor of Washington University (see *Nature*, May 1, p. 805). Spacious accommodation at Gulmarg has been provided to house the laboratory, its staff and visitors. The research observatory is run jointly by Aligarh Muslim University and the University of Jammu and Kashmir under a managing committee consisting of representatives of both these institutions. The decision to establish the observatory at Gulmarg was based on many factors, one being that Gulmarg is one of the finest hill stations in Kashmir with a very fine golf course, and another that it is easily accessible and, if need be, it is possible to keep the observatory open for the whole year. In the words of Prof. A. H. Compton: "The height of 9,000 ft. is as great as persons unaccustomed to altitude can work without discomfort, and is adequate for many types of study that cannot be performed effectively at sea-level. The altitude is comparable also with that of most of the high-altitude laboratories elsewhere with which it is important to compare results, for example, Mexico City (about the same magnetic latitude) at 7,500 ft., Huancayo, Peru, at 10,500 ft., Echo Lake, Colorado, at 10,000 ft., and Jungfraujoch, Switzerland, at 11,300 ft. The location is also suitable as a base station for work at higher altitudes, up to 11,000 ft. at Khillan Marg, one hour distant, and up to 14,000 ft. at Apharvat, three hours distant. These locations are as high as any stations at which high-altitude research is now regularly being done".

The research observatory is easily accessible, and a 'jeep' can go right up to the gate of the observatory. To get to Gulmarg, one can fly from Delhi to Srinagar, the capital of Kashmir, the flight lasting three hours, and from Srinagar Gulmarg is twenty-eight miles away. Alternatively, there is a train service up to Pathankot, from where one can take a bus to cover the 275 miles to Srinagar. A good road goes from Srinagar to Tangamarg, which is within four miles of Gulmarg, and this road is now being extended for 'jeeps' and trucks right up to Gulmarg. The proposed tunnel under the Banihal Pass will keep the road open to Srinagar throughout the year.

The physical details of the observatory are as follows: altitude, 9,000 ft.; geographic latitude, 34° 03′; geomagnetic latitude, 24° 36′; geographic longitude, 74° 24′; average barometric pressure, 707 mb.; maximum temperature, 80° F.; minimum temperature, 30° F.; and average temperature, 60° F. At present the electric power is not satisfactory, as the supply only allows for 5 kW. and the load is such that the voltage fluctuates considerably; also, the alternating frequency is 25 c./s. The Kashmir Government intends to instal a new generator which will give 220 V., 60 c./s., within a few years. During the working season, Nedou's Hotel remains open to visitors, and there are also a number of small hotels and eating places. There is a market for buying provisions. Horses, ponies and labourers are available in abundance at fairly reasonable rates.

The resources of the observatory are meagre, as the two co-operating universities are unable to provide adequate funds at present. It is hoped that in due course a small workshop will be installed. The managing committee of the observatory has empowered the director to allow Indian and foreign investigators to carry out work at this altitude and latitude, if such requests are made. It is intended to develop the observatory into a general-purpose high-altitude laboratory; though it is not meant solely for the cosmic-ray studies, this is the main field in which work has been in progress.

SOCIAL FEEDING BEHAVIOUR OF BIRDS

AUSTIN L. RAND, of the Chicago Natural History Museum, has published a paper with the object of illustrating how certain behaviour patterns in birds may have originated out of general tendencies and evolved from simple to complex patterns (*Fieldiana: Zoology*, 36, No. 1). Social feeding habits of birds, outside the breeding season, are considered from the point of view of possible stages through which the more complex patterns have evolved. Behaviour patterns are examined and compared, and arranged according to their similarity in organization and usefulness. This discloses a number of series, each starting with the simple and becoming more and more complex.

Intraspecific social behaviour is examined first, as it is simpler, and the factors involved tend to be more easily seen. Gregariousness is very pronounced in birds, and seems to be the main starting point for these associations. This flocking could be a disadvantage when food is limited; but various modifications or organizations of the flocks exist that not only cancel out such disadvantages, but also make a position in the organized flock more advantageous than solitary feeding. The most obvious of these are: spacing out of the flock to reduce competition; the leading of some individuals to food by others going to it; the beating or driving of coverts, which flushes prey into accessibility; combining of individuals to capture, kill or otherwise secure food already sighted.

The feeding associations of birds transcend species limits, and many are concerned with animals other than birds, including man and his extensions such as ships. The bird seeking the association is often the chief beneficiary, through the beating activities, the providing of scraps, and the providing of parasites and even flesh of its own body by the animal accompanied. Another series in this category is the pilfering or robbing of one species by another.

In flocks in which numerous species of birds keep together, many of the factors involved in the simpler cases mentioned above are discernible, and it is probable that several may work together, reinforcing each other. Protection from predation by flocking is probably of no great importance.

Data are given to show the extreme acuity of birds in seizing on small elements in their environment that provide food benefits. They show that such occasional benefits may lead to new habits; that new habits are still arising; and that simple or occasional associations in some species are more complex or regular in other species.

It is possible to see how complex behaviour patterns evolved if psychological processes of a low order are postulated, satisfaction or benefits being associated with the presence of certain conditions such as variability among the birds to recognize such associations and the selection of certain favourable variations until they become a part of the normal behaviour pattern.

The rapidity with which new patterns develop, and similar patterns that evolve in unrelated birds, indicate that these behaviour patterns are not necessarily phylogenetic. Despite this, these patterns indicate the stages through which complex behaviour probably passed and how it originated.

Some mixed bird parties increase competition between species, offsetting some at least of the mutual aid of the associations.

MICROSEISMS

THE name microseisms was given in 1870 by Father T. Bertelli to the ground unrest of wave period from about 1 sec. to 10 sec. and variable amplitude (about 5 μ) registered by seismographs. This movement is now studied because of its intrinsic interest and also pragmatically because of its meteorological associations. A symposium on the subject, organized by Dr. R. C. Gibbs, was held at Arden House, Harriman, New York, during September 4–6, 1952, under the sponsorship of the Office of Naval Research and the Geophysical Research Division of the United States Air Force[*]. It was attended by more than thirty specialists in the field (one each from the Netherlands and Sweden, two from Great Britain and the remainder from the United States), and the report has just been received. It contains the following eight papers together with the discussions on them: sketch of the history of microseismology, by J. B. Macelwane, *S.J.*; tripartite stations and the direction of approach of microseisms, by J. E. Ramirez, *S.J.*; amplitude distribution of storm microseisms, by Marion H. Gilmore; microseismic period spectra and related problems in the Scandinavian area, by Marcus Båth; Can sea waves cause microseisms ?, by M. S. Longuet-Higgins; storm and surf microseisms, by F. W. van Straten; the ocean as an acoustic system, by Frank Press and Maurice Ewing; on theories of the origin of microseisms, by J. G. Scholte.

It appears to be generally accepted that microseisms, more frequent in winter than in summer, are elastic waves travelling at about 100 miles/min. over the surface of the earth and not body waves through the earth. They appear to be largely Rayleigh waves together with some Love waves, and to be of different wave forms as well as of different periods. Those of period 2 sec. and less may be due to local winds or may be man-made. Group microseisms of period 3–10 sec., exhibiting beats, appear to be almost always of marine origin, and those of period 1 min. or more to occur at the time of frost near stations. The symposium was mostly concerned with problems about the group microseisms of period 3–10 sec.

Historically, it was suggested by Wiechert that these may be due to the beating of surf on a rocky coast, and later by others that they were formed near the centre of a storm at sea. Tripartite stations were used by J. J. Shaw in England (1918–22) and more accurately by Gilmore, among others, in the Caribbean (1944) to get cross-bearings, in an attempt to track the centres of microseismic disturbances. This method has not proved entirely satisfactory, supposedly because of geological barriers such as deep-seated faults, and the irregular passage and attenuation of waves by geological formations. Gilmore is now attempting to detect microseismic centres when they begin; to follow the centres once they have formed; and to get an idea of the energy at all points in the path, by empirical amplitude relationships.

The intimate connexion between events in air (such as microbarometric pulsations, gustiness, barometric gradients and cold fronts), events in the sea (waves, standing waves, surf pressure) and microseisms is not fully understood, but good progress is being made at some points. It has been shown by Deacon and Longuet-Higgins, following work by Miche, that second-order terms in the equations of the pressure field produced by standing waves at sea integrated over a sufficiently large area could quantitatively account for microseisms of half the period of the standing waves; and such microseisms have been shown to exist at Kew. Ocean waves of period 16 sec. produced 8-sec. microseisms at Kew, just as ½-sec. waves in an experimental tank produced ¼-sec. microseisms in the bottom of the tank.

Standing waves in the ocean could conceivably be produced by interference caused by a fast-moving low air pressure area, or by coastal reflexion of ocean waves; but this does not seem to be the whole picture since, on the western side of the Atlantic Ocean, Frank Press and Maurice Ewing (Columbia University) conclude from their observations that "(1) Frontal microseisms are generated very soon (often abruptly) after a cold front passes seaward from land, with no obvious correlation to prior wind and sea conditions. (2) A relatively narrow spectrum of periods appears to be generated by a front, cyclone, or hurricane at a given time when the disturbance is over an area of uniform water depth. Characteristic periods of microseisms can be related to generating areas in the ocean. (3) As a front recedes from shore, the spectrum gradually shifts to longer periods, and becomes fairly constant after deep water is reached. (4) Cold fronts and air masses following them can generate microseisms whereas warm air masses preceding the cold fronts fail to generate microseisms even when strong onshore winds are present. (5) In many cases there are no obvious correlations between swell and surf conditions and microseisms. (6) Microseismic energy is dissipated by a profound crustal discontinuity at the edge of the continental shelf. Hurricanes crossing the edge suddenly generate larger microseisms".

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[*] Symposium on Microseisms. (Publication 306.) Edited by James T. Wilson and Frank Press. Pp. vii+125. (Washington, D.C.: National Academy of Sciences, National Research Council, 1953.) 1 dollar.

Observations are still being made at observatories throughout the world, in conformity with the microseismic research project of the Section of Seismology of the International Geodetic and Geophysical Union, which was initiated in 1952, and detailed observations have yet to be made of the energy of the gusts of wind at sea likely to be associated with microseisms, and also the pressures and variations of pressure at great depths on the bottom of the ocean likely to be associated with microseisms. It is hoped that, with further observations and consideration, more progress will be made, particularly with the air–sea energy transfer.

ERNEST TILLOTSON

BASIC RESEARCH ON ODOUR

To say that the sense of smell has been neglected as an object of study, because of the formidable experimental difficulties involved, particularly when examining the peripheral aspects of the sense, is of course to state a platitude. It would appear that the newer techniques of measuring minute quantities of substances might, however, prove rewarding when applied to the investigation of olfaction, and might be the means of stimulating renewed interest, especially in these neglected peripheral phases. It was possibly with such thoughts in mind that a conference was organized in April 1953, jointly by the New York Academy of Sciences and the American Society of Heating and Ventilating Engineers, for although practically every aspect of olfaction was then reviewed, greatest emphasis was placed on the peripheral phases. The edited versions of the papers read at the conference have now been published in the *Annals of the New York Academy of Sciences*[*]. No doubt because of the participation of the latter Society, papers on technological problems occupy a prominent place, more prominent than would probably be the case at a similar conference in Britain. The whole report, therefore, provides an up-to-date review, and a short guide to the literature, of both technical and laboratory work carried out recently on odours and olfaction.

A major object of any conference such as this is to throw up ideas, and a reasonable degree of speculation is not altogether undesirable. However, this can be overdone, and unfortunately several of the participants did not resist the temptation to explain how, on theoretical grounds, odours might be converted into nerve impulses. While reading some of the papers, one was reminded of Homer Smith's comment, made when he was reviewing the earlier concepts of renal function, that the history of science has been one of rival over-simplified theories, to which fault has been added that of insufficient experimental work. Parts of the report on this conference show that our grandfathers may have been no worse than ourselves.

The first part of the conference was concerned with the problem of odour in industry; the papers were, in fact, devoted to the practical problems of how to prevent food, tobacco, paper and the interiors of buildings from being contaminated by odoriferous substances. As there is so little basic knowledge available as to either the behaviour of the odoriferous substances, or the absorbent properties of the contaminated materials, the problems are attacked along empirical lines. The cause is traced, and if it cannot be removed then various odour neutralizers or modifiers are tried until the one which is most satisfactory in the circumstances has been found.

The next major section of the conference was entitled "Problems of Odour Research from the Viewpoint of the Scientist", with contributions from a physiologist, a psychologist, a physicist and a chemist. J. Greenspan outlines some of the newer physical methods for measuring concentrations as low as parts per million; but later in the conference, R. L. Kuehner reports that such methods are still not as satisfactory as would be desired, and he suggests the use of other methods which depend upon subjective threshold sensations, or upon chemical absorption of the odorant. L. M. Beidler, the physiologist, points out, too, that by analogy with the investigations on taste a method of measuring concentrations in the air, and of controlling such concentrations, would not necessarily enable the ultimate nature of the stimulus to be understood, for the nature of the receptor is so important. J. B. Sumner, at least, is aware that the generally accepted view of odours being transmitted by volatile particles in the atmosphere is no more than a hypothesis, although undoubtedly a much more satisfactory one than others depending upon such an alternative as infra-red radiation.

The third section was concerned with the status of our present knowledge of the olfactory nervous system, and contained papers of rather uneven quality. There was in one paper a tabulated list of the functions of the turbinate bones; while another paper, which offered yet a further hypothesis of olfaction, based upon information theory this time, opened with a quotation followed by the comment, "In these words, Titus Lucretius Carus developed the first atomistic theory of olfaction in about 47 B.C. This year of 1953 marks the two-thousandth anniversary of this theory". On the other hand, K. H. Pribram and L. Kruger's review of the "Olfactory Brain" is particularly satisfying, and, at the risk of appearing invidious to the writers of other equally satisfactory articles, one may regard it as one of the most important papers of the conference and suggest that it is not to be overlooked. Their final conclusion justifies quoting: ". . . the 'olfactory brain', as defined, is not primarily olfactory, though parts of it serve olfactory functions. Nor is the current conception of a 'visceral brain' more tenable though visceroautonomic functions are also served. It is clear that the formations in this portion of the brain, though they share several characteristics, are not, at this time, usefully thought of as *a* brain serving any *one* function. Since at least three distinct systems can be delineated, each might profitably be investigated before an attempt is made to define what functions they have in common". In the third section also, M. M. Mozell and C. Pfaffman contribute a review of the afferent neural processes, largely concerned naturally with Dr. E. D. Adrian's recent work, while V. G. Dethier has a most interesting paper on the physiology of olfaction in insects.

The rest of the conference was mainly devoted to techniques of measuring and identifying odours, with a consideration of some of the results obtained. This section might preferably have been placed earlier in the conference. Most of the workers concerned with the practical problems of eliminating odours prefer to use subjective methods; but there is here also a full discussion of objective methods. It has been suggested that the olfactory mucosa is sensitive to concentrations as low as 10^{-13}; if this is true, there is some considerable way to go, and much fundamental research is required, before adequate objective methods are available. But this is not to deprecate the very valuable and important work of the present-day pioneers.

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[*] "Basic Odour Research Correlation", by A. R. Behnke and 38 other specialists. *Ann. N.Y. Acad. Sci.*, 58, Art. 2, 13–260 (1954). 3.50 dollars.

H. SOSNOWICK

AGE OF PARENT AND CHARACTER OF OFFSPRING

THE relations of an offspring to its parents are complex, and the ways in which a parent may influence the character of its offspring are many. This is especially true among the higher animals; but even when we turn to lower animals and to plants the parent–offspring relation, if simpler, is still far from simple. Though, as genetics has emphasized, the primary endowment is the complement of nuclear genes, an individual also receives from its parents its initial cytoplasm—mainly, but not necessarily exclusively, from its mother. The cytoplasm so received may contain particles of a genetic or semi-genetic nature (plasmagenes of various kinds), nutritional materials, protective substances and agents of disease (such as viruses). It is a complex endowment as yet by no means fully understood. Nor is the cytoplasm the only avenue of supply of food materials, protective substances and disease risks. The close association of offspring with parent during early life, especially in higher animals, plays its part in the nutrition, protection and disease relation of the offspring and, of course, also in its education.

Our understanding of these various links between the generations is not equal. Classically the geneticist has concerned himself primarily with the nucleus and the genes it carries, setting other aspects aside as secondary to the main problem. Initially this was an essential restriction, but of recent years especially the study of the nuclear genes has itself guided attention to the cytoplasm, to the immunological relations between mother and child, and to the effects of maternal nutrition; indeed, to the whole complexity of the parent–offspring relation. Thus as the genetical framework has become clear, the way has opened up to a co-operative attack on the broader problem by all the many interests which are concerned.

Both the complexity of the problem and the many types of approach which can be made to it are brought out by a recent symposium on "Parental Age and Characteristics of the Offspring" held by the New York Academy of Sciences*. Although in his introduction E. V. Cowdry chiefly emphasizes the effects of age of mother and father on longevity in the offspring, he recognizes in his summary that this provides only a superficial common denominator for the many phenomena described in the nineteen contributions to the symposium, and he stresses the need for a better understanding of the mechanisms which underlie the effects we observe. The observations reported cover a very wide field. Asexually produced progeny in plants are discussed alongside parthenogenetic rotifers and the sexual offspring of mammals. Longevity, germination characters of seeds, mutation-rates, the expression of congenital malformation in men and mice, mongolism and the sex ratio in man, fibrocarcinoma and leukaemia in mice, the consequences of ageing gametes before fertilization, skeletal characters, spotting, the results of altering a mother's physiology during pregnancy, and seasonal influences, are all to be found among the subjects considered. As might be expected, the importance of the mother's age emerges clearly as opposed to that of the father; but there is, again not surprisingly, little pattern to be discerned as yet even at the level of description of the phenomena. Suggestions can be, and are freely, made as to the underlying causation. Hormonal changes, cytoplasmic entities, antibody levels, viral effects, biochemical adjustments, and alterations in crossing-over with age, are all brought in, and the susceptibility of polygenically determined variants to non-nuclear effects is emphasized. But the value of this symposium lies in the problems it poses and the clues it offers rather than in the explanations it achieves or the mechanisms it exposes.

Two papers are especially interesting in their bearing on the nature of somatic ageing. The first, by A. I. Lansing, describes experiments with the rotifer *Philodrina citrina*, which, being parthenogenetic, is unlikely to show any significant amount of variation mediated by nuclear genes within its progenies. Separate lines were developed, differing in the age of the mother at the time of production of the eggs from which the next generation was raised. With eggs from adolescent mothers the longevity of the offspring tended to increase as the generations went by. The lines in which eggs were taken from middle-aged or senile mothers, on the other hand, showed a decline in longevity until they died out after five and three generations, respectively. The change is reversible by reversal of the selection. Furthermore, there is a close relation between growth and ageing, the ageing factor appearing in the eggs at the time when the mother ceases growth. Accelerated ageing accelerates growth but decreases maximal size, while retarded ageing retards growth and increases maximal size.

In the second paper E. Ashby and E. Wangerman describe experiments with clones of the water-plant *Lemna minor*. The fronds of this plant reproduce by asexual buds, the daughters so produced being successively smaller as the mother frond ages. It appears from extrapolation that the age of mother at which daughter size would be zero is the age of death. Thus the meristems grow old with the mother. As with the rotifers the process is cumulative and reversible, for first daughters are larger than their mothers where these mothers were themselves from old parents and therefore small.

The regularity and similarity of behaviour in the rotifer and the plant are striking. Though clearly not dependent on genetic segregation, the responses to selection resemble in several respects those which can be obtained with polygenic variation. Can they depend on a multi-particulate cytoplasmic system, related ultimately to the nucleus, but capable of change independently of the nuclear genes? Though it is too early to do more than speculate, these papers suggest an experimental approach which might materially advance our understanding of the changes which go on during development and ageing.

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INCORPORATION OF HALOGENATED PYRIMIDINES INTO THE DEOXYRIBONUCLEIC ACIDS OF *BACTERIUM COLI* AND ITS BACTERIOPHAGES

THE pyrimidine 5-bromouracil may be regarded as a structural analogue of thymine in which the methyl group of thymine is replaced by a bromine atom. Weygand, Wacker and Dellweg[1] showed that the inhibition of growth of *Streptococcus faecalis* R. by 5-bromouracil is competitively reversed by thymine. Using 5-bromouracil containing the isotope bromine-82, they demonstrated the incorporation of 5-bromouracil into the nucleic acids of *S. faecalis*, although they did not show whether the analogue was present in the ribonucleic or deoxyribonucleic acids.

We have found that, under conditions in which *Bacterium coli* requires thymine, 5-bromouracil and 5-iodouracil are extensively incorporated into the deoxyribonucleic acids of the bacterium and its bacteriophages, replacing thymine residues in the nucleic acid molecule. No incorporation of 5-bromouracil into the bacterial ribonucleic acid could be detected.

B. coli strain *B* was grown in a glucose – ammonium sulphate medium containing sulphanilamide (1 mgm./ml.), vitamin-free casein hydrolysate (1 mgm./ml.), xanthine (25 µgm./ml.) and varying amounts of thymine. In this type of medium, growth of *B. coli* has been found to be dependent upon the amount of thymine[2]. Two to four hours after the addition of 5-bromouracil or 5-iodouracil, the mean generation time of bacteria in this medium is increased and thereafter remains approximately constant. The degree of inhibition by 5-bromouracil increases with the ratio 5-bromouracil/thymine; but is not affected by uracil. After inhibition by either analogue, the proportion of bacteria giving colonies on nutrient agar is reduced.

The bacteriophages T_2r and T_1 were grown on *B. coli B* in the above medium containing 8×10^{-6} *M* thymine by infecting with three bacteriophages per bacterium at a bacterial density of $1{\cdot}5 \times 10^{8}$/ml.; 2×10^{-3} *M* 5-bromouracil or 5-iodouracil was previously added at a bacterial density of 10^{8}/ml. Although it has been reported that in a similar medium *B. coli* infected with T_2, T_4 and T_6 bacteriophages fails to lyse[3], under our conditions 90 min. after infection with T_2r the bacteria lysed with the production of bacteriophages. T_2r was purified by the method of Herriott and Barlow[4] and T_1 by differential centrifugation and treatment with deoxyribonuclease.

Deoxyribonucleic acid was prepared from *B. coli* by the method of Smith and Wyatt[5] and from T_1 by treatment with 0·1 *M* sodium citrate buffer *p*H 7 at 45°. Intact T_2r bacteriophage and deoxyribonucleic acid from *B. coli*, both grown in the presence of 5-bromouracil, were hydrolysed in 72 per cent w/w aqueous perchloric acid[6] and the hydrolysates run on two-dimensional paper chromatograms in *iso*propanol – water – hydrochloric acid[7] and *n*-butanol – water – ammonia[8]. In both hydrolysates, 5-bromouracil, identified by paper chromatography, electrophoretic mobility and ultra-violet spectroscopy, was found to have replaced quantitatively part of the thymine found in normal T_2r and *B. coli* nucleic acids (Table 1). The relative proportions of the other bases remained unchanged.

Table 1. MOLAR PROPORTIONS OF THYMINE AND HALOGENATED PYRIMIDINES IN DEOXYRIBONUCLEIC ACIDS FROM *B. coli* AND T_2r GROWN IN THE PRESENCE OF 5-BROMOURACIL AND 5-IODOURACIL

The nucleic acids were hydrolysed in perchloric acid, and in the case of T_2r, Wyatt's data (ref. 9) were used to allow for the 5-hydroxymethyl cytosine.

Deoxyribonucleic acid	Moles/100 moles estimated bases Thymine	5-Bromouracil	5-Iodouracil (estimated as uracil)	Thymine + halogenated pyrimidine
B coli B	27·2	—	—	27·2
B. coli B '5-bromouracil'	16 0	8 7	—	24 7
B. coli B '5-iodouracil'	19 4	—	4·5	23·9
T_2r	30·5	—	—	30 5
T_2r '5-bromouracil'	6 4	24 1	—	30 5
T_2r '5-iodouracil'	15 4	—	14·5	29 9

Deoxyribonucleic acids from *B. coli* and T_1 grown in the presence of 5-bromouracil were hydrolysed to the 5′ nucleotides with deoxyribonuclease and rattlesnake venom diesterase. The separation of 5-bromouracil deoxyribonucleotide was facilitated by the fact that 5-bromouracil bears a negative charge at *p*H 9 (presumably due to the dissociation of the 2 or 6 (OH) group) while the other bases are uncharged. Paper electrophoresis of both hydrolysates in 0·05 *M* borate buffer *p*H 9 gave, in addition to a band containing the four natural nucleotides, a second band migrating more rapidly towards the anode. This contained a substance with an ultra-violet absorption spectrum in 0·1 *N* hydrochloric acid similar to that of 5-bromouracil but shifted about 3 mµ towards the longer wave-lengths (λ max., 279 µ; λ min., 244 µ). On hydrolysis with perchloric acid, this gave 0·96 mole 5-bromouracil/mole phosphate. We conclude that the substance is 5-bromouracil deoxyribonucleotide. After hydrolysis of the *B. coli* deoxyribonucleic acid with deoxyribonuclease and snake venom diesterase and 5′ nucleotidase, a substance with the expected properties of 5-bromouracil deoxyriboside was isolated.

Perchloric acid hydrolysis of T_2r bacteriophage or deoxyribonucleic acid from *B. coli* grown in the presence of 5-iodouracil gave in addition to the usual bases a substance identified by chromatography and ultra-violet spectroscopy as uracil. The relative proportion of thymine to the other bases was decreased such that the sum of the uracil and thymine equalled the expected amount of thymine (Table 1). It was then found that 5-iodouracil, although stable alone to the perchloric acid hydrolysis, in the presence of deoxyribonucleic acid preparations is converted to uracil. Enzymic hydrolysis of the *B. coli* deoxyribonucleic acid followed by paper electrophoresis at *p*H 9 gave a substance with the expected electrophoretic mobility and ultra-violet absorption spectrum of 5-iodouracil deoxyribonucleotide. On hydrolysis with perchloric acid this decomposed giving uracil. While as yet lacking direct evidence from the isolation of iodouracil itself, we conclude that the uracil found in the perchloric acid hydrolysates of the deoxyribonucleic acids is derived from 5-iodouracil incorporated into the nucleic acids. We have also found that 5-chlorouracil will replace thymine residues in the deoxyribonucleic acid of thymine-requiring *B. coli*.

Preparations of T_2r and T_1 containing 5-bromouracil or 5-iodouracil had the same ultra-violet absorption spectra as normal preparations, and electron microscopical examination of the T_2r 'bromouracil' preparation showed particles of normal structure. However, the ratio (bacteriophage titre/optical density at 260 mμ) showed that the various 'bromouracil' and 'iodouracil' bacteriophage preparations contained 50–98 per cent non-infective particles. For example, in a preparation of T_2r in which 79 per cent of the thymine residues were replaced by 5-bromouracil, 70 per cent of the particles did not give plaques when plated on *B. coli B*.

As 5-bromouracil or 5-iodouracil was present before and after infection, it is reasonable to assume a nearly random distribution of halogenated pyrimidine residues among the bacteriophage particles. It thus seems likely that particles containing 5-bromouracil and 5-iodouracil are infective, but that the probability of successful infection by a virus particle decreases with increasing incorporation of the analogue.

The incorporation of bromine and iodine atoms into specific positions in the deoxyribonucleic acid molecule may be of considerable help in elucidating its structure by means of X-rays. This possibility is being investigated by Dr. M. F. Wilkins and his colleagues at King's College, London.

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The hypothesis that the composition of the whole deoxyribonucleic acid is characteristic of the species from which it was derived[1] does not necessarily imply that this composition is unchangeable. However, the constancy of composition in cumulative data (for a review see ref. 2), as well as the finding that the deoxyribonucleic acid of a thymine-requiring strain of *E. coli* does not change its thymine content when the cells were grown on a large excess of thymine[3], strongly suggested that the composition of deoxyribonucleic acid is independent of the environment, as, it seemed, would need to be the case for a heredity determinant.

The findings[4–8] that the unnatural purine azaguanine and pyrimidine thiouracil can be built into ribonucleic acid prompted investigation into the possibility of such building into deoxyribonucleic acid. With purines (azaguanine, 6-mercaptopurine), the incorporation, if any, was extremely low[6,7,8]. On the other hand, Weygand *et al.*[10] found that a mixture of degradation products of deoxyribonucleic and ribonucleic acids from *S. faecalis R*, grown on a medium containing the radioactive unnatural pyrimidine 5-bromouracil containing bromine-82, yielded on hydrolysis a radioactive substance or substances of a chromatographic R_F value (butanol – water) similar to that of both thymine and 5-bromouracil. These investigators suggested that the 5-bromouracil, due to its steric similarity to thymine, was indeed built into deoxyribonucleic acid of *Streptococcus faecalis*. Radioactive 5-bromouracil was also taken up by non-dividing cells of *Streptococcus faecalis* and *Enterococcus* Stei, but little, if any, was taken up by *E. coli*[11].

Table 1

Strain*	I	II	
Preparation*	*a*	*b*	*c*
Molar ratios†			
5-Bromouracil to thymine	0·43	0·236	0·260
5-Bromouracil to cytosine	0·281	0·174	0·192
Thymine to cytosine	0·652	0·738	0·738
Thymine to adenine		0·752	0·760
Adenine to cytosine		0·985	0·975
5-Bromouracil + thymine to adenine		0·927	0·958
5-Bromouracil + thymine to cytosine	0·933	0·918	0·934

* See text.

† For strain II, recovery 92 per cent of nucleic acid phosphorus; guanine recovery was least satisfactory.

We have grown certain strains of *E. coli* on a medium containing 5-bromouracil and have isolated highly polymerized deoxyribonucleic acid in which 18–28 per cent of the thymine was replaced by 5-bromouracil. Strain I was the thymine-requiring mutant mentioned above[3]; strain II was a back-mutant to thymine independency. The behaviour of these strains is described in the following communication.

The cells were grown at 37° on nutrient agar or broth containing 5-bromouracil (100 μgm./ml.). This addition partially inhibits the growth of strain I but not of strain II. Highly polymerized deoxyribonucleic acid was isolated by two methods (Table 1): (*a*) from strain I by the method previously described[3]; (*b*) and (*c*) from strain II by a modification in which grinding is replaced by incubation with 3 *M* glycine followed by three extractions with 1 *M* aqueous sodium chloride; only the latter extracts were used for the recovery of deoxyribonucleic acid. In this method two preparations were made: (*b*) not treated with 'Norit' and not dialysed; it contained 10 per cent ribonucleic acid; and (*c*) treated with 'Norit' and dialysed as described before[3]; it contained less than 1 per cent ribonucleic acid.

The final viscous preparations were precipitated with ethanol; the fibrous precipitate in 3 mgm. aliquots was hydrolysed for 40 min. at 100° with 0·08 c.c. of 7·5 *N* perchloric acid[12], diluted to 0·2 ml., centrifuged and analysed by paper chromatography in two solvent systems: (1) in butanol – water the ratio $\frac{R_F \text{ 5-bromouracil}}{R_F \text{ thymine}}$ is 1·04; this usually does not permit the separation of these two compounds (compare ref. 10), but permits the separation of the two from other nitrogenous bases; (2) in butanol – ammonia the ratio $\frac{R_F \text{ 5-bromouracil}}{R_F \text{ thymine}}$ is 0·49; this permits easy separation of the two. Accordingly, the hydrolysate was first chromatographed in system (1), and the common spot of 5-bromouracil and thymine was then chromatographed in system (2); this was accomplished technically by using either two-dimensional chromatography, or a long strip of paper in step (1).

The final spots were extracted and the nitrogenous bases content determined in the Beckman spectrophotometer. The hydrolysate of deoxyribonucleic acid of strains I and II grown on 5-bromouracil exhibited a spot (located by means of an ultra-violet lamp and special fluoroscope[13]) which in both solvent systems behaved exactly like pure 5-bromouracil, and, when extracted, showed an ultra-violet absorption spectrum identical with that of pure 5-bromouracil (in water, E max. at 276 mμ ; $E(276)/E(290) = 1 \cdot 57$; in 0·1 N sodium hydroxide, E max. at 296 mμ). In addition, this extract containing 10 μgm./ml. base computed (ultra-violet spectrum) as 5-bromouracil inhibited the growth of strain I to the same extent as did pure 5-bromouracil (for details see following communication).

The results are summarized in Table 1. It can be seen that the thymine content was approximately a quarter to a third less (on cytosine basis) than in this and two other *coli* strains grown in the absence of 5-bromouracil (in which molar ratios of individual bases are close to 1[3]); this amount seems to be substituted by bromouracil (28–18 molar per cent of cytosine).

In such a study it is, of course, necessary to exclude rigorously the possibility that the 5-bromouracil was present in deoxyribonucleic acid merely as a non-chemically bound impurity. This possibility is contra-indicated by the corresponding deficiency in thymine ; other control experiments are listed below :

(1) Normal deoxyribonucleic acid was dissolved in aqueous solution containing 5-bromouracil (100 μgm./ml.) and subjected to purification procedures for deoxyribonucleic acid, as described above. The hydrolysate of the final product contained no detectable 5-bromouracil.

(2) As can be seen from Table 1, the 5-bromouracil content of the dialysed (48 hr.) preparation (*c*), which contains less than 1 per cent of ribonucleic acid, is the same as that of the non-dialysed preparation (*b*), which contains 10 per cent ribonucleic acid ; this makes it improbable that the bromouracil was present as a low molecular-weight component or as a component of ribonucleic acid.

(3) Prior to hydrolysis at 100° for 40 min. the deoxyribonucleic acid of strain II was hydrolysed (with 7·5 N perchloric acid) for ½ hr. at 37°. This procedure liberates all purines but no cytosine and only 4 per cent of thymine. No 5-bromouracil could be detected in the hydrolysate. The 5-bromouracil was liberated only after hydrolysis (100°, 40 min.), liberating pyrimidines from deoxyribonucleic acid. (Ribonucleic acid pyrimidines are little liberated in these conditions).

(4) The presence of 5-bromouracil as an integral component of deoxyribonucleic acid was suggested by the actual isolation of 5-bromouracil deoxyriboside. 25 mgm. of deoxyribonucleic acid (preparation *b*, Table 1) were digested for seven days at 30° with the malt nuclease preparation[14] which was recently found to produce deoxynucleosides in good yield[15]; the conditions were those employed in the latter paper. The digest was concentrated and analysed chromatographically as described above. Besides natural deoxyribosides, the chromatograms showed in both solvent systems an additional spot of R_F value similar to that of 5-bromouracil. The extract of this spot showed the presence of a deoxypentose[16]; the ultra-violet absorption spectrum exhibited a maximum at 279 mμ which, like thymidine[17] (but unlike thymine or 5-bromouracil), did not shift to higher wave-lengths in 0·1 M sodium hydroxide (E max. at 277 mμ). In addition, this extract containing 0·5 μgm./ml. nucleoside computed (ultra-violet spectrum and deoxypentose content) as 5-bromouracil deoxyriboside inhibited the growth of strain I (see following communication).

When the extract was hydrolysed with 7·5 N perchloric acid at 100° for 40 min., it yielded a substance identified as 5-bromouracil by its chromatographic behaviour, ultra-violet absorption spectrum, shift of spectrum in 0·1 N sodium hydroxide, and bacterial growth inhibition, as described above. All these data indicate that the unknown (before hydrolysis) was indeed 5-bromouracil deoxyriboside.

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E. coli containing 5-Bromouracil in its Deoxyribonucleic Acid

IN the preceding communication we have reported that certain strains (I and II) of *E. coli*, when grown on a medium containing 5-bromouracil, build this unnatural pyrimidine into cellular deoxyribonucleic acid. Strain I was isolated[1] by one of us (S. Z.) from American Type Culture Collection No. 11117 ; the latter is a mutant produced by X-ray irradiation[2]. Strain I requires thymine for growth on a synthetic (asparagine) medium. It has been used for the thymine assay[3] and for the study of the effect of excess of thymine on thymine content in deoxyribonucleic acid[4]. Preliminary study[1] indicated that the thymine requirement can be replaced by thymidine or thymidylic acid but not by other natural constituents of deoxyribonucleic and ribonucleic acids.

We find that 8×10^{-7} M (0·1 μgm./ml.) thymine, 2×10^{-7} M thymidine and 2×10^{-6} M thymidylic acid represent minimum growth requirements on a synthetic medium. This may indicate that also in these strains thymidine is a more direct precursor of deoxyribonucleic acid than the other two compounds. The following compounds in concentration 100 μgm./ml. (unless otherwise stated) do not support growth : 5-bromouracil, 5-bromouracil deoxyriboside, 5-aminouracil, 2-thiothymine, 5-ethyluracil (from Dr. G. Elion, Wellcome Research Laboratories), 2-thiouracil, 6-azathymine (from Dr. W. H. Prusoff, Yale University), 5-nitrouracil, alloxan, veronal, barbituric acid, orotic acid, 6-methyl uracil, dihydrothymine, folic acid (1 μgm./ml.), vitamin B_{12} (50 μgm./ml.), thymidine diphosphate, 1-methyl thymine (from Dr. L. Cavalieri, Sloan-Kettering Institute for Cancer Research), 1-methyl-4-ethoxythymine (from Dr. L. Cavalieri), 2,4 diethoxy-thymine (from Dr. L. Cavalieri) (the last four compounds 10 μgm./ml.). In the presence of 1 μgm./ml. thymine, the above compounds (in concentrations stated) also do not inhibit growth, except for the first five, which inhibit growth for at least 48 hr. when present in the following (or higher) concentrations: 5-bromouracil (10 μgm./ml.); 5-bromouracil deoxyriboside (0·5 μgm./ml.); 5-aminouracil (100 μgm./ml.); 2-thiothymine (100 μgm./ml.); 5-ethyluracil (200 μgm./ml.). Uracil[1] and 2-thiouracil inhibit only at concentrations higher than 200 μgm./ml.

In the presence of 1 μgm./ml. thymidine, 5-bromouracil (100 μgm./ml.) does not inhibit growth; this again may indicate that thymidine is a more direct precursor of deoxyribonucleic acid than thymine. Very strong inhibition of thymine by 5-bromouracil deoxyriboside also points in this direction.

5-Bromouracil (100 μgm./ml.) partially inhibits the growth on nutrient agar. After 48 hr., a secondary growth (papillæ) appears containing mutants having various degrees of resistance to 5-bromouracil. On normal nutrient agar some of these mutant strains appear normal, whereas others form very small colonies.

By growing strain I on a synthetic medium, fortified with 0·02 per cent of 'Proteose Peptone No. 3' (Difco) (suboptimal growth) for more than 48 hr., the back-mutants to complete thymine independence can be isolated. One such back-mutant population consisted of 95 per cent cells inhibited by 10 μgm./ml. thymidine and 5 per cent cells non-inhibited: the latter were isolated and designated strain II (see preceding communication.)

Strain II, which exhibits full growth on a synthetic medium, is not inhibited by 100 μgm./ml. 5-bromouracil, but shows weak inhibition by 500 μgm./ml. of this compound.

Growth inhibition of *Lactobacillus casei* by 5-bromouracil was discovered by Hitchings *et al.*[5]. The inhibition by this compound in strain I can be reversed by increasing the concentration of thymine and is truly competitive against thymine. The mechanism may involve competition for the enzymes, such as the nucleoside-forming enzyme (thymidine phosphorylase[6]); as mentioned above, when thymidine is supplied, the 5-bromouracil indeed does not inhibit. In mammalian tissue, this enzyme synthesizes 5-bromouracil deoxyriboside fully half as readily as thymidine[8]. In our experiments the inhibition index of 5-bromouracil *vs.* thymine in strain I was 2·5 (16 hr.). In strain I both metabolites come from outside; in strain II, thymine is manufactured in the cell; this may explain the two hundred times lower inhibitory effect in strain II.

5-Bromouracil deoxyriboside (if indeed an intermediate) may also be less readily utilized for the synthesis of deoxyribonucleic acid; hence strong inhibition by this nucleoside. The possibility that the deoxyribonucleic acid containing 5-bromouracil participates less readily in the activities of the cell in strain I also cannot be entirely excluded.

More interesting is the finding that the 5-bromouracil can be built into deoxyribonucleic acid also without inhibition of growth. Indeed, strain II on 100 μgm./ml. 5-bromouracil builds in 17–19 per cent (on a cytosine basis) of this unnatural pyrimidine (see preceding communication); yet the speed of cell divisions remains the same as on a medium free from 5-bromouracil.

The above discussion referred to phenotypic changes In view of the possibility that the deoxyribonucleic acid is a factor in heredity, it was also interesting to study whether such a profound change in its composition, which might have occurred in most, if not all, cells, would be reflected in genotypic changes such as 'mass-mutation'. The thymine-requiring cells (strain I) had indeed entirely different colonies (flat, faint) when grown on a 5-bromouracil medium; however, they returned to normal on a thymine-containing medium free from bromine, in which thymine replaced 5-bromouracil in the deoxyribonucleic acid. The change (inhibition) ought therefore to be classified as merely phenotypic. As mentioned before, the back-mutant colonies (strain II) on a medium containing 100 μgm./ml. 5-bromouracil showed no change whatsoever. This does not preclude the induction of rare mutations by 5-bromouracil; it merely means that, in spite of its being built in rather large amounts into deoxyribonucleic acid, this unnatural pyrimidine does not induce demonstrable mass-mutations.

Thus certain changes are permissible in the deoxyribonucleic acid molecule without demonstrably affecting life of the cell; the changes are reversible; they do not demonstrably change the function of deoxyribonucleic acid as a factor in heredity (if indeed these acids are determinants in inheritance).

Obviously, these findings raise more questions. Do all deoxyribonucleic acid molecules have some of their thymine replaced by 5-bromouracil, or do some of the deoxyribonucleic acid molecules (perhaps genetically inactive) have all their thymine replaced by 5-bromouracil? What is the distribution of 5-bromouracil along the molecule? Can 5-bromouracil be built into deoxyribonucleic acid of other species[7], especially when administered as deoxyriboside? (compare refs. 6,8).

Work is in progress to determine whether unnatural bases can also be built into the deoxyribonucleic acid of unrelated strains of *E. coli* (strain *B* used as host for *T*-phage experiments; American Type Culture Collection No. 9637) and into the deoxyribonucleic acid of *Haemophilus influenzae* having transforming activity; the growth of these micro-organisms was not inhibited even by 1 mgm./ml. 5-bromouracil.

The work presented in both these communications was supported by research grants *E15* (*C7*) and *C*-1760 (*c*) from the National Institutes of Health, Public Health Service (H. E. Alexander and S. Zamenhof, principal investigators), and by an institutional grant from the American Cancer Society to Columbia University.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nuclear Uptake of Glycine-2-^{14}C in the Newt Embryo

EXPERIMENTS with early amphibian embryos, using glycine-1-^{14}C as a tracer and the autoradiographic technique of Doniach and Pelc[1], have shown that the nuclei take up this substance into high-molecular weight compounds more rapidly than does the cytoplasm[2]. Ficq[3] has also observed a greater activity in the nuclei, using orotic acid-2-^{14}C as well as glycine-1-^{14}C. She points out that, by the neural-tube stage, incorporation has occurred in all tissues which are actively engaged in morphogenesis; and she has shown that the labelled substances were taken up into nucleic acids as well as protein.

In some recent experiments, late blastulæ of *Triturus palmatus* were kept in a solution of glycine-2-^{14}C (1·4 μc./ml.) until they reached the late yolk-plug stage, and early to mid-gastrulæ were kept similarly until the neural-plate stage. They were then fixed in 10 per cent trichloracetic acid, sectioned at 5 μ, coated with Kodak autoradiographic film and exposed for 10–35 days; after development they were lightly stained with Mayer's hæmalum. The autoradiographs of the late yolk-plug embryos show strong incorporation into the nuclei of the mesoderm, both that which had already invaginated to form the archenteron roof and that which still remained on the surface. There was also a somewhat high incorporation into the nuclei of the presumptive neural plate; but in the epidermis and endoderm there is no appreciable difference in activity between the nucleus and cytoplasm. In the neural-plate embryos, heavily charged nuclei are found in the archenteron roof and more lateral mesoderm, and also in the neural plate itself (Fig. 1). Some endoderm nuclei are beginning to be charged at this stage; but there is still no sign of high activity in the epidermis, although this is very obvious at a rather later stage in *Xenopus*[2]. We thus have clear evidence of a high metabolic activity of the nuclei, beginning in the organizer region and spreading to the neural tissue which it induces. Work is proceeding on the characterization of the substances into which the glycine is incorporated.

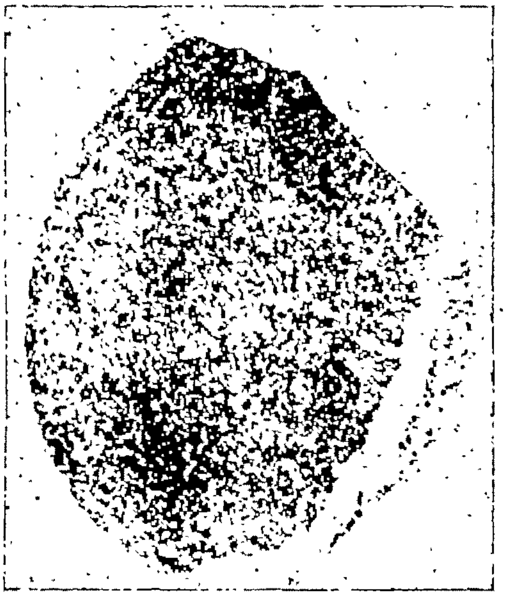

Fig. 1. Autoradiograph of a neural-plate embryo. (× 60)

This work received financial support from the Agricultural Research Council.

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Partial Sex Linkage in the Mouse

THE chromosomes of *Mus musculus* have a high chiasma frequency[1], and for this reason very loose linkages are to be expected. Many of the problems of linkage and independence in this species may therefore have to be solved by cytogenetic methods rather than the breeding techniques of formal genetics.

Among them is the question whether linkage group VII is carried in the pairing segment of the sex chromosome. Partial sex linkage of two group VII mutants, *waved*-2 (*wa*-2) and *shaker*-2 (*sh*-2), was reported in 1947 by Wright[2]. However, there were two unusual features in her results, namely, (*a*) recombination was in excess of 50 per cent, and (*b*) *wa*-2 and *sh*-2 showed the same recombination with sex, though they are not closely linked. As a result, the partial sex linkage interpretation has not been universally accepted. Carter and Phillips[3] repeated Wright's experiment, but failed to find any consistent evidence of sex linkage.

With the object of obtaining evidence on questions such as this we have induced a number of translocations in the mouse, using X-rays, and have identified linkage groups involved in eleven of them. One translocation, *T*8, involves groups I and VII. The linkage with group I was found by backcrossing animals heterozygous for *T*8 and for the group I marker *chinchilla* (c^{ch}) to chromosomally normal $c^{ch}c^{ch}$ homozygotes, and testing their progeny for the semi-sterility which indicates the presence of the translocation. No recombinants were found among forty-seven tested gametes. The *c*-locus was then used for 'tagging' the translocation in further linkage tests, and was found to show close linkage with *wa*-2 and loose linkage with *Rex* (*Re*), also in group VII:

Genotypes of parents	Phenotypes of progeny			
$T8++/+c^{ch}wa\text{-}2 \times +c^{ch}wa\text{-}2/+c^{ch}wa\text{-}2$	$\frac{++}{8}$	$\frac{+wa\text{-}2}{0}$	$\frac{c^{ch}+}{1}$	$\frac{c^{ch}wa\text{-}2}{12}$
$T8++/+c^{ch}Re \times +c^{ch}+/+c^{ch}+$	$\frac{+Re}{5}$	$\frac{++}{11}$	$\frac{c^{ch}Re}{14}$	$\frac{c^{ch}+}{3}$

Translocation *T*8 thus offers a means of settling the question whether linkage group VII is sex-linked. The translocation and the sex bivalent should be cytologically recognizable in primary spermatocytes; it should therefore be possible to establish their chromosomal independence or interdependence.

This work was part of a programme carried out for the Medical Research Council.

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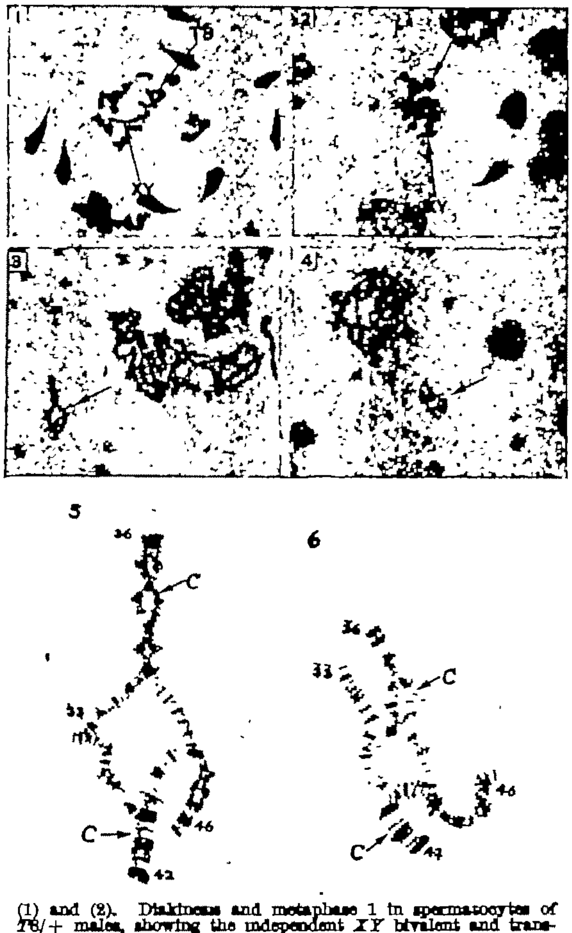
Cytological study of mice heterozygous for the translocation *T*8, mentioned above by Carter, Lyon and Phillips, shows that it does not involve the sex chromosomes. The *XY*-bivalent is clearly recognizable in the accompanying microphotographs of diakinesis and metaphase nuclei of *T*8/+ males and, independent of it, the translocation figure. Analysis of the pachytene figures in the other two photographs has shown that the translocated chromosomes are the medium-sized autosomes numbered 11 and 13 in the preliminary pachytene map of the mouse[1].

It follows that loci in linkage groups I and VII in the house mouse cannot be partially sex linked.



(1) and (2). Diakinesis and metaphase 1 in spermatocytes of *T*8/+ males, showing the independent *XY* bivalent and translocation figure

(3)–(6). Microphotographs and camera lucida drawings of *T*8 in two spermatocyte pachytene nuclei. Autosome 11 is at the upper left part of each figure, autosome 13 lower right; the numbers refer to divisions on the preliminary pachytene map; *C* denotes the centromere

This work was supported by the Medical Research Council.

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[1] Slizynski, B. M., *J. Genet.*, 49, 242 (1949).

Placental Transfer of a High Molecular Ferric Carbohydrate

In 1953, I suggested[1] that the placental transfer of iron in the rat is brought about by the placental structures building up a fairly high concentration of some hydrolysable iron compound or compounds, partly or wholly ferritin, the source of which was supposed to be the maternal serum iron. The fœtal needs for the metal were taken to determine the rate at which these intermediate placental iron compounds were mobilized. The iron transfer from the maternal to the fœtal organism thus seemed to be regulated in a manner not very different from that suggested by Granick[2] for the gastro-intestinal absorption of iron. Since Nissim[3] first introduced saccharated colloidal iron for parenteral use, several papers on this subject have appeared. Considering the possibility of an untoward effect upon the fœtus brought about by the colloidal iron preparation, it seemed important to investigate this therapeutic agent, particularly as to permeability of the placenta to it, before recommending its use in the anæmias of pregnancy. In doing so, I have used the material and techniques described in my earlier communication[1], in which measured values in normal untreated pregnancy were given; these values have been used as controls in the present investigation.

1 ml. of 'Ferrigen' (in the United States 'Astrafer'), kindly put at my disposal by Astra Ltd., Södertälje, Sweden) was injected intravenously into the pregnant rat 24 hr. before killing; 'Ferrigen' is a ferric carbohydrate of high molecular weight, the stable solution of which contains 20 mgm. of elemental iron/ml., and has a *p*H of 7·3. 51 pregnant rats were used and divided into five groups, pregnancy being allowed to continue for 15, 17, 19, 20 and 21 days. The iron fractions determined were the same as measured earlier[1], that is, for the fœtal bodies: (1) the total iron of the fœtus, and (2) the iron hydrolysable according to the method used (the latter iron fraction was taken to correspond to the depot iron fraction). In the placental organs the hydrolysable iron fraction only was recorded.

It was found that the maternal rats did not reveal any blood dilution 24 hr. after the injection, the hæmatocrit values being within the normal range (41·0 ± 0·9). The plasma iron values of the mother rat were high, the mean value being 265 ± 13·1 γ per cent. As the iron saturation limit for rat serum has been found to be about 500 γ per cent[4], it was concluded that no loosely bound iron was left in the plasma. The values for the hydrolysable iron fraction of the maternal livers was found to be about four times that measured in normal untreated pregnancy, or 48·0 ± 2·9 mgm. per cent. In all the above-mentioned respects, the maternal animals were identical without significant variations associated with the duration of pregnancy. The total and hydrolysable iron concentrations of the fœtal bodies at different stages of pregnancy are shown in Fig. 1. From the fairly high concentrations of total and

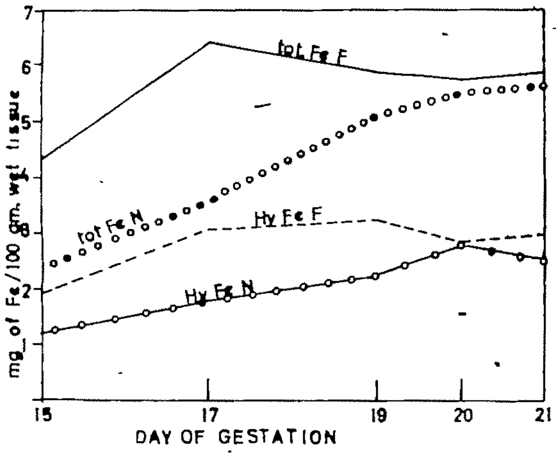

Fig. 1. Total and hydrolysable iron per unit fresh fœtal weight in 'Ferrigen'-treated (*F*) and untreated (*N*) rats during the observed period of pregnancy

hydrolysable iron measured in the fœtal bodies of the rats treated with 'Ferrigen' in the earlier period of gestation, it is clear that some of the iron of the therapeutic agent has passed through the placental barrier. If the preparation had passed freely and unaltered through, we would expect its passage to increase with the duration of pregnancy (see Flexner and Gellhorn[5]). Here, however, the reverse happens. Furthermore, since the iron compound of 'Ferrigen' is very easily hydrolysable, we would expect to find the hydrolysable iron fraction to be proportionally further increased if the preparation had passed the placental barriers unaltered. This did not happen; the hydrolysable iron fraction throughout constitutes some 50 per cent of the total fœtal iron, as was the case in untreated pregnancies. Hence the ferric carbohydrate does not pass through the placental organs unaltered, but is broken down by the maternal organism, giving rise to increased iron depots and serum iron concentration. This is accompanied by an increased synthesis of the intermediate placental iron compound referred to earlier (Fig. 2), from which iron is mobilized by the fœtus according to its need. It is important to note that at no stage of pregnancy do the fœtal bodies of the 'Ferrigen'-treated rats accumulate more iron than is found at term in untreated pregnancies.

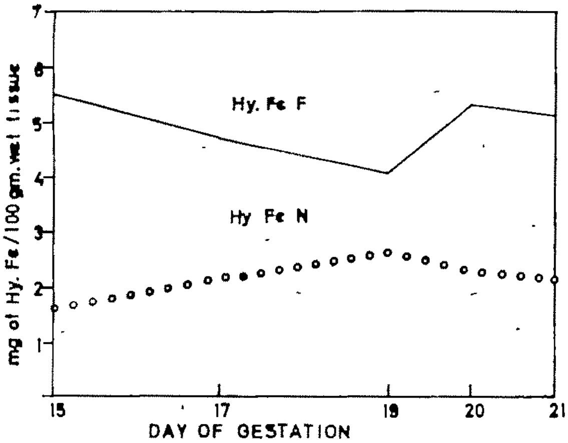

Fig. 2. Hydrolysable iron content per unit fresh weight of the total placental organ during the observed period of 'Ferrigen'-treated (*F*) and untreated (*N*) pregnancies

The features of placental iron transfer suggested here are further supported by the finding that in the 'Ferrigen'-treated rats the period of greatest iron transfer to the fœtus coincides with the lowest iron concentration measured in the placental structures.

A detailed report of these investigations will appear elsewhere.

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Effect of Cervical Sympathectomy on the Onset of Œstrus in Ferrets

THE view that the hypothalamus controls the functions of the pars distalis of the pituitary by way of a chemotransmitter transported through the pituitary portal vessels does not accord with the fact that female ferrets, when exposed to added light, will come into heat during the winter months, whether or not there is a direct vascular link between the pituitary and the hypothalamus[1]. Attention has therefore been turned again to the possibility that peripheral nervous pathways may be concerned in the response.

Bilateral superior sympathetic ganglionectomy was performed on sixteen female ferrets during the autumn of 1953. Seven of these animals were exposed to evening illumination (4.30–10.30 p.m. daily) beginning October 30, 1953. The remaining animals were kept under ordinary laboratory conditions. Sham operations were performed on four animals, all of which were exposed to extra light. Fourteen normal female ferrets were housed as control animals with the group of seven operated animals receiving added light, and nineteen normal female ferrets were kept as normal control animals for the nine operated animals in the non-illuminated group.

By January 22, 1954, the eighteen non-ganglionectomized ferrets which were exposed to added light were in full œstrus. At this time no sign of œstrus was apparent in any one of the seven ganglionectomized animals kept in the same room. These animals were still ancœstrous in the middle of June 1954.

Normal spring œstrus had begun by early April in all the nineteen normal control animals kept under ordinary laboratory conditions. At the time of writing, all but two of the nine ganglionectomized animals kept under the same conditions were still ancœstrous.

The results suggest that the cervical sympathetic chains are in some way concerned in the mechanism whereby the exposure of ferrets to light accelerates the onset of œstrus.

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Injurious Effect of Air-saturated Water on Certain Invertebrates

It is generally accepted by zoologists as a law of Nature that aquatic animals benefit by as much dissolved air as they can get. Consequently, after a catch is brought home from pond or shore the water is if possible aerated. Yet it is known, especially from the classical work of Juday[1], that whereas the oxygen content of the deep water of certain lakes falls very low and remains so for several months in summer, there is an active invertebrate fauna in and above the mud. It has never been suspected, however, that dissolved oxygen at atmospheric partial pressure, that is, in fully aerated water, might actually be harmful to certain mud dwellers in pond and sea; yet we have found this to be so.

Experiments have now been made in which the survival-time was compared, in water at two different degrees of aeration, of aquatic invertebrates that live in or near the surface of mud. In each experiment, through one sample of water, containing animals, air was bubbled continuously for several weeks, and through another a mixture of one part of oxygen to twenty-four parts of nitrogen, giving water approximately one-fifth aerated. The following animals survived longer in the less well-aerated water: the larvæ of *Chironomus* and of *Anatopynia* (another chironomid midge), *Heterocypris* (an ostracod), young *Tubifex* and young *Scoloplos* (a polychæte worm). The following animals lived equally well in one-fifth aerated and in fully aerated water: *Herpetocypris* (another ostracod), adult *Tubifex*, young *Arenicola*, adult *Planorbis*, *Physa* (another pond snail), *Pisidium* and *Phaenocora* (a rhabdocœle worm). The only animals which survived longer in fully aerated than in poorly aerated water were *Sabella*, young *Planorbis* and young *Limnaea*.

Not only did a number of species survive longer in poorly than in well-aerated water, but *Chironomus* larvæ, young *Tubifex* and young *Scoloplos* grew bigger in the poorly aerated water. In addition, although fewer young *Planorbis* survived in poorly aerated water, nevertheless they grew bigger in it, and *Phaenocora*, which survived equally well in well-aerated and poorly aerated water, grew bigger in the latter.

A full account of this work, in which specific names will be given, is to be published in the *Proceedings of the Royal Society*.

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Chlorophyllide, the Probable Precursor of a Growth Inhibitor

When investigating the production of growth substances by *Chlorella vulgaris* var. *viridis*, difficulties were met which were ascribed to a growth-inhibiting substance, possibly Pratt's 'chlorelline'[1]. *Staphylococcus aureus* proved to be a suitable test object for the growth inhibition. Small pieces of filter paper or agar slices containing concentrated and dried crude ether extracts of *Chlorella* were placed on agar plates seeded with bacteria. After 2–5 hr. of diffusion of the extract, and incubation of the bacteria at 37° C., clear inhibition zones were visible around the filter paper or agar slices.

When trying to separate the supposed chlorelline from the growth-promoting substances by shaking ether extracts with dilute hydrochloric acid or sodium bicarbonate, the chlorelline always disappeared from the alkaline as well as from the acid solutions, and also from any remaining ether extract. It was found that light—daylight and red light—inactivated the chlorelline during the working up of the extracts. Green light was inactive, so the manipulations were carried on in dim green light.

Bacillus subtilis proved to react differently from *S. aureus* with chlorelline. In the first place, the inhibition zones were larger than those of *S. aureus*. Secondly, light did not always inactivate the antibiotic action, and thirdly, after the plates had been developed, the inhibition zones expanded during several days in diffuse daylight.

This suggested that chlorelline consists of more than one component. The spectral activity indicating some relation with the chlorophylls, a mixture of benzene, petroleum ether and acetone (10 : 2·5 : 2), was used as a solvent for the separation of the components by paper chromatography. The ether extract was spotted on a paper strip (Whatman No. 4, buffered at pH 6, stored above sulphuric acid) and the ascending method was used. After drying, the paper strips were tested on agar plates seeded with bacteria. The plates received dim light in the incubator. *S. aureus* showed one zone of inhibition ($R_F = 0$) around the spot of the chlorophyllides on the strip; *B. subtilis* showed three zones of inhibition: (*a*) $R_F = 0$, expanding after development; (*b*) $R_F = 0{\cdot}60$, just below the xanthophyll; (*c*) $R_F = 0{\cdot}95$ at the same spot as the carotene.

Being mainly interested in the zone with $R_F = 0$, because of its expansion, we stopped the investigation of the two other inhibitors, which are only active on *B. subtilis*, for the time being.

We first examined the later expansion of the inhibition zone with *B. subtilis*, and found that this is due to the fact that *B. subtilis* can contract in spore form; *S. aureus* cannot do this.

When testing whether light is responsible for the expansion on the *B. subtilis* plates, we obtained varied results. Plates of *B. subtilis* and of *S. aureus* supplied with dried ether extracts on filter paper were incubated immediately in the light (daylight and red light) and in the dark (green light) respectively. In the dark no inhibition was found whatsoever and in the light scarcely any.

After testing several possible explanations with negative results, we came to the next hypothesis, namely, that there is a precursor of the inhibitor proper which is soluble in ether and in water. This precursor would diffuse into the agar plates and be transformed by radiation into an inhibitor which cannot diffuse. Experiment proved that this explanation is the correct one.

The extract was allowed to diffuse from the filter paper into water. The solution formed was tested by means of the cup test on plates with *B. subtilis*. All manipulations were carried out in green light. After incubation in the dark, no zones were present; but after a few hours exposure to daylight clear zones appeared. Controls, remaining in the dark, continued to show no inhibition. Also with *S. aureus* the inhibitor could be demonstrated, provided that the plates were illuminated only after the diffusion of the precursor had taken place. The zones produced in our early experiments evidently were due to the admission of light, which we had not yet learned to avoid properly, after a certain diffusion time in the dark.

We consider these experiments as a proof that the inactive precursor is soluble in water and in ether and is converted by (red) light into the inhibitor, which is either insoluble in water or strongly adsorbed to the carrier (paper or agar).

The evidence that chlorophyllide is the precursor of the inhibitor is corroborated by four further observations: (1) extracts of *Chlorella* cells, grass and kale all show the same inhibition phenomena; when chromatographed, the precursor had always the same R_F value as the chlorophyllide, which is formed during the extraction while the extract is in contact with the extracted cells, that is, in the presence of chlorophyllase; (2) the inhibitor always appears exactly on the same spot as the chlorophyllides, when chromatographed with water, ether, acetone, ethylacetate, a mixture of benzene, petroleum ether and acetone, butanol–water, butanol–water–ammonia, butanol–water–acetic acid, *iso*propanol–water–acetic acid, *iso*butanol–water; (3) the inhibitor is produced only from extracts kept in contact with the cells or tissue and which contain chlorophyllide; we were unable to find it in fresh extracts, extracts from boiled tissue and extracts kept apart from the cells or tissue, all of them containing chlorophyll-*a* and -*b*, but no, or scarcely any, chlorophyllide; (4) when the inhibition has become apparent after illumination, the chlorophyllide has bleached.

A detailed account of the experiments will be published elsewhere.

Investigations are in progress on the interaction of chlorophyllide and light on the cell division of *Chlorella* and of other green plants, especially in view of the many phenomena controlled by light, particularly by the longer wave-lengths, probably through inhibition of cell division (photoperiodicity, leaf abscission, dormancy of seeds, etiolation, etc.).

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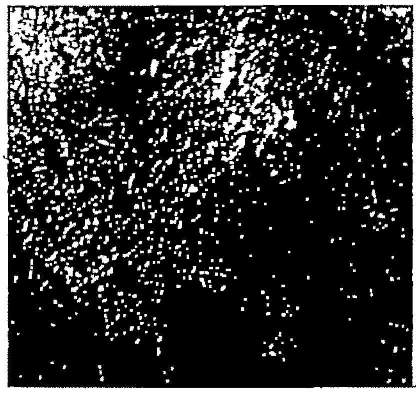
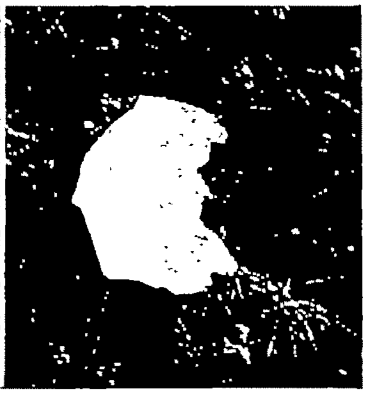
[1] Pratt, R., *Amer. J. Bot.*, **29**, 142 (1942); **31**, 418 (1944); **35**, 634 (1948).

Rapid Extraction of Intact Crystalline Inclusions from the Cells of Plants Infected with Tobacco Mosaic Virus

The intracellular inclusions produced by different plant viruses vary in their stability and resistance to handling. In 1950, I extracted[1] intact inclusions formed by the viruses of cabbage black ringspot, cauliflower mosaic, severe etch, *Hyoscyamus* mosaic and tomato aucuba mosaic. All these inclusions are resistant to handling and are only slightly soluble in distilled water. On the other hand, the inclusions formed by tobacco mosaic virus, as shown by Sheffield[2], are very soluble in water and extremely fragile. In 1953, Steere and Williams[3] devised a freeze-drying technique which enabled these intracellular inclusions to be removed from the cell intact and photographed in the electron microscope.





Since the effect of freeze-drying is probably only a fixation of the nucleoproteins, a much more simple and rapid method has been devised. This consists in removing strips of epidermis, containing crystalline inclusions, from the leaves of mosaic-infected tobacco plants, and immersing them for 3–4 min. in Carnoy's fluid. They should then be rinsed in 96 per cent alcohol and placed in distilled water. The intact crystals can then easily be removed by means of two fine needles, and mounted for electron microscopy. If necessary, the inclusions can be preserved in 96 per cent alcohol for a year or more.

Figs. 1 and 2 are electron micrographs of two crystalline inclusions of tobacco mosaic virus obtained by this method. They show clearly the arrangement of the virus particles.

Acknowledgments are due to Mr. J. D. Bakker for taking the electron micrographs and to Prof. Van Slogteren, director of the Laboratorium voor Bloembollenonderzoek, Lisse, Holland, where this work was carried out.

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A New Type of Branching in Liverworts

Recently, we began a study of the morphogenetic effect of various factors on the gemmæ of *Marchantia polymorpha* and *Lunularia cruciata*. These structures offer excellent material for such studies, since they are readily obtainable in quantity at all seasons of the year, are large enough to be handled readily, but small enough to be economical of space and require no special equipment for their study beyond some Petri dishes and a dissecting microscope. We have found that they are sensitive to treatments of many kinds; but for some reason they seem to have been overlooked, for we have been able to find only one paper on experimentation with them—that of Nagai[1], who plasmolysed them with rather interesting results.

At the very beginning of our studies, we found that gemmæ treated in a number of different ways responded by branching in a most unusual manner. Ordinarily, thalli of *Marchantia*, *Lunularia* and other thallus liverworts spread out in a fan-like shape and become continually wider by the extension of thallus tips and the formation of new apical cells from time to time. The new type of branching took place at right angles to the usual direction of branching. This resulted in the formation of two lobes at the tip of the thallus, with one above the other so as to produce a 'double-decker' effect.

Gemmæ which had been treated with various concentrations of a number of substances were grown on a klinostat; it was found that the direction of branching had no relation to the direction of the pull of gravitation, but always took place in a plane parallel to that of the flat surface of the thallus, regardless of the orientation of that structure.

The peculiar type of branching has been produced by all the following substances: acenaphthene, actidione, caffeine, colchicine, chromic acid, naphthalene, parathion, picric acid and sodium cacodylate.

The preceding represents a most diverse and miscellaneous group of chemicals, which have little in common save that five of them are known polyploidizing agents. Thus far, of chemicals tested, surprisingly few have failed to induce the new type of branching. Plant growth hormones—indole acetic acid, indole butyric acid, maleic hydrazide, diphenylamino, ether, benzoguanimine, and dichlorophenoxyacetic acid (2-4-D) have not produced branching.

Irradiation with ultra-violet light produces the new type of branching, and cobalt irradiation has a like effect.

Branching of this type appears to be transitory. Usually, the lower lobe of a pair secures dominance over the upper and grows out rapidly, leaving the upper lobe as a mere ridge or at most a ligule-like appendage. Very rarely, the upper lobe becomes the dominant one and the lower one is then suppressed. In gemmæ grown on the klinostat, both upper and lower lobes may grow for two or three weeks. However, after that length of time, and while still on the klinostat, the lower lobe usually becomes dominant, and the two, formerly independent, lobes grow together in some way not yet understood.

In spite of the results secured with several substances which are known often to cause polyploidy, it is not thought that this branching is due to polyploidy, nor does it appear that any of these effects are permanent. Chromosome counts will be made to find out whether or not polyploidy plays a part in the process. It is proposed also to make studies on the mechanism of this type of branching.

It is notable that branching of this type has never been reported in Nature and has never been found in any growths of *Lunularia* and *Marchantia* observed by either of us in greenhouses or in the open. It has, however, appeared two or three times in control cultures of *Lunularia* grown on filter paper in Petri dishes. A somewhat similar type of bifurcation has been produced by Labouriau[2], by the application of growth hormones to the leaves of the fern, *Anemia collina raddi*.

Details of studies on the new type of branching and of other morphogenetic effects of various factors on liverwort gemmæ will be published elsewhere.

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[1] Nagai, I., *Bot. Mag.*, 33, 99 (1919).

[2] Labouriau, L. G., *Rev. Bras. Biol.*, 12, 33 (1952).

Amino-Acid Content of Plants

WITH the object of correlating existing information and the possibility of establishing a relationship with taxonomy, we have examined, both qualitatively and quantitatively, the free and combined amino-acid content of the cell juices of a number of plants widely distributed throughout the vegetable kingdom, using a carefully worked-out paper chromatographic method. A complete account of the work will be published in due course; but in view of recent publications[1] on the use of paper chromatography in the study of various aspects of the distribution and metabolism of amino-acids in plants, it appears to be desirable to place on record the results we have obtained during the past few years.

Table 1 gives the percentages of the total (Kjeldahl) nitrogen present in that portion of the total solids of the plant juice soluble in 75 per cent ethyl-alcohol as each of the amino-acids listed, and Table 2 the corresponding figures for the amino-acids found in hydrolysates of the insoluble residues after alcohol extraction. The amino-acids found in *Malus sylvestris* agree with those qualitatively identified by Hulme and Arthington[2]. *Funaria hygrometrica*, *Mucor mucedo*,

Table 1. AMINO-ACIDS AND AMIDES PRESENT IN 75 PER CENT ALCOHOL EXTRACTS

Acid	*Beta vulgaris*	*Malus sylvestris*	*Funaria hygrometrica*	*Pinus sylvestris*	*Mucor mucedo*	*Equisetum arvense*
Alanine	5·3	1·7	1 7	5·4	1·8	5 8
β-Alanine	8·3	1·2	—	2 8	—	—
Arginine	3·5	9 2	9·4	9 4	4·8	9·6
Asparagine	7·6	12·2	1·4	2 4	9·5	10·2
Aspartic acid	4·5	7·4	15 4	2·7	22 8	7·4
γ-Amino butyric acid	8·0	9·8	5·3	6·3	6·8	3·5
Citrulline	—	—	6 3	—	—	—
Cystine	0·8	—	2 2	—	—	—
Glutamine	26·2	24 8	2 3	5·3	15 2	15·4
Glutamic acid	6 0	8 9	23·4	43 2	11·6	8·2
Glycine	2 0	1·2	0 5	2·4	1·9	2 5
Histidine	3·0	—	—	—	—	—
iso-Leucine	1·0	2 6	1·2	1 9	1·9	2·9
Leucine	3·4	8 4	10·4	1·7	2·4	7 8
Lysine	2·2	0 8	7·2	1 4	3·7	4·5
Methionine	—	—	—	1·3	0·6	0·9
Proline	—	1·3	—	—	1·4	—
Phenylalanine	2·0	1·4	0 6	—	0·9	0 9
Serine	4·0	0 9	0·6	0·7	2·4	2 5
Threonine	3·6	1·0	0·8	1·6	1·1	4 1
Tyrosine	2·0	0·9	2·4	0·9	1·2	0·9
Valine	2·3	2·4	2·4	4·9	2·9	6·2
Total	95 7	96 1	92·6	93·3	92·9	93 3

Table 2. AMINO-ACIDS PRESENT IN HYDROLYSATES OF ALCOHOL-INSOLUBLE FRACTIONS

Acid	*Beta vulgaris*	*Malus sylvestris*	*Funaria hygrometrica*	*Pinus sylvestris*	*Mucor mucedo*	*Equisetum arvense*
Alanine	6 8	3·6	6·8	8 6	6·7	4·3
Arginine	14 3	15·8	13·2	15·7	12·2	19 5
Aspartic acid	9 0	10·2	7·8	10·2	16 4	8·2
Cystine	1·1	1 0	1 5	1 2	2·2	—
Glutamic acid	21·2	19·2	18·8	20·2	35·2	14 5
Glycine	4 7	3 8	6·5	3·6	8·8	6 5
Histidine	2 0	2·1	—	4·1	1 6	4·2
Hydroxy-proline	—	1·0	—	0 9	—	—
iso-Leucine	2·2	4·1	2·2	6·1	0·7	4·3
Leucine	10·8	18 9	11·3	14 2	5 2	9 6
Lysine	2 5	2 2	8 4	2·2	3·8	11·2
Methionine	2·5	2·1	0·9	1 2	1·1	1·4
Proline	4·5	3 4	4·2	1·7	4·2	5·1
Phenylalanine	3·1	2·4	5 6	2 4	1 0	4·2
Serine	4·5	3·0	3·4	0·6	3 3	2·8
Threonine	4·0	2·3	4·4	0·6	2·2	3·7
Tryptophan	3·2	2·5	—	2 5	—	—
Tyrosine	2·8	2·1	3·0	2 1	2·1	3 7
Valine	6 2	6·0	7·2	1 9	4·4	2·3
Total	105·4	105 7	106·1	104·0	105·1	105 5

Pinus sylvestris and *Equisetum arvense* were chosen as well-known examples of the Bryophyta, Thallophyta, Gymnospermae and Pteridophyta respectively. We have also obtained qualitative results on *Lolium italicum* which agree closely with those of Synge[3] on *L. perenne*, and on *Medico sativa* agreeing with those of Vickerey[4], who used standard chemical methods of analysis.

E. arvense has also been examined at regular intervals throughout the development of the sporophyte generation.

Work on these and related lines is being actively pursued.

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Occurrence of *Falkenbergia rufolanosa* in the Isle of Man

Since the reports by de Valera[1], Harvey and Drew[2], and Drew[3] of the occurrence of *Asparagopsis armata* Harv. and what is believed to be another phase of its life-history, *Falkenbergia rufolanosa* in a number of localities in Ireland and on the south-west coast of England, its spread around the British coast has been watched with interest by phycologists. A spread eastwards along the south coast was reported by Kerslake[4] in September 1953 when *Asparagopsis armata* was found on Wembury Beach.

During the course of a survey of an area in and around the harbour at Port St. Mary, Isle of Man, by a party of students from the University of Liverpool and Royal Holloway College, London, at the end of March, *Falkenbergia rufolanosa* was found in great quantity floating in the water in the harbour at low tide, and both floating and attached to other seaweeds in pools in various positions on the shore. This is the first record for the plant in the Isle of Man, and it is of interest that it should appear in abundance, first of all, in one of the functioning harbours and one used by coastal vessels. A search of the shores near by indicated that it had, as yet, spread very little from the harbour, though the spread had obviously begun; it was found growing attached in a few pools on the outer side of the breakwater, and one can perhaps assume that its spread around the Island is only a matter of time. Of all the material examined, none was found to be reproducing.

It will be of interest to see whether the invasion of the Isle of Man by *Falkenbergia* is followed, as it has been in other places, by *Asparagopsis armata*.

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Use of Glutamine by the Mammary Gland for the Synthesis of Casein

In continuation of earlier work on casein synthesis[1], further experiments have aimed at determining which components, taken from the blood-stream by the mammary gland, provide the glutamic acid of casein.

1-^{14}C DL-glutamine was injected intravenously into a lactating goat and specific activities were measured in various components of blood and milk taken at intervals up to 12 hr. after injection. During the first few hours the specific activity of the free glutamine of plasma remained many times that of both the free glutamic acid and the glutamic acid of plasma proteins. This difference is illustrated (Table 1) by the specific activities in blood taken at 3 hr. after injection; in samples taken at 20 min. and 1 hr. the specific activities of glutamine were higher than at 3 hr. while those of free glutamic acid and plasma protein glutamic acid were approximately the same or lower.

Table 1. SPECIFIC ACTIVITIES IN BLOOD AND MILK SAMPLES TAKEN AT 3 HR. AFTER INJECTING 1-^{14}C DL-GLUTAMINE (425 MGM. : 38·0 μC.) (μc./m.mol. carbon in carbon No. 1)

Blood plasma		Milk	
Free glutamine	117×10^{-6}	Casein glutamine (*a*)	143×10^{-6}
Free glutamic acid	$27{\cdot}2 \times 10^{-6}$	Casein glutamic acid (*a*)	$< 25 \times 10^{-6}$
Plasma protein glutamic acid	$1{\cdot}73 \times 10^{-6}$	Total glutamic acid of casein (*b*)	122×10^{-6}

(*a*) After enzymatic hydrolysis (*b*) After acid hydrolysis.

Casein samples were hydrolysed in two ways: by heating with hydrochloric acid and by incubating with a pancreas suspension. The specific activity of glutamic acid in each acid hydrolysate was measured, and glutamine and glutamic acid were isolated from each pancreas hydrolysate and their specific activities also measured. The first milk sample was taken at 1·5 hr.; the specific activities found in the casein of the second milk sample taken at 3 hr. are shown in Table 1. It is seen that the specific activity of casein glutamine is slightly higher than that of the free glutamine of plasma at 3 hr., while that of casein glutamic acid is much lower. The results suggest that those residues which are present in casein as glutamine are derived largely from the free glutamine of plasma, and those present as glutamic acid are derived from some other source.

To confirm that the free glutamine of plasma is directly incorporated into casein, (1-^{14}C : amide-^{15}N) DL-glutamine was injected intravenously into the goat and milk taken at 1·5 hr. after injection. It is seen in Table 2 that, as expected, the ratio (μc/m.mol. carbon : atoms per cent excess ^{15}N) in the glutamine

Table 2. (1-^{14}C : AMIDE-^{15}N) DL-GLUTAMINE (563 MGM.) INJECTED AND MILK TAKEN 1·5 HR. LATER

	Atoms % excess ^{15}N	μc./m.mol. carbon in carbon No. 1	$\dfrac{\text{μc./m.mol. carbon}}{\text{Atoms \% excess }^{15}\text{N}}$
Injected glutamine	25·8	$1{,}800 \times 10^{-6}$	$69{\cdot}8 \times 10^{-6}$
Casein glutamine	0·611	$30{\cdot}6 \times 10^{-6}$	$50{\cdot}1 \times 10^{-6}$
Amide N. of casein (*a*)	0·444	—	—
Non-amide N of casein (*b*)	0·004	—	—

(*a*) Nitrogen released as ammonia on acid hydrolysis. (*b*) Nitrogen not released as ammonia on acid hydrolysis.

of casein was approximately the same as in the injected glutamine.

It has been postulated that γ-glutamyl peptides formed from glutamine by enzymatic exchange reactions are important intermediates in protein synthesis[2]. The present results suggest that the glutamine which is incorporated into casein does not exchange or lose its amide nitrogen in the process, and therefore apparently does not pass through intermediate γ-glutamyl peptides.

Techniques which differed from those used in previous work on casein synthesis[1] were as follows. 1-^{14}C DL-glutamine was synthesized from 1-^{14}C DL-glutamic acid by the method of King and Kidd[3]; amide-^{15}N DL-glutamine was synthesized from DL-glutamic acid and ^{15}N ammonia by a slight modification of the same method. The pancreas suspension contained 25 gm. of fat-free and minced pig pancreas/100 ml. 25 per cent ethanol; before use it was incubated and then dialysed to remove amino-acids. Glutamine and glutamic acid were isolated from blood plasma, and protein hydrolysates, by chromatography on 'Dowex-50' resin. Specific activities of carbon No. 1 of glutamine and glutamic acid were measured after decarboxylation with glutamic decarboxylase. The amide nitrogen was obtained from glutamine for ^{15}N analysis by converting to pyrrolidone carboxylic acid and ammonia.

I am indebted to Dr. D. D. Woods for providing the glutamic decarboxylase and pancreas suspension, and to Dr. D. H. Tomlin for making the determinations of nitrogen-15.

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A Case of *Shigella sonnei* Septicæmia in a Calf

During the course of routine laboratory examinations performed on a long bone from a two months-old calf, which died without symptoms the previous day, we isolated in pure culture from the bone-marrow a strain of a Gram-negative, non-motile, non-spore-forming organism.

At the time of the isolation, it exhibited the following characteristics:

Glucose	acidified without gas in 24 hr
Lactose	acidified without gas in ten days
Saccharose	acidified without gas in eight days
Mannitol	acidified without gas in 24 hr.
Rhamnose	acidified without gas in four days
Salicin	no fermentation recorded in thirty days
Xylose	no fermentation recorded in thirty days
Methyl red reaction	positive
Voges–Proskauer reaction	negative
Indole	no production recorded
Hydrogen sulphide	no production recorded
Urease	no production recorded
Sodium citrate	no growth recorded
IMVIC formula is thus	– + – –

As these were the characters of *Shigella sonnei*, the agglutination with an antiserum was performed and confirmed the identification.

This is the first case, so far as we know, of a human *Shigella* occurring in an animal, either as an intestinal infection or as a septicæmia. The finding of *Sh. sonnei* in the medulla is not extraordinary, since it has already been described in human beings[1]. The importance of our finding is still to be assessed, especially for its repercussion in meat hygiene.

We are indebted to Dr. R. Buttiaux for confirmation of our diagnosis. Full details of our investigations will be published elsewhere.

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Identification of Certain 'Ketosteroids' from Cattle Urine as Ionone Derivatives

In recent years, our knowledge of 17-ketosteroid excretion and metabolism in the human being has greatly increased. However, in the little research work in this field which has been devoted to cattle, great uncertainty has always prevailed regarding the nature of the compounds measured by the Zimmermann or Pincus reaction. All investigators are agreed that the steroids from cattle urine could in no case be identical with the 17-ketosteroids from human urine[1].

A short time ago we succeeded in identifying several of these compounds as ionone derivatives, which Prelog and his co-workers isolated from pregnant mares' urine[2]. The presence in cattle urine of these substances had been surmised by Klyne (personal communication). One of the two main fractions, which we obtained by chromatography of the neutral ketonic lipid fraction from cattle urine, without regard as to whether it was urine from bull, cow or ox, proved to contain (2,3,6-trimethyl-benzal)-acetone (Prelog's ketone *J*) among other, as yet unidentified, compounds. The other main fraction consisted almost entirely of 5-hydroxy-*cis*-tetrahydro-ionone (Prelog's hydroxyketone *G*) and a smaller fraction, which follows the second main fraction, consisted of this compound and 5-oxo-*cis*-tetrahydro-ionol (Prelog's hydroxyketone *E*). The presence in cattle urine of other ionone derivatives which have been isolated from mares' urine, such as 5-oxo-*cis*-tetrahydro-ionone (Prelog's diketone *D*), 2,2,8-trimethyl-bicyclo-[0,0,4]-dekadien-5,7-one-4 (Prelog's ketone *K*) and a bicyclic hydroxyketone of not fully established structure (Prelog's hydroxyketone *C*), is not excluded, but as yet not definitely proved.

It is very remarkable that all these substances react in the Zimmermann test. The absorption spectra of several of the coloured compounds are identical with those of cattle urine extract: an absorption curve which falls continuously from shorter to longer wave-lengths with a more or less pronounced plateau at about 500 mμ. One of the compounds (ketone *J*) even gives a pure violet Zimmermann colour which is similar to that of 17-ketosteroids. It shows a distinct absorption maximum at 530 mμ and low absorption at shorter wave-lengths.

With the Pincus reagent the hydroxyketone *G* gives a blue-violet colour with an absorption maximum at 550 mμ, identical with the colour given by the second main fraction from cattle urine extract. In some cases this absorption maximum appears in the Pincus colour of the total ketonic fraction. This maximum has also been described previously by Meschaks and by Mixner and Saunders.

Among these ionone derivatives, which form by far the greater part of the compounds determined by the usual ketosteroid reactions, a few 17-ketosteroids occurred in minute quantities. Three of these could be identified with more or less certainty as dehydro-*epi*-androsterone, etiocholanolone and 11-hydroxyandrosterone. In any event, the large amounts of the testosterone metabolites androsterone and etiocholanolone, which are excreted in human urine, were shown to be absent in cattle urine. This is most peculiar, as testosterone is believed to occur in the cattle organism. It was isolated for the first time from bulls' testes by Laqueur in 1935. These findings, however, are in accordance with the very low content of androgens in bulls' urine.

As to the origin of these ionone compounds, it is very likely that they are derived from carotenoids (Prelog *et al.*). Bearing in mind the fact that the ionone derivative 5-hydroxy-*cis*-tetrahydro-ionol, which Prelog and his co-workers isolated from pregnant mares' urine (diol *A*), has also been found in bulls' and pregnant cows' urine by Broadbent, Brooks and Klyne[3], and that horses and cattle mainly feed on the same carotene-rich material, it is not surprising that the same carotenoid derivatives should occur in the urine of both kinds of animals. It seems very probable, therefore, that these compounds will occur also in the urine of other animals whose food is rich in carotenoids, and that they will interfere there with ketosteroid determinations. We found in a preliminary investigation that they are absent from dogs' urine.

Full details of this work, which is still in progress, will be published elsewhere.

We are much obliged to Prof. V. Prelog and his co-workers, Dr. B. G. Engel and Dr. J. Würsch (Zurich), who supplied us with samples of the ionone compounds for identification purposes. Thanks are also due to Dr. W. Klyne (London) for valuable information.

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Effect of Œstrogen and of Vitamin A on Vaginal Cornification in Tissue Culture

RECENT interest in the rodent vaginal epithelium as a target organ for studying the interaction of dietary and endocrine factors[1] has led to an investigation of the post-fœtal vaginal epithelium of the rat in tissue culture. Whereas Emmens and Ludford[2] were unsuccessful in a similar attempt, quite recently Hardy, Biggers and Claringbold[3] were able to culture the mouse vaginal epithelium by the hanging-drop method and demonstrated the sensitivity of this tissue to œstrogenic substances.

In the present investigation, 99 explants of the vaginal epithelium of eleven prepuberal rats (3–4 weeks old) have been successfully grown for one to nine days in watch glass cultures[4,5], and keratinization has been produced precociously by means of œstrone (0·13 mgm./100 ml. media) added to the nutritive medium. It was found, however, that the control vaginal epithelium cultivated in a standard medium also underwent keratinization, although not as rapidly as that treated with the folliculoid.

Before cultivation the vaginal epithelium is in the typical prepuberal state. After only one or two days on the œstrogenized culture medium, the epithelium becomes stratified, squamous and highly keratinized, although not hyperplastic. Up to the second day, the control groups appear much like the tissue before cultivation; but during the third or fourth day the cells beneath the original cuboidal epithelium become squamous, and by the fourth or fifth day have formed a typical stratified squamous epithelium and keratin. On continued cultivation, the epithelium becomes highly cornified and is histologically indistinguishable from that treated with œstrone. Careful examination of the control photograph presented by Hardy *et al.*[3] shows the beginning of a stratified squamous epithelium beneath the superficial cuboidal cells in their 96-hr. culture of mouse vagina; in our experiments with rat tissue the cuboidal cells are afterwards sloughed.

These results confirm the observations of Hardy *et al.*[3] that œstrogens have a direct action on the rodent vaginal epithelium *in vitro*, but the local response to a steroid under the simplified conditions of organ culture may not be evoked in the same way as a systemically distributed steroid *in vivo*. These *in vitro* results, therefore, do not exclude the possibility of metabolic 'activation' as suggested by Szego and Roberts[6].

The tendency for the control groups to undergo keratinization may be due to a lack of available vitamin A. Recent experiments have shown that synthetic vitamin A added to the control culture medium not only suppresses keratinization but also induces the production of a mucus-secreting epithelium (cf. Fell and Mellanby's observations[5] on chick ectoderm *in vitro*). On the other hand, a concentration of vitamin A which inhibits keratinization in normal medium does not prevent but only delays cornification in the presence of œstrogen. A detailed report of this work will be published in the near future.

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Local Anæsthetic Potency and Penetration of Monomolecular Layers of Nerve Lipoids

IN an attempt to find the site of action of local anæsthetics in peripheral nerves, we have endeavoured to discover whether a correlation exists between the anæsthetic potency of some local anæsthetics and their penetration of a monomolecular layer of nerve lipoids.

Table 1. MINIMUM ANÆSTHETIC CONCENTRATION, INCREASE IN PRESSURE IN THE MONOLAYER, AND NUMBER OF MOLECULES PENETRATIN THE MONOLAYER, pH 7·0

In columns 3, 5 and 7, procaine is set equal to 1

Anæsthetic	Minimum anæsthetic concentration (mM/L.)	Relative anæsthetic potency	Increase in pressure in monolayer (dyne/cm.)	Relative increase in pressure	Concentration in monolayer (mol./cm.^{2} × 10^{13})	Relative concentration
Procaine	4·6	1	7·0	1	8·9	1
Cocaine	2·6	1·8	9·0	1·3	10·0	1·1
Tropacocaine	2·2	2·1	9·4	1·3	9·7	1·1
Tetracaine	0·01	460	2·5	0·4	3·8	0·4
Nupercaine	0·005	920	3·7	0·5	5·4	0·6
Butyl alcohol	68	0·07	9·8	1·4	14·7	1·7

The anæsthetic potency was estimated as the minimum anæsthetic concentration, that is, the minimum concentration which produces anæsthesia when distribution equilibrium of the anæsthetic agent between its solution and the nerve tissue has been attained. It was determined on isolated desheathed sciatic nerves from frogs (*Rana esculenta*). The local anæsthetics investigated are all tertiary amines which in aqueous solutions will be partly dissociated. The anæsthetic potency of these local anæsthetics depends on the pH of the anæsthetic solution; it was determined at pH 7·0. Butyl alcohol was taken as a representative of an undissociated aliphatic anæsthetic.

The nerve lipoids used for the monolayer were extracted from frogs' sciatic nerves. The monolayer was spread on a Ringer solution which contained 0·01 M sodium phosphate, pH 7·0, and the area of the monolayer was adjusted to a pressure of 10 dynes/cm. This area was kept constant during the experiment. Varying concentrations of the local anæsthetics were injected in the Ringer solution below the monolayer, and after careful stirring, the increase in pressure against the Ringer solution was measure (Fig. 1).

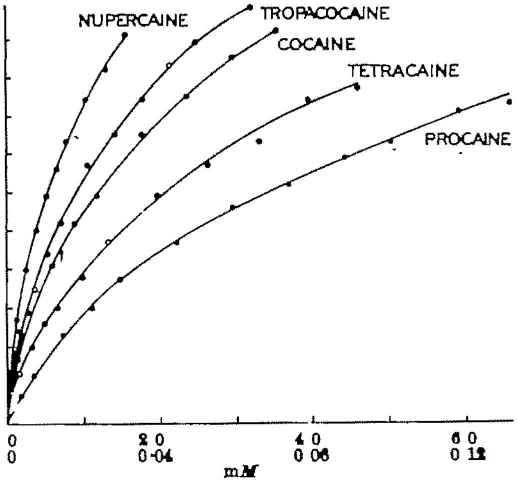

Fig. 1. Increase in pressure in a monolayer of nerve lipoids plotted against the concentration of the local anæsthetics in the Ringer phosphate buffer, pH 7·0. The upper row on the abscissa refers to procaine, cocaine and tropacocaine the lower to tetracaine and nupercaine

Table 1 shows the increase in pressure produce by the minimum anæsthetic concentration of the fiv local anæsthetics and of butyl alcohol. In additio is shown the number of molecules which penetrat per cm.^{2} of the monolayer at the minimum anæsthet concentration. These numbers were calculated b means of Gibbs's adsorption equation.

The order of the ability of the six anæsthetics tc penetrate the monolayer followed that of thei anæsthetic potencies; but the increase in pressure ir the monolayer produced by the minimum anæsthetic concentration of the six anæsthetics differed (Table 1, col. 4), and the numbers of molecules penetrating per cm.^{2} were also different (col. 6). However, ir view of the large differences between the minimum anæsthetic concentrations (1 : 920, or if butyl alcohol is included, 1 : 13,500), the differences in the results from the monolayer are so small that there seems to be a correlation between the anæsthetic potency and the penetration of a monolayer of nerve lipoids.

A more detailed report of this work will appear in *Acta Pharmacologica et Toxicologica*.

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Heparin and Histamine in Mast-Cell Tumours from Dogs

THE granular basophil cell of the tissues, the mast cell, has for long been thought to be the source of heparin[1]. Recently, it has been shown that the mast cell is also rich in histamine, a suggestion first made on histological grounds[2] and afterwards confirmed by the finding of a strong positive correlation for mast cells and histamine in a wide variety of normal and pathological tissues[3]. However, up to the present, the only comparative study of mast cells for heparin and histamine in the *same* starting material has been carried out on normal ox lung, in which the pleura especially yielded high values for all three[4]. It is thus of some interest that we have recently obtained six cases of subcutaneous mast cell tumour from dogs for estimation of their heparin and histamine contents.

As described elsewhere[5], tissue for histamine estimation was immersed as quickly as possible after removal in 10 per cent (v/v) trichloracetic acid for later extraction and assay on the standard guinea pig

Table 1. HISTAMINE AND HEPARIN VALUES OF SIX CASES OF SUBCUTANEOUS MAST CELL TUMOUR FROM DOGS

Case No.	Breed	Age (yr.)	Sex	Site	Delay (hr.)	Duration (months)	Histamine (μgm./gm.)	Heparin (I.U./gm.)
I	Terrier	10	M	Flank	12	1·5	765	61·2
II	Terrier	7	M	Perianal	0	6	500	147·2
				(recurrence)	0	2	790	54·2
III	Golden cocker spaniel	10	F	Flank	0	2	1,290	110·0
				(recurrence)	3	2	650	357·0
IV	Golden Labrador	10	F	Leg	50	Unknown	7	120·0
V	Scottie	7	F	Leg	3	3	520	21·4
				(recurrence)	0	2	277	21·0
VI	Black Labrador	12	M	Thigh	48	24	550	174·0

Ileum preparation or on the blood pressure of the atropinized cat, the specificity of the response in each case being confirmed by the use of mepyramine. Tissue for heparin estimation was placed at the same ime in water containing a few drops of chloroform ind was later digested with trypsin at *p*H 8 and assayed for anticoagulant activity by the method of Adams and Smith[5]. The results are presented in he accompanying tables. Table 1 lists the breed, age and sex of the dog and the site of its tumour. Of importance for the interpretation of the histamine values is the delay (shown in the sixth column) which elapsed between removal of the tumour and its preservation in trichloracetic acid. Attention has previously been directed to the progressive loss of histamine in small fragments of excised tissue exposed o air or immersed in water[3]. Table 2 gives average control values for histamine and heparin in a series of non-malignant tissues taken from normal or tumour-bearing dogs and placed at once in trichloracetic acid or chloroform water.

Table 2. AVERAGE CONTROL VALUES FOR HISTAMINE AND HEPARIN IN NON-MALIGNANT TISSUES FROM DOGS

Tissue	Histamine (μgm./gm.)	Heparin (I.U./gm.)
Kidney	1	6·2
Lymph node	4	9·0
Spleen	5	7·2
Skin	9	11·0
Lung	25	12·8
Liver	25	19·7

It is necessary merely to glance at the tables to see that mastocytomas from dogs are in general exceedingly rich in both heparin and histamine, the low histamine value in case IV being no doubt due in part to the delay which occurred before this small specimen was treated with trichloracetic acid and in part to its having been sent to us wrapped merely in a swab moistened with formalin. A similar delay occurred with specimen VI: however, this was an exceptionally large tumour and only its comparatively fresh central portion was used for histamine assay 48 hr. later. The heparin values also showed considerable variation, and here it is of interest to observe that the tumours with the highest heparin contents were also those which contained the highest proportion of mast cells filled with strongly metachromatic granules. Indeed, when distant metastases were present, we found it possible to anticipate histological evidence of tumour mast cells in other organs by the demonstration of their raised histamine and heparin values.

Thus, so far as conditions in the dog are concerned, it is clear that not one but at least two highly potent pharmacological substances are present in the tissue mast cells—heparin and histamine.

Full details of these tumours will be published elsewhere.

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Photographs of Serial Sections of the Lung projected rapidly in Sequence using 16-mm. Film

THE course and condition of small branching structures within a sample block of histological material cannot be appreciated with ease or demonstrated very successfully. With lung tissue, for example, casts and coloured, or radio-opaque, injections of the bronchial and vascular trees have been of great assistance; but these methods usually entail the removal or clearing of surrounding structures. Alternatively, serial sections may be observed *en masse* by serial reconstructions, thus overcoming, to some extent, the fact that the direct examination of serial sections in sequence is too slow for a full understanding of the plan of the tissue as a whole.

This communication describes a method for the visualization of a whole block of tissue histologically by introducing a regular short time interval between visual impressions of consecutive serial sections photographed on 16-mm. film. Preliminary trials with serial sections of rabbits' lungs have proved interesting.

There are two principal problems, the first being the inevitable loss of detail from the use of small frames of film. This disadvantage will vary with the type of material and the power of magnification, but in the present trials it has not been severe enough to detract from the interpretation of the projected film. The use of 35-mm. film would improve the quality of the picture, but exceptionally fine detail is not necessary when differing histological appearances are presented in rapid succession.

The second problem is to match one section accurately to the next, and I have been fortunate in obtaining the use of a hand-operated Kodak ciné camera fitted with a sliding prism, which deflects the image to be photographed upon a ground-glass screen. The image of this screen was enlarged and projected on paper, giving a picture 9 cm. × 12 cm. The principal features of the image were drawn in pencil and erased after each change of field, and the intensity of the light was adjusted to give an exposure time of 5 sec. The open positions of the revolving shutter were marked against the positions of the crank for reference with each exposure. Test strips of negative film were developed in the laboratory and the final spliced strips were printed elsewhere.

Before film was used, a trial was made with a short series of consecutive sections photographed on 9 cm. × 12 cm. plates and matched by ink sketches on the ground-glass screen. Prints were mounted on cards and it was found that four changes of section each second could be followed satisfactorily. This rate was used in the film, four frames being exposed for each tissue section (film speed, 16 frames/sec.).

The film sequence could not be presented in motion from the start. The projection of the first of the serial sections was maintained for about five seconds to allow for the choice of a particular structure to be followed in the sequence. It was found necessary also to project the last section for the same length of time. Smoother sequence would be obtained using very thin serial sections, but vessels in the lung are easily disturbed when cut and a thickness of 7 μ (melting point of wax, 58° C.) was needed to avoid most of this displacement. Lung tissue tends to become stretched and distorted when cut and mounted in paraffin wax. This was not obvious until the film was projected, when these defects were seen to interfere, to some extent, with the smooth sequence of section detail. The use of a firmer embedding medium may solve this problem. A whole sequence was spliced in ring form and could be repeated until all the features of the film had been assimilated. One sequence was prepared from sixty transverse sections (7 μ thick) along the course of a branch of a lower lobe bronchus in the undistended lung of a rabbit, and it was possible to trace the lumen of a small bronchus through several branches down to the related air sacs in 15 sec. The mode of branching of pulmonary arteries and their relations to branching bronchi were well shown, as also was the distribution of collections of lymphoid tissue.

The further application of this method to the study of lungs and other organs, normal or abnormal, should assist both in the evaluation of serial section material in general and in its presentation for teaching purposes.

I wish to thank Prof. Geoffrey Hadfield for his advice.

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Radio Emission from the Andromeda Nebula

Observations have been made at a wave-lengt of 3·7 m. with interferometers of different resolvin powers to determine the distribution of radio brigh ness across the Andromeda nebula, *M*31, which ha also been investigated at radio wave-lengths b Hanbury Brown and Hazard[1]. When observations a made with small movable aerials, errors are cause by reception of radiation from adjacent radio star Good discrimination was therefore obtained wit the present measurements by using several differen sections of the large Cambridge radio telescope although this method reduced the number of differen axes and aerial spacings available. The relationshi of the four axes used to the Andromeda nebula shown in Fig. 1.

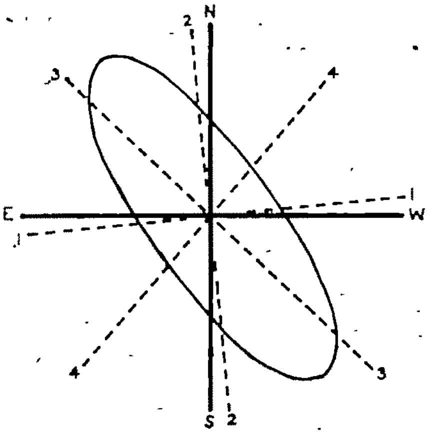

Fig. 1. Relationship of the interferometer axes to the Andromeda nebula

Column 1 of Table 1 gives the recorded amplitud expressed as a fraction of the amplitude for zer spacing, the total intensity of the source, which wa found to be $2 \cdot 0 \times 10^{-24}$ watts.m.$^{-2}$(c./s.)$^{-1}$.

The strip distribution of radio brightness projecte on axis 1 is shown in Fig. 2, together with the stri distribution of the optical emission from *M*31, o the mass as derived by Wyse and Mayall[3] and of th expected distribution of radio brightness calculated using the same model as that derived by Westerhou and Oort[4] from radio measurements on our own galaxy. The recorded amplitudes which would be expected from the models of Wyse and Mayall and Westerhout and Oort are shown in columns 2 and 3 of the table.

From Fig. 2 and from a comparison of the amplitudes for the axes 2 and 3, it can be concluded that the source of radio emission extends to radial distances

Table 1

Axis 1				Axes 2			
Aerial spacing	1	2	3	Aerial spacing	1	2	3
6 λ	0·96±0·1	0·95	0·98	14 λ	0·35±0·15	0·56	0 70
9 λ	0·84±0·1	0 91	0 94	Axis 3			
12 λ	0·60±0·15	0·88	0·89	18 λ	0·22±0·1	0·37	0·54
18 λ	0 20±0 1	0·70	0 80	Axis 4			
				18 λ	0·22±0·1	0·37	0·90

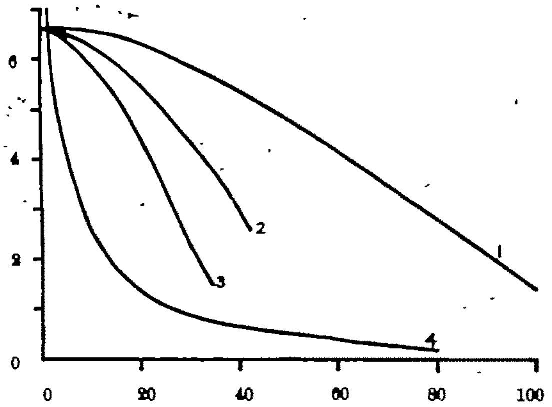

Fig. 2. The strip distributions, projected on axis 1, of: (1) the experimental determination of radio brightness; (2) Wyse and Mayall model; (3) Westerhout and Oort model; (4) the optical emission

the plane of the nebula which are considerably eater than either of the models. Further, examinaon of the figures for axis 4 shows an even greater screpancy between the observed and derived gures; the observations indicate that the radio nission also extends to very great distances normal the plane of the nebula. The existence of uch a distribution of sources is of considerable imortance.

Westerhout and Oort[4] showed that it is only possible explain the observed distribution of radio emission om the galaxy in terms of sources distributed like ommon stars if an isotropic component is subtracted om the observed values. They concluded that this omponent is probably of extragalactic origin, a ossibility which has been discussed further in a paper y Shakeshaft[5]. The present observations suggest at, in fact, most of this component may be ue to the existence of galactic radio sources disributed to great distances from the plane of the alaxy.

In order to make an estimate of the magnitude of is component, and in the absence of more detailed formation, it is convenient to interpret the present bservations in terms of two separate populations f radio sources: (*a*) a distribution similar to that roposed by Westerhout and Oort, which contributes bout a third of the total intensity; (*b*) a distribution hich has approximately spherical symmetry and xtends to radial distances greater than 10,000 parocs and which contributes about two-thirds of the otal intensity. With this model it can be shown at an observer in the plane of *M*31 at a radial istance corresponding to that of the solar system ould find a brightness temperature in the direction f the poles of about 200° K. at a wave-length of ·7 m.

In order to make an estimate of the polar intensity hich might be produced by such a population of ources in our own galaxy, it is convenient to suppose that the compositions of the two galaxies are lentical; the relative intensities in the polar irections will therefore be related to the total power adiated by the two galaxies. Westerhout and Oort howed that the total intensity to be expected from he concentrated population of our own galaxy at e distance of *M*31 would be 2 × 10^{-24} watts.m.$^{-2}$ ./s.)$^{-1}$ at 3·7 m. when corrected for the new distance scale. It has been found that the flux associated with this population in *M*31 is approximately 0·7 × 10^{-24} watts.m.$^{-2}$(c./s.)$^{-1}$. It therefore seems possible that the extended population of radio sources in our own galaxy might produce a polar brightness temperature of about 600° K., a figure which is comparable with the observed value of 950° K.[6].

The observations of the Andromeda nebula have suggested the existence of a hitherto unexpected population of radio sources; a similar population in our own galaxy might also account for a large part of the so-called 'isotropic' component of cosmic radio emission.

This work was carried out as part of a programme of research supported in the Cavendish Laboratory by the Department of Scientific and Industrial Research, to which I am indebted for a maintenance allowance.

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July 1.

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Recession of the Galaxies in Eddington's Theory

THE first important formula in Eddington's "Fundamental Theory" (Cambridge, 1946) is (p. 6)

$$R_0/\sqrt{N} = 2\sigma, \qquad (1)$$

where R_0 is the radius of an Einstein universe, N the number of particles and σ the uncertainty constant of the physical origin. Einstein's formula for the total mass, considered as equivalent to $\frac{1}{2}N$ hydrogen atoms each of mass m, gives the independent relation (p. 10):

$$R_0/N = \gamma m/\pi c^2 = 3\cdot 95 \times 10^{-13} \text{ cm.} \qquad (2)$$

From (1) and (2):

$$R_0 = (2\sigma)^2/3\cdot 95 \times 10^{-13}, \qquad (3)$$

and Eddington finds Lemaître's limiting speed of recession of the galaxies, $V_0 = c/(R_0\sqrt{3})$, to be 572 km./sec. per megaparsec. For this "most accurate" determination, he uses in (3) his formula for $1/\sigma$ as a numerical multiple of the Rydberg constant. The 'observed' recession-factor he estimated (1944) to be 560 km./sec. per megaparsec, in agreement with his result.

In reviewing this book, I noted one[1] error, which occurs on p. 5 just before the result (1) above; this implies that in (1) 2σ should be 3σ. Thus the value of R_0 in (3) should be multiplied by 9/4 and V_0 by 4/9; the same change applies to his determination $V_0 =$ 585 based on proton–proton scattering. This change is not in conflict with recent astronomical observation; for Baade has found[2] that current estimates of the distances of the galaxies should be doubled, so that the recession factor should be halved.

Amending equation (1) spoils the good agreement of N with Eddington's purely theoretical value $\frac{3}{2} \times 2^{256} \times 136$; but it does not affect his calculated values of the microscopic physical constants (in Chapters 2, 3, 9 and 11).

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Thermodynamics of the Two-Fluid Model of Liquid Helium II

THE two-fluid model for liquid helium II first put forward by the late F. London[1] has been largely accepted as at least a very useful working hypothesis. There are, however, certain thermodynamical difficulties arising from this model which do not seem to have received an entirely satisfactory solution. For example, Gorter[2] has pointed out that an application of the phase rule leads to a unique triple point for the co-existence of the two fluids and the vapour phase, whereas, in fact, a whole range of such points is observed; and he has suggested that this may be explained by assuming that the Gibbs function for the fluids and vapour is not linear in the concentrations.

In this communication an alternative explanation of this anomaly is put forward based on the hypothesis that there is chemical equilibrium between the normal and superfluid components. This hypothesis seems reasonable, if not inevitable, since whatever the exact mechanism of the transition from the normal to the superfluid component, the very fact that such a transition does take place under changes of temperature (and pressure) would seem to imply some sort of chemical equilibrium between the two components for any given state of the liquid. Suppose, then, that U is the internal energy of a mass m of the liquid of volume V and entropy S, and let m_1 and m_2 be the masses of the normal and superfluid components, respectively. If we define the chemical potentials of the two components to be

$$\varphi_1 = \left(\frac{\partial U}{\partial m_1}\right)_{V,S,m_2}, \quad \varphi_2 = \left(\frac{\partial U}{\partial m_2}\right)_{V,S,m_1},$$

then for a general infinitesimal reversible change:

$$dU = -pdV + TdS + \varphi_1 dm_1 + \varphi_2 dm_2. \qquad (1)$$

If u, s, and $1/\rho$ are the specific energy, entropy and volume, respectively, equation (1) may be written:

$$du = (p/\rho^2)d\rho + Tds + \varphi_1 dc_1 + \varphi_2 dc_2, \qquad (2)$$

where

$$c_1 = m_1/m, \quad c_2 = m_2/m.$$

Since

$$c_1 + c_2 \equiv 1,$$

we have:

$$du = (p/\rho^2)dp + Tds + (\varphi_1 - \varphi_2)dc_1. \qquad (3)$$

But the condition for chemical equilibrium between the two components is expressed by $\varphi_1 = \varphi_2$, since mass is conserved in the transition between the two components. Therefore:

$$du = (p/\rho^2)d\rho + Tds;$$

that is, u is a function $u(\rho_1 s)$ of ρ and s only. B
$U = mu$, so that:

$$U = mu(\rho,s) = mu(m/V, S/m).$$

This means that the internal energy of the flu depends on m_1 and m_2 only through the combinati $m = m_1 + m_2$; so that, although we regard the bu liquid as containing two components, it will beha thermodynamically as if it were composed of a sin substance. The observed range of equilibrium poin for the vapour and the liquid then finds an immedia explanation if we allow this to be determined, the liquid side, by the function $U(V,S,m)$ of equ tion (5).

As regards the proportion of the normal to t superfluid components for temperatures below t λ point, the thermodynamics has apparently prediction to make unless some further hypothe is made. This is not surprising, however, since t theory developed in this communication would clear be applicable to any equilibrium mixture of tv isomeric components. In this connexion, a con parison with the theory of allotropy put forward A. Smits[3] might be of interest.

Finally, we notice that additional support for t hypothesis here put forward is offered by the follo ing derivation of the formula for the thermo-mecha ical effect. Suppose that two separate masses liquid helium II are connected by means of a ve fine capillary tube. On the assumption that on the superfluid can pass along this capillary, the con dition for both masses to be in equilibrium states that the chemical potential of the superfluid con ponent should have the same value in each. B from equation (5) it follows that the chemical pote tial of the superfluid component is given by:

$$\left(\frac{\partial U}{\partial m_2}\right)_{m_1,S,V} = \left(\frac{\partial U}{\partial m}\right)_{m,S,V} = g, \qquad ($$

where g is the Gibbs's function per unit of mass the bulk fluid, namely:

$$g = u - sT + p/\rho. \qquad ($$

Therefore, the equilibrium condition for the tw connected masses A and B is

$$g_A = g_B. \qquad ($$

If, now, the states of the two masses differ on slightly, the equilibrium condition becomes

$$\delta g = 0, \qquad ($$

that is,

$$-s\delta T + \delta p/\rho = 0, \qquad (1$$

and

$$\delta p/\delta T = \rho s,$$

which is the accepted formula for the therm mechanical effect first derived by H. London[4] o the assumption that the superfluid component h zero entropy.

It is clear that the derivation of the formula f the thermo-mechanical effect just given should appl in theory at least, to any equilibrium mixture two isomers divided into two masses separated by membrane permeable only to one of the two con ponents. It is difficult, however, to see how th theory could apply in practice to any mixture apa m liquid helium II, or an analogous substance, if ch exists; since a temperature difference across a mi-permeable membrane separating two masses of ch a mixture would normally lead to a flow of at, by means of the permeable component, which uld ultimately result in the disappearance of this fference. In the case of liquid helium II, however, nere the semi-permeable membrane is replaced by fine capillary through which only the superfluid mponent may pass, a continuing temperature fference is possible because the superfluid, having ro entropy, is entirely incapable of transporting y heat from one container to another. If this alysis is correct, the supposed zero entropy of the perfluid component has a practical rather than a eoretical importance for the thermo-mechanical fect in liquid helium II.

Note added in proof. The more general relationship $p/\partial T)_B = \rho s$ may be derived immediately from quation (8) by varying conditions in A while keeping ose in B constant.

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Molecular Weight and Volatility

I wish to direct attention to the fundamental fect of molecular mass on volatility, since it does ot support the widely accepted view that volatility creases with increase in molecular weight. The tter view relies on the various *empirical* relationships between molecular weight and boiling point, ut it has no theoretical basis. Indeed, detailed guments will be presented elsewhere suggesting at these empirical relationships are fortuitous and at the apparent increase in boiling point with molecular weight is due to other causes. By contrast, e *fundamental* effect of mass on volatility has a eoretical background and affords a rational explanaon of certain boiling-point 'anomalies'.

The fundamental effect is clearly revealed by the omparison of vapour pressures of compounds differg only in isotopic composition ('isotopic molecules'). hese comparisons are least complicated by differences intermolecular forces, and it can be assumed that ifferences in vapour pressures are due to the effects f mass alone. The relative vapour pressures of sotopic molecules' vary in a complex manner, and is intriguing to find that the lighter species is not lways the more volatile. In fact, the review by lusius[1] of hydrogen and deuterium compounds hows that the relative vapour pressures vary with emperature in the sense that higher temperatures avour the volatility of the heavier species. Similar ehaviour by other 'isotopic molecules' was reported y Urey[2] and Stokland[3]. However, this peculiar ehaviour is explicable in terms of statistical thermoynamics[1,3,4] although a rigorous treatment seems to e confined to simple cases such as that given by bbelohde[5].

If this mass-effect is fundamental, then it should e a general phenomenon recognizable whenever vapour pressures of two compounds are compared. However, it is a second-order effect usually obscured by the greater effect caused by differences in intermolecular forces, and is only disclosed in favourable circumstances, for example, isotopic molecules. Nevertheless, a novel example of this phenomenon was recently reported by Bradley, Mehrotra and Wardlaw[6]. They found that some tetra-alkoxides of hafnium, $Hf(OR)_4$, were more volatile than the corresponding alkoxides of the lighter element zirconium, and preliminary vapour-pressure measurements showed the molar heats of vaporization of the tertiary amyloxides $M(OCMe_2Et)_4$ (M = Zr or Hf) to be practically equal. Clearly, because of the equalization of intermolecular attraction, due to shielding of the central atom, the fundamental effect of mass on volatility is being asserted in a 'super-isotope effect'. Moreover, this theory predicts a super-isotope effect as a general phenomenon occurring in centro-symmetric systems such as $M^{I}X_n$ and $M^{II}X_n$, where M^{I} and M^{II} are n-valent elements with nearly identical atomic radii and X is a univalent shielding group. Besides zirconium and hafnium, it seemed likely that compounds of niobium and tantalum and also molybdenum and tungsten might fulfil these conditions. A survey of the literature revealed that this is indeed the case, as is shown in Table 1, which gives data for pairs of compounds in which the heavier species is the more volatile.

Table 1

	NbF_5 : TaF_5 (ref. 7)		$NbCl_5$: $TaCl_5$ (ref. 8)		MoF_6 : WF_6 (ref. 9)	
Formula weight	187·9	275·9	270·2	358·2	210·0	297·9
Boiling point, ° C.	234·9	229·2	254·0	239·3	35·0	17·5
Radius of central atom (A) (ref. 10)	1·34	1·34	1·34	1·34	1·36	1·37
Molar heat of vaporization (k.cal./mole)	12·9	13·0	13·2	13·6	8·34	8·69

The relative boiling points of these 'anomalous' pairs are quite inexplicable in terms of the conventional empirical rule connecting volatility and molecular weight, yet this behaviour is expected on the basis of what is here proposed as the fundamental effect of molecular weight on volatility. This theory will be presented in full elsewhere; meanwhile, experimental work is proceeding to test further these ideas.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR/JUNIOR LECTURER IN ANATOMY—Prof. D. V. Davies, Anatomy Department, St. Thomas's Hospital Medical School, London, S.E.1 (August 19).

ASSISTANT, Grade A (with a special mathematics degree, or a general honours degree, including pure and applied mathematics, or an engineering honours degree including mathematics), IN THE MATHEMATICS DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (August 21).

LECTURER (preferably with a special interest in the strength of materials) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Liverpool (August 21).

SCIENTISTS (with a good honours degree, or equivalent, in engineering or physics, and some relevant postgraduate experience in any of the following fields—light engineering development, pneumatic and/or hydraulic mechanism design, design of light electro-mechanical mechanisms, optical mechanisms), in the Central Research Establishment II of the National Coal Board, Isleworth, Middlesex, for work concerned with the study of methods of establishing suitable instrumentation for use in mines, and to design, develop and prove instruments required in all aspects of mining, and research into mining techniques—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/815 (August 26).

GEOLOGISTS (with a university degree, preferably with honours, or equivalent, with all the subjects of geology at third year standard; or other such qualifications and experience as considered suitable), and GEOPHYSICISTS (with a university degree, preferably with honours, or equivalent, with a major (three year) pass in geophysics, physics, geology, mathematics or other appropriate subject) in the Department of National Development, Commonwealth of Australia, for work with the Bureau of Mineral Resources—The Senior Representative, Department of National Development, Australia House, Strand, London, W.C.2 (August 27)

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or chemistry, and at least three years subsequent experience), to carry out operational research in the field of radiation protection, develop specialized methods of identification and measurement of radioactive contaminants and apply the results to the practical control of radiation hazards in laboratories and plants—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berkshire, quoting 2/103/110 (August 27).

LECTURER (with experience in the field of interconnected power systems) IN ELECTRICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, August 28).

ASSISTANT IN BOTANY—The Secretary of University Court The University, Glasgow (August 31).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edinburgh (August 31).

ASSISTANT LECTURER (with an honours special degree in geography) IN GEOGRAPHY—The Secretary, Bedford College, Regent's Park, London, N.W.1 (September 1).

DEMONSTRATOR IN GEOLOGY—The Registrar, The University, Nottingham (September 4).

RESEARCH ASSISTANT (with a good honours degree in botany, chemistry or biochemistry, and with experience of handling and growing micro-organisms) IN THE DEPARTMENT OF BOTANY, to work on the metabolism and photosynthesis of micro-organisms—The Secretary, University College London, Gower Street, London, W.C.1 (September 4).

SENIOR LECTURER IN ENGINEERING, and LECTURERS (2) IN ENGINEERING—The Registrar, The University, Manchester 13 (September 4).

DEMONSTRATOR or LECTURER IN PHARMACOLOGY—The Registrar, The University, Leeds 2 (September 6).

LECTURER or ASSISTANT LECTURER (with qualifications and experience in chemical engineering or a branch of chemical technology), IN THE DEPARTMENT OF CHEMISTRY, University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 11).

LECTURER (with an honours degree and some practical experience) IN MECHANICAL ENGINEERING—The Registrar, The University, Leeds (September 13).

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in metallurgy or equivalent qualification, and at least three years postgraduate metallurgical research experience) at the Ministry of Supply London Headquarters, to assist in research and development work on metals and their alloys for aircraft construction, and in the initiation and arrangement for experimental work in the Universities and Industrial Laboratories—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S 4364/54 (September 14).

READER IN ASIAN ANTHROPOLOGY at the School of Oriental and African Studies—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 27)

ASSISTANT LECTURER (with special qualifications and interests in petrology) IN GEOLOGY—The Registrar, University College of North Staffordshire, Keele, Staffs (September 30).

LEVERHULME FELLOW AND LECTURER (with considerable experience of research work in nuclear physics, and preferably between the ages of 25 and 35 years) IN THE DEPARTMENT OF PHYSICS—The Registrar The University, Liverpool (October 16).

CHAIR OF AGRICULTURE at Rhodesia University College—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 18).

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY, Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1.

BIOCHEMIST or ORGANIC CHEMIST, Experimental Officer or Assistant Experimental Officer grade in the Insecticides Department, to assist in work on insect biochemistry in relation to the mode of action insecticides—The Secretary, Rothamsted Experimental Statio Harpenden, Herts.

CHEMISTS, Scientific Officer grade (with a first- or second-cl honours degree or equivalent in chemistry, and with research e perience, preferably in physical chemistry), at various research statio of the Ministry of Supply, mainly in the south of England—T Ministry of Labour and National Service Technical and Scienti Register (K), 26–28 King Street, London, S.W.1, quoting F.546/54

DEPARTMENTAL RESEARCH ASSISTANT (with a degree in physics chemistry) to develop and maintain techniques applied to the investig tion of macromolecules in solution (for example, sedimentation, diffusio light scattering, etc.)—Dr. P. Johnson Department of Colloid Scienc The University, Cambridge.

FISHERIES OFFICER (with an honours degree in a natural scienc with an emphasis on biology) in H.M. Colonial Service, Nigeria, carry out applied and operational research into peasant fish culture- The Director of Recruitment, Colonial Office, Great Smith Stree London, S.W.1, quoting BCD.65/14/01.

LECTURER IN EDUCATION at the University of Malaya, Singapore- The Secretary, Inter-University Council for Higher Education in th Colonies, 1 Gordon Square, London, W.C.1.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honou degree in chemistry, or equivalent qualification, together with ma years research experience in applied chemistry), to direct and supervi the work of a Materials Development and Advisory Section—Seni Recruitment Officer, Atomic Weapons Research Establishmen Aldermaston, Berkshire, quoting 201/W G.E./2.

RESEARCH ASSISTANT (with a good honours degree in geolog preferably with emphasis on mineralogy, petrology or structur geology) IN THE DEPARTMENT OF GEOLOGY—Head of Departmen Department of Geology, University College, Science Buildings, Merri Street, Dublin.

RESEARCH FELLOW (graduate in zoology or veterinary science, an prepared to undertake teaching duties as well as research) IN PARASITOLOGY in the Faculty of Veterinary Science—The Registra University of Queensland, Brisbane, Queensland, Australia.

SOIL CONSERVATION OFFICER (with a degree in agriculture, and least five years experience of the principles and practice of soil co servation), in the Agricultural Department, Nigeria, for duties whic will include the design and layout of soil conservation schemes an the training of staff (Ref. BCD.63/14/025), and an AGRONOMI (with a degree in agriculture or a related subject, and preferabl with postgraduate research or advanced field experience and som experience of simple surveying), in the Somaliland Protectorate, t supervise agricultural experimental work with special reference t dry farming under semi-arid conditions, and to develop, in co-oper tion with a Hydrologist and Soil Surveyor, flood irrigation exper mental pilot schemes etc. (Ref. BCD 63/5/04)—The Director o Recruitment, Colonial Office, Great Smith Street, London, S.W.1 quoting appropriate Ref. No.

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(not included in the monthly Books Supplement)

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TECHNOLOGICAL AND TECHNICAL EDUCATION IN BRITAIN

THE very guarded statement which the Chancellor of the Exchequer made in the House of Commons on July 13 indicates that official policy for technological education in Great Britain is at last taking shape, though there was no indication of any policy for technical education which should be developed *pari passu*. As already noted in *Nature* of July 17 (p. 111), Mr. R. A. Butler stated that, in accordance with his request of July 1953, the University Grants Committee had submitted its report and recommendations for the development of higher technological education outside London, and that, after considering its recommendations, he had approved plans for developments, mainly at Glasgow, Manchester, Leeds and Birmingham. Mr. Butler indicated that provision was also made for developments elsewhere; but that they would take place at institutions already in receipt of recurrent grants on the recommendation of the University Grants Committee. It would be necessary, accordingly, to increase the resources available to the University Grants Committee, both for recurrent and non-recurrent purposes, in the last three years of the quinquennium 1952–57.

The Chancellor is now considering the timing of these developments, some of which, he hoped, would start in the next academic year; and the further statement, which he promised to make in due course, will no doubt give details of the proposed increase in the vote for the University Grants Committee. Those details, if the Government is reasonably generous, should themselves attest the wisdom of the Committee's refusal to disperse over too wide a field the strictly limited allocation which can be spared to higher technological education from the national resources at the present time. Meanwhile, the University Grants Committee has rightly resisted the temptation to spread those resources over six or more institutions as suggested in the Percy Report of 1945, still more over the fifteen or twenty regional colleges suggested in the report on the Development of Higher Technological Education submitted to the summer meeting of the Association of Principals of Technical Institutions and the Association of Technical Institutions* last June. That report, which followed broadly proposals advanced by Principal J. C. Jones to the latter Association in February, was concerned with securing adequate regional cover; but it failed to distinguish between technical and technological education. Nevertheless, the report proposed that the selected colleges should all receive contributions from the central government amounting to not less than 75 per cent of the agreed net expenditure. It was also proposed that these colleges should provide advanced courses and facilities for postgraduate studies and research for a region rather than the area of a particular local education authority, and that, accordingly, they should be financed by grants covering a period of not less than three years and administered solely by a governing body on which the industry and commerce of the region as well as local education authorities should be represented.

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*Association of Principals of Technical Institutions and Association of Technical Institutions. Report on the Development of Higher Technological Education. (Summer Meeting—Southport, 10th–12th June, 1954.) Pp. 7. (London: Association of Technical Institutions, The Polytechnic, London, W.1, 1954.)

It may well be a matter for consideration how far it is desirable for technical education to be given more independence from local authority control; continuity, greater freedom and improved conditions of service for the staff of technical colleges could be bought too dearly if local interest and co-operation should be adversely affected. The development of technical education depends largely on such local interest and co-operation and, to the extent to which they are secured even under the existing arrangements, it should be possible continuously to improve conditions so that staff of the requisite quality is attracted and retained, and provided with the facilities for effective research as well as teaching. What needs to be remembered is that the technical colleges are doing a job no less important than, but complementary to, that of the technological institutions. It is not a matter of one type of institution being inferior to the other, but of providing each with the most appropriate conditions for efficiency, and apportioning the available resources between the two types of institution in accordance with the needs of the country.

That is the reason for some doubt, in the absence of fuller information, as to whether the resources available for higher technological education are not even now being distributed too widely. Great Britain clearly cannot afford the resources necessary for developing five major technological institutions of the type of those at Massachusetts or Delft, nor should it be assumed as yet that that is the intention of the Government. All that can be said at present is that the Government's plans contemplate the development of the Imperial College of Science and Technology into a major technological institution of university rank. It can safely be assumed that such development will not diminish the fructifying interaction and intercourse between the pure and applied sciences, or between them and other fields of study which the authorities of that College have shown themselves so anxious to promote. The proposals announced on July 13 appeared to contemplate the development as independent institutions of university rank of the Royal Technical College, Glasgow, and the College of Technology, Manchester; but Mr. Butler's subsequent statement of July 20 seemed to deny this, though in view of existing relations between the latter College and the University of Manchester the position is not clear. Lord Woolton has already indicated that it was contemplated that the latter College should become independent, with its own governing body and a substantial government grant, and the implications of the Government's proposals are already being considered by the Manchester City Council.

The Manchester College of Technology has close ties with the University of Manchester, and Lord Salisbury, during his visit to Manchester, indicat that these relations would be maintained under t new arrangement. Nor is it likely that in the develo ments at Glasgow there will be any interruption such interaction and intercourse, or any excessi segregation of specialities. At Leeds and Birmingha it would appear that developments will procee within the framework of the existing universi departments of technology, and so far as the Gover ment's policy is disclosed, accordingly, it wou appear to take care of the great danger of segregatio against which Sir Philip Morris, Sir Richard Sout well, Lord Eustace Percy and others have warned so plainly and to be seeking to improve and develo existing institutions rather than create entirely ne ones. Three clear lines of evolution can be discerne none of which appears likely to depart too far or t abruptly from our tradition of multi-purpose institutions, yet all of which would appear to offer reasonab scope for experiment with new ideas and ne methods.

Discussion on the expansion of higher technological education in Britain should in future tur more on the tactics to be used rather than on th policy to be pursued, subject to the reservation tha no policy for higher technological education will mee the nation's needs without an adequate policy fo technical education. Education must be viewed a a whole, and the available resources—finance materials and man-power—allotted in accordanc with some reasoned appraisal of the situation as whole and of the complex interrelations of which th shortage of science teachers has at least helped t make the nation better aware. Technological education cannot be expanded without due regard to th general needs of the universities, of technical education and of secondary education, and indeed of adul education in general. As the Percy Committe pointed out, technical education needs to be surveyed and planned as a whole, and in the field o adult education as well as in its technological studie it requires co-ordination with university education.

This emphasis of the Percy Committee on diversit of function has frequently been ignored in subsequen discussions. Had the comment of the report that diversity of function is not inconsistent with equality o status between the technical colleges and the institutions specifically for higher technological educatio been heeded, the futile discussions about awards would scarcely have persisted into the recent report from the Association of Technical Institutions and the memorandum of the Parliamentary and Scientific Committee. Fortunately, some at least of the papers such as that of Mr. F. H. Perkins, given at the Conference of the Associations of Technical Institutions and of their Principals, showed a clear idea of the situation and of industry's need for both technicians and technologists.

Mr. Perkins, in his paper on industry and technical colleges, to some extent followed ideas expressed by Dr. P. F. R. Venables at the North of England Educational Conference (see *Nature*, January 30, p. 197); but the plan for which he pleaded would concentrate major developments in two or three technical lleges rather than the twelve or fifteen suggested Dr. Venables. These, however, would provide ll-time and sandwich courses for selected students an advanced level, organized on a residential basis, which the students could participate fully in the mmunal life of the college, much as Dr. Venables d urged. These developments would be accomnied by a further increase in the number of students king first degrees in science and technology at the iversities, so as to reduce a deficiency in the supply scientists and technologists, which by 1955 is kely to exceed considerably that forecast in the arlow Report.

This policy, so far as can at present be judged, ay be nearer to that which the Chancellor of the xchequer contemplates than the more diffused rogramme suggested by Dr. Venables or Mr. Jones. r. Perkins was dealing more particularly with dustry's requirements for recruits capable in due urse of filling its more senior posts. Stress was ccordingly laid upon residence, a broad curriculum ased on science and strong seminar activities as the ost likely means of developing the qualities required. he need will not be met by measures which merely rovide increased opportunities for those studying nder the handicap of evening classes or long daily urneys to and from home.

The first need is to provide for the expansion of igher technological education in a way which will upply industry with technologists of the calibre and otentialities it requires ; but that expansion must ot be at the expense of the technicians which it equires in even greater numbers. For the chemical dustry, Mr. Perkins said that the number of such en and women with lesser scientific or technical ualifications and experience required is probably bout fifty per cent greater. To provide such men nd women and also less highly qualified technicians (which for other industries may well outumber technologists by five to one) is the primary esponsibility of the technical colleges and the funcion which has to be most closely related to local eeds. One difficulty in the development of higher echnological education at the Manchester College of Technology is likely to be the College's responsibility or providing the local education authority's national ertificate courses, a responsibility that cannot be ivested until subsidiary colleges are built. The way n which the expansion of technological education is inked with that of technical education could not be etter illustrated.

The corollary of the proposals announced by Mr. Butler is in fact a clear statement of the policy which he Minister of Education proposes to adopt in echnical education. Of that Miss Horsbrugh gave o sign when she was addressing the annual conerence of the Association of Education Committees at Scarborough on June 25. Her claim that at the nd of April £12 million had been spent on building technical colleges since the end of the War, another £18 million on those still under construction and that xpenditure of a further £4·5 million was projected does not amount to a policy, any more than her easonable plea for more co-operation between local authorities or her promise to issue regulations which would minimize the causes of friction in financial arrangements.

It is not only, however, in respect of financial arrangements that a lead from the Minister could help to remove friction and foster co-operation. A clear statement of policy and of the resources to be made available for the development of technical education is essential in order to secure the co-operation of industry, and it might also facilitate the establishment of effective relationships between the colleges of technology and the university departments of technology and the technical colleges. As Miss Horsbrugh rightly pointed out, it is not sound or economically possible for the technical colleges to serve all the needs of an area, and the exact means by which needs, and especially the advanced needs, are best satisfied will vary from area to area. But until some overall picture of the Government's policy and plans can be seen, it will be impossible to remove by reasoned argument and discussion the disappointments, sometimes rooted in local jealousies or history, which the wisest selection is liable to engender, and to secure co-operation and goodwill. The goodwill and understanding of the local authorities are essential, moreover, if conditions of service in the technical colleges are to be such as to attract staff of a calibre to undertake usefully either consulting work or research, and to win and hold parity of status with the institutions for technological education.

BRITISH BIRDS

The Birds of the British Isles

By Dr. David Armitage Bannerman and illustrated by George E. Lodge. Vol. 1: Corvidae, Sturnidae, Oriolidae, Fringillidae. Pp. xviii+356+41 plates. Vol. 2: Alaudidae, Certhiidae, Paridae, Vireonidae, Muscicapidae, Motacillidae, Sittidae, Laniidae, Bombycillidae, Regulidae. Pp. viii+302+41 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 45s. net each vol.

THIS is a work on British birds in the grand manner, the like of which one had scarcely expected to see again; one gathers that it has been made possible by the artist's creation of a trust fund to subsidize the reproduction of his plates. The work is sumptuously produced, beautifully illustrated, and written in a leisured style with care and distinction. These two volumes are the first of three dealing with the passerine birds; and from this one can estimate that six or seven volumes in all, of which the rest are to be issued over a period of years, will be required for the complete work.

The author and the artist—Dr. David Bannerman and Mr. George E. Lodge—are both past vice-presidents of the British Ornithologists' Union and are already very well known for their work. Shortly after these volumes appeared, one regretted to hear of the death of Mr. Lodge, although at a great age; but he had completed his series of paintings for this work some years ago, and one is happy to know that it will be illustrated throughout with plates in colour by the foremost ornithological artist of our time and country. These not only serve the purpose of accurate and useful illustration, but they are also pleasing as pictures in high degree.

Dr. Bannerman's professional studies, during forty years at the British Museum (Natural History), have been concerned mainly with the birds of West Africa, on which he is the recognized authority. The present work he describes as the child of his leisure hours, and they have indeed been well spent—in wide reading, in the expert examination of specimens, and notably in the field, all of which forms of study have clearly contributed to the success of the final result. Moreover, he has been at pains to provide a very readable text to match the beauty of the plates, in contrast to the highly compressed summaries with which the writers of most modern works of reference have to be content; in this he has deliberately followed the model of the great ornithologists of a more gracious age, from whose writings he also effectively quotes.

The arrangement is of the usual systematic kind: for each species information is given on identification (with differentiation of races where relevant), distribution at home and abroad, migration, habits and breeding. This is, of course, a well-worked field; but, in addition to bringing information up to date, or amplifying it from hitherto unpublished sources, the author has critically re-examined earlier statements and made his own assessments. (Special acknowledgment is made of the numerous notes supplied personally to Dr. Bannerman by another ornithologist, Dr. H. M. S. Blair.) A special feature is the wealth of information about British migratory species in their other habitats abroad and, where possible, actually on passage: this is a valuable contribution, largely based on Dr. Bannerman's personal observations during the extensive travels that he has for many years undertaken for the express purpose.

There are naturally points on which other experts may differ from the author, some questions of classification and nomenclature being among them. In his preface, Dr. Bannerman indulges some personal views about lines of ornithological study with which he is not in full sympathy; fortunately, however, neither the bionomics of bird populations nor interpretations of bird behaviour are essential to the particular purpose which Dr. Bannerman is in the process of fulfilling so well.

LANDSBOROUGH THOMSON

RESPIRATION IN PLANTS

Plant Respiration

By Dr. W. O. James. Pp. ix+282. (Oxford: At the Clarendon Press; London: Oxford University Press, 1953.) 30s. net.

THAT plants, like animals, absorb oxygen and give out carbon dioxide has been known for well over a century; but the significance of this as a feature of an oxidation of carbohydrate or other material by which energy is released only came to be realized later. To emphasize this as the essential characteristic of respiration, Barnes in 1905 suggested the term energesis; and although this term was not accepted by the generality of botanists, almost all plant physiologists have now for many years regarded respiration in plants as including all those processes in which a substrate is broken dov with release of energy. Thus processes not involvi an oxidation, notably the breaking down of sug to carbon dioxide and ethyl alcohol, are includ in respiration and are distinguished from norr respiration as 'anaerobic' respiration. During th past ten years or so there has been a tendency limit the application of the term respiration to tho processes in which sugar or some other substrate broken down by oxidation and to use the ter fermentation to denote those processes previous known as anaerobic respiration. It is, howeve quite impossible to give any detailed account plant respiration without also dealing with th degradation of sugar in absence of oxygen; and the opening pages of this treatise on plant respiratic Dr. W. O. James gives reasoned and cogent arg ments for using the term 'plant respiration' to incluc all those processes in which complex substanc undergo changes that in the aggregate lead to diminution of free energy.

Dr. James's account of plant respiration is ver comprehensive, and the various aspects of the subje are dealt with in detail. The arrangement of th material, if to some degree unusual, is satisfactor and, indeed, successful. The earlier chapters on th rate of respiration, which includes temperatu effects, respiratory drifts and the respiratory quotien deal with information which for the most part ha been well established for many years. The followin chapter on respirable materials includes a discussion o the important topic of the phosphorylation of carb hydrates. The remaining five chapters of the bool comprising somewhat more than half of the whole tex which are headed glycolysis, oxygen effects, oxida tion mechanisms, oxidation stages in respiration an connexions with other processes, deal with what i often described as the mechanism of respiration. I is with the aspects of respiration considered in thes chapters that our knowledge of the subject ha developed most during the past twenty years, development which has been brought about in n small measure by Dr. James's own researche Whereas some twenty years ago so little was know of the course of the breakdown of the respirator substrate in plants that it was little more than matter for conjecture, we now have a complet scheme for the course of degradation of carbohydrat to carbon dioxide and water which, if not proved, i at least credible and in harmony with experimentall discovered facts. These chapters, in particular, wi be read with interest by all wishing to acquir detailed information of recent work on the mechanism of respiration.

It seems clear that respiration supplies the energy for certain syntheses in plant cells and for the intak of salts into cells against concentration gradients The problems of the way in which the energy provided by respiration is utilized in these processe are still unsolved, as a perusal of Dr. James's last chapter shows. But many plant cells do not appea to be concerned in such processes or, indeed, in any activity requiring a supply of energy, and yet they respire. What then is the general significance o respiration? This question is dealt with in the concluding paragraphs of Dr. James's book; but he decides that there is at present no valid evidence either in support of, or against, the idea that respiration is essential for protoplasmic maintenance. With this conclusion the present reviewer is in complete agreement, and, indeed, he is far from convinced at respiration is necessary for cells to remain alive, distinct from actively living.

Dr. James is to be congratulated on producing a asterly and scholarly monograph on plant respira- on in which the researches of more than a century e critically considered and ably presented. This ork, by a recognized authority on his subject, forms valuable addition to the literature of plant ysiology.

W. STILES

TREATISE OF PALÆONTOLOGY

raité de Paléontologie

ublié sous la direction de Prof. Jean Piveteau. ome 3 : Les formes ultimes d'Invertébrés ; morph- ogie et évolution ; Onychophores. Par C. echaseaux. Arthropodes, Proarthropodes. Par C. echaseaux et G. Waterlot. Trilobites. Par P. upé. Crustacés. Par C. Dechaseaux, N. Grekoff, . Roger, H. et G. Termier. Myriapodes, Insectes. ar D. Laurentiaux. Mérostomes, Arachnides. Par . Waterlot. Échinodermes, Hétérostélés, Cystidés. ar L. Cuénot. Blastoïdes. Par F.-M. Bergounioux. drioastéroïdes. Par J. Piveteau. Crinoïdes, Stel- roides, Ophiocystoïdes. Par G. Ubaghs. Echinides. ar H. et G. Termier. Holothurides. Par M. eflandre-Rigaud. Stomocordés, Ptérobranches et raptolites. Par G. Waterlot. Machaeridiens, onulaires, Hyolithes, Tentaculites. Par H. et G. ermier. Pp. viii + 1063 + 17 plates. (Paris : Masson t Cie., 1953.) Broché 9,600 francs. Cartonné toile 0,320 francs.

VOLUME 3 of the "Traité de Paléontologie" includes all the Invertebrata not dealt with in he first two volumes. Of editorial practices already riticized[1], authors and dates of the various taxonomic nits are still too seldom given, and the type, or any pecies of the genera mentioned, is too often omitted. ome pre-Linnæan names of Echinoid genera are also ncluded. The scale of magnification of the figures usually indicated, however, and the high standard f printing and illustration is well maintained.

The Onychophora, scarcely known fossil, are reated in a brief and lucid essay which indicates the mportance of this group to theories of annelid–rthropod relationship. An important chapter on he basic characters and phylogeny of the Arthropoda s useful as an introduction to this vast phylum. Of he chapters on the various classes, that on the rilobitomorpha meets the requirements of a text-ook, but the Trilobita are handled in a speculative ashion and numerous new family-group units are roposed. The author's enthusiasm and ability have evertheless produced a well-documented account ith excellent illustrations. The Crustacea are well, f conservatively, dealt with ; but more space might ave been allotted to the Ostracoda in view of their conomic importance, and no chapter on the Cirripedia an be adequate that ignores the work of the late T. H. Withers, especially his three catalogues pub-ished by the British Museum (Natural History). Of he remaining chapters on Arthropoda, that on the Insecta, though permitting some taxonomic novelties, ar surpasses anything previously available.

The first two chapters on Echinoderms are the last f many profound contributions by the late L. Cuénot nd deserve the respect due to all his work. The ections on the Crinoidea and Stelleroidea are beautifully fitted to the scale of the "Traité", though the new ordinal and family-group names in the former should not have been proposed here. The chapter on the Echinoidea is scarcely worthy of the rest of the "Traité" or of the tradition of French work in this group. The morphology is inadequately illustrated, and the drawings in the systematic section are clumsy and too often taken from poorly preserved material. The concluding six chapters call for no special comment, though that on the Graptolites seems rather severely compressed.

Each of the first three volumes of the work includes more speculative matter than would a British work of the same kind, and they are not primarily useful as systematic reference books in all groups. They should not be placed in the hands of students without caution. The durability of their value, therefore, rests on a somewhat uncertain basis ; but the standard of morphological and ontogenetic information is high, and it is these introductory sections of each chapter that are likely to prove of most use. Many of the systematic sections are excellent ; but the average level is lowered by a few chapters which weaken the authority of the whole.

R. V. MELVILLE

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[1] *Nature*, 172, 560 (1953).

WILLIAM HERSCHEL : HIS WORK AND PERSONALITY

William Herschel

Explorer of the Heavens. By J. B. Sidgwick. Pp. 228 + 4 plates. (London : Faber and Faber, Ltd., 1953.) 12*s.* 6*d.* net.

THROUGHOUT the history of astronomy, there are one or two names which stand out in sharp relief when one begins to consider the observational side of the science. Hipparchus, Tycho Brahe and Sir William Herschel are three which immediately come to mind. Each made substantial contributions, and each provided fine sets of observations which were of vital importance to those who followed. But while it is virtually for their observations alone that we remember Hipparchus and Tycho Brahe, William Herschel is noted not only for his outstanding observations but also for the great theoretical use he made of them ; Herschel was, in fact, a great theoretical astronomer as well as the observer *par excellence*.

An able and sympathetic account of this surprising genius is given by Mr. J. B. Sidgwick in this book, in which he concerns himself especially with Herschel the man. He begins, appropriately, with the Herschel family in Hanover, and follows them through their various vicissitudes which finally resulted in William and his elder brother Jacob settling in England. Mr. Sidgwick has a great feeling for his subject ; indeed, we soon find the formal "Herschel" being replaced by the more familiar "William", although a return to "Herschel" occurs when the narrative becomes concerned with his theoretical work. The book usefully brings out the success which attended Herschel's work as a professional musician and gives an admirable picture of the keen amateur astronomer who, in his diary, reported with such obvious relish that ". . . I gave up much time to astronomy and also attended many scholars. Some of them made me give them astronomical instead of musical lessons". Mr. Sidgwick also gives graphical descriptions of Herschel's labours as a telescope maker and shows how his careful application to this work enabled him to produce instruments of a quality far surpassing anything then available; so good, in fact, that the magnifying powers he was able to use were for a time doubted by his contemporaries.

But it is in William Herschel's prowess and assiduity as an observer that his greatest claim to fame lies; and while it may be felt that Mr. Sidgwick gives more place to biographical details than to Herschel's astronomical work, nevertheless we do obtain a real sense of the perpetual observing which Herschel carried out as well as of the devoted assistance rendered by his sister Caroline. As to Herschel's pioneering endeavours in the theoretical field, in which he drew on his own unique fund of observational material, it is here that the book is not quite so satisfactory, as is to be expected, perhaps, in one written to have so wide an appeal as is clearly Mr. Sidgwick's aim. All in all, however, this volume, written with style and imagination, gives a good portrait of one of astronomy's greatest figures. It is free from any gross errors and, with its short but useful bibliography, is to be recommended.

C. A. RONAN

1950 INTERNATIONAL CONGRESS OF ELECTRON MICROSCOPY

Comptes Rendus du Premier Congrès International de Microscopie Électronique

Paris, 14–22 Septembre 1950. Mémoire hors série No. 1. Publié par la Société Française de Microscopie Théorique et Appliquée avec le concours du Centre National de la Recherche Scientifique. Pp. viii + 768. (Paris: Éditions de la Revue d'Optique Théorique et Instrumentale, 1953.) 8000 francs.

THE First International Congress of Electron Microscopy, held in Paris in 1950, attracted such a great number of participants that the report of its proceedings constitutes in itself a survey of the whole subject of electron microscopy as it stood at that time. In a short review it is only possible to indicate its scope. Electron optical theory claims thirty-one papers, but the design and construction of the microscope itself only eight papers; there are twelve on electron diffraction. Metallurgical applications, in eighteen papers, include work on metal physics as well as on more immediately practical problems of both ferrous and non-ferrous metallurgy. Twenty contributions on chemical applications range from pigments and polymers to photographic emulsions and clays. Biological applications not unnaturally attracted most attention, with forty-four papers which dealt with specimen preparation techniques (fixation, drying, sectioning, replicas), on one hand, and on the other with the use of the electron microscope in almost every type of biological and medical problem (viruses, bacteria, cancer, nerve, muscle, blood cells, teeth).

In two respects the Congress report is more informative than the meeting itself: first, it was physically impossible to attend all the sessions, and now every paper is available in print; and secondly, a large group of papers from Japan (twenty-four) which were read in title only are now printed in full. Two complaints may be made against the repor it appears almost three years after the meetin although the manuscripts should have been su mitted before the meeting, and the price is high. Th explanation in both cases probably goes back to th desire to include every contribution in full. In such rapidly advancing subject as electron microscop speed is possibly more important than comprehe siveness in publication.

It should also be mentioned that the Paris Congre was not the first in electron microscopy either *facto* or *de jure*: the first meeting of the Internation Commission for Electron Microscopy to be he under the auspices of the International Council Scientific Unions was held this year in London, an prior to the Paris meeting at least two conferenc of an international character had taken place, Cambridge (1948) and in Delft (1949).

V. E. COSSLETT

USE OF DIMENSIONS IN PHYSICS

Dimensional Methods and Their Applications

By Dr. C. M. Focken. Pp. viii + 224. (London Edward Arnold and Co., 1953.) 30s. net.

LIKE most of the basic principles of science, th subject of dimensions has grown up rathe untidily; it is presented differently and with differen conventions in almost every department. Th appearance of this book, with its suggestions fo standardization and its careful consideration of man of the difficulties involved, is therefore very welcom If it reads in places somewhat like a tract, this i only because the author wishes to present every sid of each problem and yet to make his own fir recommendation about which side to accept.

The subject is covered very well, with ampl references and quotations from some of the mor important papers. The sections on the dimension of thermal and electrical and magnetic quantitie will be found by most physicists to be extremel helpful.

In such a thorough treatment, it seems strang that the possibility of vector notation has not bee considered. This could be very useful; for example the dimensions of energy and of the moment of force are both (ML^2T^{-2}); but physically they ar quite dissimilar, the former being a scalar and th latter a vector. If a distinction could be made, i would be possible to make use of the result that al terms of an equation should be either scalar o vector, as well as dimensionally similar.

One point with which physicists will be inclined t disagree is the author's rejection of the physical basi of the principle that the argument of a transcendenta function (for example, e^x) should be dimensionless This basis seems so reasonable that the reviewer, a any rate, will continue to make use of it when h has need.

The book is well bound; but the printing is rathe displeasing. It appears to be reproduced fron electric typewriting; but the spacing of the word and even of the letters is not up to goo printing standards, and the right-hand edge of th type is often rather ragged. It is to be hoped tha this method of printing books will not be copie until it is a great deal better.

H. LIPSON

he Kalahari Sands of the Lunda (N.E. Angola), their Earlier Redistribution and the Sangoan Culture

Companhia de Diamantes de Angola: Museu do Dundo. Subsídios para a História, Arqueologia e Etnografia dos Poros da Lunda. Publicacoes Culturas No. 20. By J. Janmart. Pp. 65. (Lisboa: Companhia de Diamantes de Angola.) n.p.

SENHOR J. JANMART, chief of the prospecting service of the Companhia de Diamantes de Angola, has spent many years in studying the Kalahari Sands and their immediate derivatives. The Sands themselves fall into a threefold chronological series: Lower Kalahari (Kamina formation); Middle Kalahari (silcrete); and Upper Kalahari Kalahari Sands). All three deposits are pre-Pleistocene in age. Following on the deposition of the Upper Kalahari Sands denudation and redeposition have taken place, and a series of beds of redistributed sands has been determined. The volume under eview deals with the first two of these post-Upper Kalahari beds and their correlation with archæological discoveries.

The Upper Kalahari Sands and the earliest of the redistributed sand layers so far have yielded no human artefacts. If the Upper Kalahari Sands are assigned to a late Pliocene date, the succeeding layer may perhaps be considered as early Pleistocene, since the succeeding layer (redistributed sands (II)) contains Sangoan industries. Actually two typical Acheulean coups de poing have been found in a deposit which seems to date immediately anterior to the deposition of the redistributed sands (II), and this is what one would expect since the Sangoan culture is post-Acheulean in date and belongs to the Middle Stone Age complex both in East and South Africa.

This volume under review is an interesting contribution to knowledge and is well illustrated both in the way of half-tones and maps, sections and reproductions of stone implements. Those of us who read Portuguese with some difficulty are grateful to the author for having so considerately written the volume in English.

M. C. Burkitt

Australian and New Zealand Botany

By Prof. J. McLuckie and Dr. H. S. McKee. Pp. xx+758. (Sydney: Associated General Publications, 1954.) £Aust.4 4*s*.

ONE of the problems of teaching elementary botany in the Antipodes is that the text-books are European. The enthusiastic teacher may illustrate his lectures by the use of Australian plants, and he will be obliged to use some local types in the laboratory; but the student will still turn to standard British texts, and will read about fertilization in *Fucus* although he has seen it in *Hormosira*, and about the male cones on *Pinus* although he has dissected them on *Macrozamia*. There has long been need of a text-book up to first-year university standard based on plant life as the Australian student sees it, not as the professor from England remembers it. Drs. McLuckie and McKee have now supplied this need admirably. Their book amply covers a conventional first-year course. It is well illustrated with large numbers of original drawings. There are a full and up-to-date discussion of physiology, and a lucid section on fungi (where most of the types are providentially similar for the English and Australian student); a summary, all too brief, on the Australian and New Zealand flora, containing material which has not been assembled before in accessible form; and finally a brief history of botany in Australia and New Zealand. The book is a credit to Australian publishing, which until recently could not have produced such a book as this. It will undoubtedly be the mainstay of generations of Australian and New Zealand students.

E. A.

Science in Everyday Life

By Ellsworth S. Obourn, Prof. Elwood D. Heiss, and Gaylord C. Montgomery. Pp. viii+612+16 plates. 30*s*. net. Teachers Guide for Science in Everyday Life. Pp. 21. 3*s*. net. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.)

THE book is written for young adolescent boys and girls, and aims at developing an interest in science and an understanding of its applications in solving everyday problems. A very broad field is covered; indeed, the book has something of the character of an encyclopædia; but it is designed as a definite teaching course covering a single school year. The 'topic' method is followed as a means of stressing the unity of science, and emphasis is laid throughout on the underlying theme of energy.

With so wide a range of subject-matter the treatment is perforce very superficial, and from the point of view of general science teaching one feels that the authors have at times tried to build too much on what must necessarily be meagre foundations. For this reason the book would find only very limited application in the classroom in Great Britain, where the tendency is rather to narrow the field and so allow more detailed treatment. It would commend itself rather as a personal reference book for the bright thirteen-year-old child with a scientific bent. As such its appeal is enhanced by the numerous good illustrations and diagrams, also suggestions for experiments or observations drawn from common daily experience.

Maurice Ashby

Seventh Congress of the Universities of the Commonwealth, 1953—Report of Proceedings

Edited by Dr. J. F. Foster. Pp. xxxviii+296. (London: Association of Universities of the British Commonwealth, 1954.) 21*s*.

THIS admirably produced report of the proceedings of the Seventh Congress of the Universities of the Commonwealth, 1953, includes the text of the opening addresses at the five main sessions of the Congress and also those given at the two sessions on the special topic of the subject or subjects to-day best fitted to fulfil the part played previously in the university curriculum by the classics, as well as reports of the ensuing discussions. Although there is no index, the layout of the contents is such as to facilitate ready reference to the remarks made by any particular speaker or on any subject discussed. Besides the report of the executive council of the Association of Universities of the British Commonwealth for the period July 1948–June 1953, there are appended a report by the Committee for Commonwealth University Interchange on interchange visits between Commonwealth Universities and a note by the Principal of the University of London on the effect of superannuation schemes on mobility of academic staff within the Commonwealth. The Association is to be congratulated in placing on permanent record so much material of continuing interest in current discussions in a form as pleasant to handle as it is convenient of reference.

THE ROYAL SCOTTISH MUSEUM, EDINBURGH (1854–1954)

By DR. F. S. WALLIS
City Museum, Bristol

THE centenary of an organization provides a suitable opportunity to indulge in a historical survey and to indicate lines of progress for the future. Dr. D. A. Allan, the director, has developed both these themes in an admirable brochure published to commemorate the centenary of the Royal Scottish Museum in Edinburgh.

In common with the history of the majority of museums, the roots of the idea ante-date the actual foundation. In 1812 there was initiated in the University of Edinburgh a Natural History Museum, which though mainly formed for teaching purposes also served the general public to a limited extent. The collections were chiefly zoological; but a certain amount of the then inevitable ethnological material soon appeared.

The middle years of the nineteenth century witnessed a tremendous interest in industrial processes, and eventually, as a result of strong representations in Parliament, in 1854 a sum of £7,000 was voted for the purchase of a site and initial expenses in connexion with the establishment of an Industrial Museum for Scotland. The site, immediately to the west of the University of Edinburgh, consisted of an open space and two buildings. Dr. George Wilson was appointed the first director in April 1855 and later he received the appointment of professor of technology in the University of Edinburgh. This Industrial Museum of Scotland was really intended to be a museum of the industry of the world in special relation to Scotland. Also in 1855 the Edinburgh Town Council, patrons of the University, voted that the Natural History Museum in the Old College be handed over to the same body—the Department of Science and Art—controlling the new Museum. The foundation stone of the building, designed in Venetian Renaissance style, was laid by the Prince Consort in 1861. The first section was the eastern one, nearest the University, and subsequent additions extended westwards and southwards. On May 19, 1866, the first portion was opened formally by Prince Alfred, Duke of Edinburgh, while the most recent addition was opened in 1938. In 1864, to meet the dual functions demanded by two types of museums, the title was changed to the Edinburgh Museum of Science and Art. In view of the wide educational use made of museums in the present day, it is interesting to note that about this time courses of lectures for artisans were organised in natural history, geology, chemistry and natural philosophy at the modest fee of 1*s*. per course.

In the early days the work of the staff was impeded by almost continuous building operations, and the interest of the public was rather retarded by the discomforts of poor entrances and finally the construction of a street along the Museum frontage. Notwithstanding all this, some large attendance figures are recorded and the staff constructed some pioneer natural history groups, built technological models and prepared three catalogues on mineralogy, geology and British Foraminifera. The Museum also commenced to stage loan exhibitions, beginning with art, needlework and art fans, while one of Indian gifts made to H.R.H. the Prince of Wales brought the attendance in 1879 to 647,294. In 1904 the Museum celebrated its jubilee and its name was changed to the present one of the Royal Scottish Museum. Also in this year the building was refloored with oak, the roofs were reglazed—top lighting is a continual bugbear to administrators—and a new heating and ventilating system installed.

Up to this time the Royal Scottish Museum, in common with similar institutions, acquired its collections by gift, purchase or loan. The choice was thus limited by the likes or dislikes of private collectors. Such a state of affairs made it difficult to build up a systematic, comparative or chronological series, and in 1907 Mr. E. Ward was sent to Egypt to take part in archæological excavations and thus acquire material with adequate data. This policy of selective acquisition was soon extended to other Departments in the Museum. In 1910 a report was made concerning the state of local museums in Scotland. Thus was started that fatherly interest which has been such a feature of Dr. Allan's directorship. His influence on local museums to secure greater efficiency can scarcely be over-estimated. In 1930 "The Exhibit of the Month" was introduced, whereby some notable specimens or a new accession could be brought to the special notice of the public. Even at this period of its existence the need for a lecture theatre was stressed, for public lectures given fortnightly were attracting audiences of about two hundred. The priority of this requirement is still being emphasized by the Standing Commission on Museums and Art Galleries. But with the frequent extensions to the buildings and the consequent reallocation of galleries a certain amount of inevitable confusion had arisen. The evacuation of material necessitated by the Second World War gave the opportunity in 1946 for a re-arrangement on simpler lines. Natural history and geology now occupy the eastern block, art and ethnography the centre, and technology the western block. The administrative offices and laboratories are situated in the rear, while the reserve collections are housed in the basement and in one special block. The post-war reorganization also permitted of new schemes of redecoration, and for the first time a complete scheme of colours for walls, staircases, passages and case framings was drawn up with the aim of securing a harmonious background against which the exhibits would be accentuated. The Museum is now administered by the Scottish Education Department at a cost of about £75,000 per year.

The record of achievement concludes with short histories by the keepers of the separate Departments. Mr. Robert Kerr, keeper of the Department of Art and Ethnography, points out that though the original collections were associated with the early Industrial Museum, it was not until 1901 that the present departmental nomenclature was adopted and the acquisitions became more and more associated with the arts—not the graphic ones—and craftsmanship. They include metalwork, ceramics and glass, ivories, furniture and woodwork and textiles. The Main Hall nd large hall beyond provide a display of specimens illustrating European art, Oriental art, primitive art and the civilization of Ancient Egypt. On the first floor are the main comparative series of ceramics, arms, coins, glass and medals. The silver is notable for some excellent Scottish examples. The Textile Gallery shows a representative collection of lace, Persian and Oriental embroideries and early pieces from Egypt and Peru. Upstairs, on the second floor, are galleries illustrative of comparative ethnography, with some outstanding Japanese prehistoric material.

Dr. A. C. Stéphen stresses the association of the early natural history specimens with Prof. Robert Jameson, that outstanding personality who inspired so many Scots to collect in foreign lands. The exhibition galleries comprise fourteen rooms in the eastern half of the building and includes sections devoted to British and foreign birds, British mammals, extinct animals, beasts of prey, large ungulates, proboscideans, reptiles, fish and a recently arranged insect display. The Children's Gallery, with a fine diorama of the foreshore facing Bass Rock, is a striking feature. Mention must also be made of the Type Gallery and the Hall of Comparative Osteology, designed chiefly to meet the needs of students as distinct from members of the general public. The technical equipment of this Department is remarkably complete, and includes two studios for the skinning and mounting of animals, a large de-greasing plant and recently a freezing apparatus is being installed in the basement. The subject of botany is, of course, dealt with in the Royal Botanic Gardens.

Mr. A. R. Hutchieson, keeper, in describing the Department of Technology, naturally refers to the fact that it had its beginnings in the Industrial Museum of Scotland, and even some of its collections go back to the material acquired from world-wide sources following the Great Exhibition of 1851. These are augmented by industrial models and scientific apparatus derived from the Royal Scottish Society of Arts, the Royal Highland and Agricultural Society of Scotland and the University of Edinburgh. As early as 1866 a technological workshop was started in the Museum, and this in recent years has produced some amazingly accurate models, notably one of the Temple bascule bridge, Glasgow, complete with traffic controls, and equipped with a talking label, employing wire recording apparatus. In both World Wars the workshop became a small production unit for national purposes. The collections are housed in six galleries, devoted to power, shipping, mining and metallurgy, navigation and science. Adjacent to the Science Gallery is the Radiation Gallery, in which is a series of exhibits operable by the visitor and showing the properties of a variety of rays.

Dr. C. D. Waterson, assistant keeper in the Department of Geology, refers with natural pride to the historic nature of the collection under his care. They recall the great Wernerian–Huttonian controversy, the exploration of the North-West Passage, and the hobby of Hugh Miller, the stonemason. In common with the other Departments, the return of the material after evacuation for the War gave the opportunity for entirely new display methods in the four galleries at the east end of the top floor. The recent publication of a Catalogue of Fossil Fish recalls the name of Dr. R. H. Traquair, of international repute, who was at one time keeper of the Department of Natural History.

In a closing section, Dr. Allan rightly recalls that centuries are more than end-points, for they are starting-points for a new period of endeavour. With other museums now in the City of Edinburgh, the Royal Scottish Museum still has as its main function the collecting, conservation, display and interpretation of material in art, ethnography, natural history with geology, physical sciences and technology. World-wide exhibits are used where necessary, and Scottish ones where possible.

It only remains to state that the format of this brochure is very attractive. Illustrated with half-tone blocks and plans, it gives a visual impression of the buildings at various stages of their development, and a genealogical diagram portrays clearly the composition of the present staff and their inter-relationships.

It is written and edited in that individualistic, factual but stimulating style which we now associate with the pen of Dr. D. A. Allan, and is not only interesting as a record of achievement in Edinburgh but also recapitulates faithfully much of the history of the museum movement in Great Britain.

THE MUSEUMS ASSOCIATION

THE sixtieth annual conference of the Museums Association was held amidst the capital splendour and beauty of Edinburgh during July 19–23, under the presidency of Sir Leigh Ashton, director of the Victoria and Albert Museum, London.

The conference coincided with the centenary of the Royal Scottish Museum, and members were privileged to attend the ceremony on this historic occasion and share in the greetings offered by distinguished guests. The Minister of State, the Right Hon. the Earl of Home, presided, and felicitations were expressed by those representing the City, the University and museums at home and abroad. Dr. Douglas A. Allan, director, replied and paid a warm tribute to the Ministry of Works and other colleagues who had brought the Royal Scottish Museum to its present high standard of display.

This year no overall theme was selected for the conference; but the individual papers were of a high level, and the discussions were stimulating and of interest both to the professional members and institutional delegates. Sir Leigh Ashton, in his presidential address on "The Functions of Museums", stressed the importance of conservation and enumerated the other functions as assistance given to the scholar, the child and the general public. He paid tribute to the Carnegie United Kingdom Trustees for their welcome help to the museum movement and the influence of their grants for improved presentation, and stressed the importance of imagination in dealing with the educational side of museums.

Mr. Ritchie Calder, in a paper on "Museums: our Wasting Heritage", felt that an artificial culture was replacing real values. He appealed to the museum profession to help in the preservation of our heritage and felt that they could study with advantage much of the publicity methods of the commercial world.

Dr. D. E. Owen (Leeds), speaking on "Making Friends for the Museum", considered that the needs of the museum were different from those of the art gallery. The former required workers both for the acquisition and identification of material, while the latter were in need of patrons to lend, give or buy works of art. A museum of archæology probably required both types. He considered that much help could be given to folk museums by systematic circularization of those in close touch with the countryside.

For the first time in the history of the Association and as an experiment a session was given to sectional meetings. In that devoted to archæology, ethnography and folk-life, Dr. D. B. Harden was chairman, and Mr. R. J. C. Atkinson gave a paper on "A National Index of Archæological Collections". Mr. Atkinson sought the co-operation of museums in the compilation of illustrated indexes of British archæological objects: (1) Inventaria Archæologica of associated groups chiefly of the 2nd millennium B.C.—an international project of which some Belgian and German cards are published; (2) British Association card index of bronze implements, formerly in the British Museum, now at Oxford, in abeyance since 1939; (3) Corpus of Bronze Age pottery, being organized by the Council for British Archæology; and (4) School of Scottish Studies, Edinburgh, neolithic and bronze age indexes. Mr. F. G. G. Carr (National Maritime Museum) and Miss Elspeth M. Gallic (Old Glasgow Museum) then dealt with the difficult problem of the purposeful display of personalia and historical relics. Both speakers stressed the need for proving the authenticity of personalia and historical relics and, if possible, for exhibiting them as part of a well-defined and general pattern. An endeavour must be made to re-create the person to the visitor.

In the section dealing with art and applied art, the president took the chair, and the first discussion was opened by Prof. A. F. Blunt, of the Courtauld Institute of Art, whose subject was "The Teaching of Art History, and the Museum Profession". He described the training in the history of European art provided at the Courtauld Institute. The Institute could not, he stressed, give instruction in the administrative and technical aspects of museum work—this came only with experience and specialized training; but it did provide education of a high standard of great value to entrants to the museum profession.

The other speaker was Miss Helen Gluck, who discussed "The Dilemma of the Painter and Conservator in the Synthetic Age". She showed how, since the commercial introduction of packaged paints, the quality of artist's materials had deteriorated. The situation had become worse since the introduction by the colourmen of synthetic materials. If the paintings of to-day were to survive, the most thorough investigation was required, and a centre, which would make it its business to see that standards were maintained, should be established. Miss Gluck's paper was the subject of lively discussion and the meeting agreed to recommend to the Ministry of Education, as the body responsible for most of the schools of art, that this matter be given serious attention.

The third section, under the chairmanship of Dr. W. E. Swinton, discussed two difficult but important fields for museum treatment. Mr. D. Chilton (Science Museum) defined the essentials of display for meteorology, which is becoming increasingly of public interest, recommending the exhibition of the standard instruments, in use, if possible, and a selection of cloud photographs. Dr. John Burton (medical director of the Central Council for Health Education) stressed the ways in which the local museum could play its part in the hygiene campaign and discussed the kinds of travelling exhibitions which were and could be prepared, and the part that the local medical officer of health could, and probably would, play in co-operation with the museum.

Dr. F. J. North, chairman of the Education Committee, opened a discussion on training problems in the museum profession. After referring to the difficulties of the task and its consequent challenge he said that it should be possible to induce at least one university to establish a department of museology or better still, to create conditions in which the Association could have its own training institution. Subsequent speakers stressed that such a training should be in the nature of a postgraduate diploma course. The training needs of museum curators fall into two categories. First, instruction in some museum subject generally received in a university or equivalent institution, and secondly, the application of that knowledge to the needs of a museum. As matters are at present, training in the latter part can only be given in museums and several trainee-assistant schemes are in operation. Dr. North naturally summarized the diploma scheme of the Museums Association for curators and the more recently instituted technical certificate. Opportunity was taken at the end of the discussion to express the gratitude of the Association for his great services during his eight years chairmanship of the Education Committee and for his pioneer work with regard to the establishment of the diploma and technical certificate.

The hospitality of Edinburgh was extended to members by receptions at the Assembly Rooms, the Royal Scottish Museum and the Scottish United Services Museum, and the Association was honoured by the presence of the Lord Provost and other distinguished citizens at its annual dinner. Tours to Loch Lomond and the Loch Sloy scheme, Haddington and East Lothian and the Border Abbeys closed a stimulating week.

At the annual meeting of the Association, Sir Leigh Ashton was re-elected president, and Mr. E. C. Chubb, director of the Durban Museum and Art Gallery during 1910–51, was elected an honorary fellow. It was decided to hold the next conference at Birmingham during July 4–8, 1955.

THE UPPER ATMOSPHERE

As part of its summer meeting in the University of Edinburgh during July 15–17, the Royal Meteorological Society held a symposium on "The Upper Atmosphere". Dr. O. G. Sutton, president of the Society and director of the Meteorological Office, presided.

The first speaker at the symposium was Sir Edward Appleton, principal of the University, who began by emphasizing the remarkable complexity of the structure of the upper atmosphere and proceeded to give a survey of the present state of our knowledge of the subject, indicating the regions that are the seats of the various phenomena which were to be discussed by subsequent speakers in the symposium. He likened the upper atmosphere to a vast laboratory in which the sun daily actuates a series of experiments at low pressures, in conditions and on a scale which we cannot hope to reproduce experimentally. Solar ultra-violet radiation creates, at different levels, the ozonosphere and the ionosphere by dissociating molecules and by ionizing both atoms and molecules. Further, the gravitational attraction of the sun and moon causes marked atmospheric tides at high evels, and the influence of the earth's magnetic field comes into action as soon as any charged atmospheric particle begins to move. Meteors, sporadic and in showers, produce streaks of ionization which can be observed by eye if clouds are absent and always—even in Manchester—by radio. It may be that fine meteoric dust forms a permanent part of the onosphere.

Sir Edward then discussed some ionospheric problems which he and his research assistants in Edinburgh, Mrs. Pritchard and A. J. Lyon, have recently examined. "If the nature of your occupation prevents you from doing any experiments, it need not prevent you from thinking—thinking about other people's measurements." In the field of geophysics, many people are engaged in making measurements, but he sometimes wondered whether enough people are thinking about what these measurements mean, when they are compared with one another. He and his assistants have been examining measurements of ionization densities in the layers of the ionosphere from a world point of view by using the observations of ionospheric stations operating in different parts of the world.

Examining first the world morphology of the *F*2 layer, they investigated the variation of *fF*2 at noon at the equinoxes with both geographical and geomagnetic latitude and have found the closer fit with the latter. The curve shows a trough in the region of the equator, where *fF*2 is a minimum. When curves are drawn for other times of the day, it is found that in the late evening hours the trough becomes a crest. No such effect appears in similar curves drawn for the *E* and *F*1 layers. This difference between the *F*2 layer and the lower *E* and *F*1 layers is not thought to indicate that the *F*2 layer is caused by electrified corpuscles. They think that ultra-violet radiation, certainly the cause of the *E* and *F*1 layers, is also responsible for the *F*2 layer and that the effect is due to geomagnetic distortion. The movements associated with the diurnal oscillation, tidal or thermal in origin, which these observations disclose, would be subject to strong control by the geomagnetic field at the low densities obtaining at the *F*2 level. But, though theories have been proposed by Martyn, Maeda and Weiss, there is as yet no satisfactory theoretical explanation. The investigation of the *F*2 layer by Sir Edward and his co-workers has further revealed that, during an ionospheric storm, the value of noon *fF*2 is reduced in high latitudes and increased at the equator.

While their examination of the world morphology of the *E* and *F*1 layers has shown no strikingly abnormal effects, even here there are small departures from simple theory. It was well worth while investigating such discrepancies, for there is always the possibility that the investigation may yield a method of measuring the magnitude of the factor which itself causes the discrepancy. In illustration, Sir Edward then considered some features of the *E* layer, and from the continuity equation showed that, in an ionized medium:

$$N = \sqrt{\frac{q_0 \cos\chi}{\alpha}},$$

where N is the ion (or electron) concentration, χ the zenith distance of the sun and α the coefficient of recombination. If q_0 and α are constant, then N is uniquely determined by $\cos\chi$. A curve showing the annual variation of N_E for constant χ may be drawn using experimental data, since χ is the same at noon in winter and in the early morning or late evening in summer. They have found, in fact, that N_E for constant χ has a minimum in June, so that either q_0 or α, or both, varies; conditions are not the same in summer and winter at the same height.

Finally, Sir Edward discussed the methods they are using in their attempt to determine accurate values of the recombination coefficient at low pressures at all times of the day throughout the year and showed how the coefficient may be determined from observation of the time-lag between the maximum of the ionizing process (at noon) and the ionization maximum; values of the order of 10^{-8} and 10^{-9} have been obtained. They have taken the opportunity, afforded by the recent eclipse, of making such measurements at a minimum of solar influence; Mr. Lyon has successfully made radio observations on the ionosphere at Slough, and they are at present engaged on working out the results.

By studying the reflexion of radio waves from the trail of ionized air produced by a meteor, the atmosphere at heights between about 85 and 105 km. may be sampled, simply and at low cost, several hundred times per hour throughout the day. Dr. Ian C. Browne summarized the results obtained by many workers using this method at Jodrell Bank, University of Manchester, since 1946. Measurements of air density and of scale height (about 3×10^{-9} gm. per c.c. and 8·5 km. respectively at 95 km.) may be obtained from observations of the intensities and heights of appearance of meteor echoes, and the atmospheric diffusion coefficient may be calculated from the time of duration of the echoes. In addition, movements of meteor trails of the order of one metre may be detected by using a special technique, so permitting the measurement of wind speed at the height of the trail, for 'meteor winds', in contrast to those obtained by ionospheric methods, are true mass movements of the air. Superimposed on a prevailing wind of about 10 m./sec., there is a semidiurnal component which may have an amplitude of 30 m./sec.; the phase and amplitude of this semidiurnal component show seasonal changes. The winds increase with height, the value of the shear being about 2×10^{-3} per sec., that is, roughly the same as in the troposphere; but there is no change in wind direction with height and no detectable vertical component. Dr. O. G. Sutton asked if Dr. Browne could suggest a mechanism which would account for the maintenance at such great heights of such a regular shear. Dr. Browne was of the opinion that the explanation lies in the temperature distribution at these levels. Dr. T. W. Wormell doubted if the motion of an ionized meteor trail is identical in magnitude and direction with the general air-motion at the same level; he questioned if we could neglect completely the effect of magnetic forces on the moving ions and electrons.

Dr. H. P. Palmer summarized the work at Jodrell Bank on the fluctuations of the power received from the intense sources of radio emission in Cassiopeia and Cygnus. The facts that the fluctuations occur mainly during the night and that the degree of fluctuation varies from night to night, showing a close correlation with the occurrence of 'spread *F*' ionospheric echoes, indicate that the cause is a terrestrial agency, which is thought to be a diffracting screen of irregularities above the maximum of ionization in the *F* region. Small time-differences, which are detectable when records from receivers 2–3 km. apart are compared, are interpreted as evidence of drift motions of the diffracting screen. Drift speeds of 50–300 m./sec. in an east–west direction have recently been determined from approximately vertical observations from three stations. During the months December–April, when these stars transit near midnight, the drift is found to be easterly until 01 hr., U.T., then to reverse sharply and to remain westerly thereafter. When the stars are observed at lower culminations, the line of sight traverses the *F* region in the auroral zone, and fluctuations are then observed at all times, even on magnetically quiet days. Drifts now observed are of greater magnitude and more variable direction, predominantly towards the east during the period 19–21 hr., and towards the north-east or north-west during 21–06 hr.; but it may be that the apparent north–south components arise from vertical motions.

During an investigation into methods of representing the wind field at the 100-mb. pressure-level, it was found that winds observed at this level from British upper-air stations show diurnal and semidiurnal variations. D. H. Johnson, of the Napier Shaw Laboratory, Meteorological Office, Dunstable, gave an account of an analysis he has made of these solar tides in the lower stratosphere. He pointed out that observations at the 100-mb. level are particularly suitable for this study since the lower stratosphere is relatively free from effects that might mask the tides; synoptic variations of wind, for example, are small. Using observations made by radar and radio direction-finding techniques, he computed the deviations of the annual mean south- and west-wind components at three-hourly intervals from the respective overall annual mean wind components and found expressions for the annual mean oscillation of each component by harmonic analysis. He found that the stratospheric oscillation is approximately in phase with the surface wind oscillation derived theoretically by Bartels from Simpson's expression for the semidiurnal variation of surface pressure, a result in accordance with tidal theory. The amplitudes of the south and west wind-component oscillations at the 100-mb. level are 0·67 and 0·51 knots, respectively. The corresponding values derived by Bartels for the surface wind-component oscillations are 0·87 and 0·85 knots, respectively [see also p. 363].

D. H. McIntosh, superintendent of Eskdalemuir Observatory, discussed the possibility of determining winds at ionospheric levels from geomagnetic observations. He outlined the development of theoretical work on the problem of the interpretation of geomagnetic observations since Balfour Stewart suggested in 1882 that the upper atmosphere is highly conducting and that its daily horizontal tidal movement across the vertical component of the earth's field induces currents, the magnetic field of which is observed at the ground as the magnetic daily variation. Schuster, and later Chapman, have developed the theory of the magnetic solar daily variation and of the corresponding lunar effect. While many problems remain unresolved, the theory in its fundamentals has received striking confirmation in several ways, initially by the experimental discovery of the ionosphere and most recently by the discovery by a rocket ascent of a discontinuity of the geomagnetic field at about 100 km., revealing the presence there of a current sheet. So, the dynamo theory of the daily magnetic variation implies that any mass movement of air at ionospheric levels must register in the magnetic records. Wulf has recently examined the problem of determining ionospheric winds in this way, but success has been limited. Vestine, on rather debatable assumptions, has derived wind systems compatible with the annual variation of magnetic disturbance and with the features shown by a particular magnetic storm. Mr. McIntosh wa confident that, with the prospect of obtaining direc measurements of ionospheric winds by means o the newly developed radar-sonde, important progres with this problem is likely in the near future.

A paper by Dr. A. H. Jarrett, of the Universit of St. Andrews, on the possibilities of multilayer coatings for auroral research was read by J. Paton University of Edinburgh, Dr. Jarrett having been detained after his eclipse observations in Sweden longer than anticipated. Examination of the spectrum of auroræ provides a method of estimating temperature at auroral levels; but, because of the low dispersion of auroral spectrographs and of the long exposures necessary with an extended source like the aurora, measurements are difficult and results uncertain. The use of multilayer coatings in place of the usual silver films in the interferometer considerably reduces absorption and so the times of exposure With exposures as short as twenty minutes, Dr. Jarrett has recorded Fabry–Perot fringes from auroræ using the 5577 A. line, by placing the interferometer in front of the *f*/2 Summar 5-cm. focal length camera lens. This preliminary investigation indicates the great possibilities of the use of multilayer coatings in auroral spectroscopy. The United States National Committee for the International Geophysical Year has generously proposed to lend to the British Committee the latest type of auroral spectrograph, working at *f*/0·8 with a dispersion of 25 A./mm. This instrument will be installed at St. Andrews Observatory and will make possible the first British measurements of temperature from auroral spectra. Dr. Jarrett hopes to equip the instrument with a photoelectric scanning arrangement for direct recording.

Brilliant displays of the rare noctilucent clouds have recently been seen from central Scotland, and their height, position and speed have been determined from parallactic photographs. Mr. Paton discussed the importance of observations of these clouds in providing information concerning the physical state of the upper atmosphere at the height of about 80 km. at which they invariably occur. Besides yielding direct measurements of wind, they indicate the existence of a temperature minimum at 80 km. Wind speeds of the order of 50 m./sec. have been measured; Störmer has recorded speeds of more than 100 m./sec., and Jesse of about 300 m./sec. On every occasion when the clouds have been observed from Scotland, this movement has been from the east-north-east. But, since they are made visible by the sunlight scattered by the material of which they are composed, they are observed only on nights when the sun remains close below the horizon—that is, during the summer months in middle latitudes. Presumably they may be present at other times and in other latitudes, but they will not remain sunlit long enough to be observed. Their nature is still in doubt, though their tendency to appear at times of comet and meteor occurrences strongly supports the belief that they consist of meteoric dust. E. G. Bowen has recently pointed out that they appear either on or very near the dates of the daylight meteor streams discovered at Jodrell Bank, but Scottish observations show no such tendency. On one occasion, a portion of the clouds was observed to hange colour from vivid blue to white, suggesting growth of the cloud particles by condensation. When pportunity offers, the new spectrograph at St. Andrews will be employed to investigate such hanges in the spectrum. Finally, slides were shown llustrating a remarkably sudden change from their haracteristically stable structure to quite chaotic hapes that occurred in the early morning of July 25, 1950. Noctilucent clouds have been observed on wenty-two nights since 1939; but this was the only ccasion when turbulence was seen. It may be significant that it was also the only occasion when aurora ccurred simultaneously with the noctilucent clouds.

OBITUARIES

Prof. J. T. Hewitt, O.B.E., F.R.S.

Prof. J. T. Hewitt, while crossing the road near his home at Hurst, Berkshire, on July 9, was knocked down and killed by a motor-car. Although he was eighty-five years of age, he was still active, and his death came as a shock to all who knew him. He was born at Windsor in 1868. After an unconventional schooling, he went to the Hartley Institute (now the University of Southampton) and at sixteen was a student at the Normal School of Science (later the Royal College of Science). At eighteen he was a scholar of St. John's College, Cambridge. He took the Normal School associateship in 1887, and three years later had a first in both parts of the Natural Sciences Tripos and a first in the London Honours B.Sc. Before 1893 was out, he had worked in Heidelberg and in Berlin and had acquired the Ph.D. (Heidelberg) and the D.Sc. (London). He was appointed professor at the People's Palace Technical Schools at Easter 1894, at the age of twenty-five. In the next twenty years, during which the Schools had emerged as a school of the University of London under the title of East London College (now Queen Mary College), he had as students or research students many men who later rose to important academic, governmental or industrial posts. To make a selection is always invidious, but the following names might be mentioned to show the range of interests involved: H. A. Phillips, A. E. Pitt, T. S. Moore, A. E. Dunstan, J. J. Fox, J. Kenner, G. M. Bennett, J. C. Drummond, A. D. Mitchell, T. F. Winmill and W. G. Hiscock.

Hewitt, F. G. Pope and Clarence Smith shared the lecturing at East London; Hewitt gave the intermediate inorganic lectures, which were first class and very well illustrated by experiments, and all the general and honours lectures on inorganic and on physical chemistry. He also attempted to teach his students some mathematics. What was so attractive about Hewitt's lectures was his unconcealed interest in any and every branch of chemistry: in dealing with sodium thiosulphate he could not keep out Bernthsen's methylene blue synthesis, nor Willgerodt and Mascarelli when he was talking about iodine. To him, metallurgical processes, the phase rule, and the determination of accurate atomic weights were all intellectually diverting.

When Hewitt was elected into the Royal Society in 1910, he had an international reputation as an authority on the relation between colour and constitution. He had original views on fluorescence, on the connexion between depth of colour and degree of conjugation, on the constitution of phenthiazine and safranine dyes and on other subjects. Any student in his department who showed ability and enthusiasm was encouraged by Hewitt to get through the routine analytical course as quickly as possible and start some research.

Hewitt wrote an excellent practical book, "Organic Chemical Manipulations", which was unfortunately allowed to get out of print. He invented a process for the quick maturing of whisky and was consulted by the French wine trade. He played an important part in the famous aspirin law case which was lost by the Bayer group.

During the First World War, Hewitt first worked out processes for manufacturing acetic anhydride and for converting benzene–xylene mixtures into toluene. In 1915 he was commissioned as major and went to the Dardanelles, where he was concerned with such diverse matters as water analysis and cylinders of chlorine. Early in 1916 he returned to England and was seconded to the Department of Explosives Supply. He controlled a small factory at Chiswick, with Clarence Smith as a colleague. They dealt first with explosives and later with materials for chemical warfare. Hewitt was a great admirer of his 'chief', Lord Moulton.

Hewitt resigned from his chair at the end of the First World War and in 1919 joined with T. D. Morson, C. S. Roy, Clarence Smith, J. L. Baker and Miss Hewitt (his much beloved sister) to manufacture fine chemicals (quinine ethyl carbonate, quinoline, methylquinolines, benzthiazole, phenylhydrazine, phenylmethylpyrazolone, etc.). This concern gradually decayed for one reason or another, and the Hewitts left it during 1940. Miss Hewitt died in 1943 and thereafter Hewitt lived alone in his cottage at Hurst. He often went to London, to the Chemical Society and to meetings of the University Board of Studies, of which he was an original member (1901). He was one of the first Fellows of Queen Mary College.

Hewitt was a good chemist, a very human personality and (there is no other word) a gentleman. He enjoyed his life and his memories. It was always a pleasure to see him enter a room full of people he knew: that characteristic, half-courtly salutation—the irresistible charm of a man who lived and worked with zest.

E. E. Turner

Prof. H. Frankfort

Henri Frankfort's most outstanding achievement was to have appreciated and by practical example to have taught others to appreciate the value of archæological evidence as a source of human history. His first work—the two volumes of "Studies in the Early Pottery of the Near East"—was not only an original and pioneer comparison of the then available archæological material from predynastic Egypt, prehistoric Mesopotamia and pre-Hellenic Greece, which despite the unpredictable results of many subsequent excavations still provides the accepted guiding lines for the interpretation of Egyptian prehistory. But his "Studies" also eloquently demonstrated how a detailed objective analysis of ceramic techniques, decorative motives and art styles might disclose a history of very much the same sort as that extracted by philologists from orthodox written sources. Frankfort had been trained in the rigorously literary disciplines of the Classics and Egyptology as taught in Holland during the 'twenties. But coming as a postgraduate to University College, London, he fell under the spell of Petrie and imbibed something of his flair for the humanist value of material objects made by man. This combination found original expression in the "Studies" and developed ever more fruitfully in his maturer works: for these remained works of scholarship and interpretation.

Of course, Frankfort was no armchair archæologist—he could never have been a great interpreter had he been that. He gained field experience and added to human knowledge first in directing the Egypt Exploration Society's excavations at Tell el-Amarna and then as field director of the Iraq Expedition of the Oriental Institute of the University of Chicago. The latter post gave not only opportunities of studying the monuments in their proper setting but also of organizing a scientific expedition on a lavish scale. The scientific value of the results obtained at Tell Asmer and Khafaje are essentially the fruits of Frankfort's success as its organizer. For though the expedition did uncover some spectacular objects—hoards of early Sumerian statues, for example—it was the (in Mesopotamia) unprecedented thoroughness and accuracy of the planning, recording and conserving of all finds that have invested the latter with unique historical significance. The publication, still far from complete, had been planned by Frankfort, and his own personal contributions—two volumes devoted to the Sumerian statuary—disclose his sensibility as an art critic and vigour in interpretation.

Still, it is in more comprehensive syntheses, written while he was professor in Chicago and later director of the Warburg Institute in the University of London, that Frankfort's genius found fullest expression. In "Kingship and the Gods", and perhaps still more in the introduction and conclusion (written in collaboration with his first wife) to "An Essay on Speculative Thought in the Ancient Near East", entitled in Great Britain "Before Philosophy" and in the United States. "The Intellectual Adventure of Ancient Man", the reader can see how successfully and naturally an archæologist can assume the role of philosopher and sociologist. V. G. Childe

Dr. Henri Mineur

With the untimely death of Henri Mineur, which occurred after a short illness in Paris on May 7, France has lost one of her most distinguished astronomers, and the Paris Observatory one of the best-known members of its staff.

Henri Mineur was born at Lille in 1899. Entering the army at the age of eighteen, he served for a few months with the Engineers and was demobilized with the rank of second lieutenant. Completing his interrupted education at the École Polytechnique, he graduated in 1921 and took his doctorate in mathematical sciences in 1924. At this stage he decided to make his career in astronomy and accepted a post as assistant astronomer at the Paris Observatory in 1925. Within eleven years of work at the Observatory, he had made such a name for himself that he was appointed, at the age of thirty-seven, as the first director of the newly established Institut d'Astrophysique. Work at the Institute had not got into full swing when, at the outbreak of the Second World War, it was virtually suspended, and he became director of a mathematical laboratory devoted to the solution of defence problems. Enlisting in the Armed Forces in 1940, he was appointed professor at the school of military engineering at Versailles shortly before the fall of France. Demobilized in August 1940, he joined the resistance movement and was dismissed from his official posts by the Vichy Government in 1941. Three years later he was reinstated by the new French Government and served for a short while as captain in an anti-tank unit. Again demobilized in 1946, he turned his energies once more to astronomy, and by the date of his death had re-established the Institut d'Astrophysique as a national postgraduate centre for theoretical and observational attacks on current problems on the frontiers of astrophysics.

Mineur's personal researches covered a wide field in celestial mechanics, pure mathematics, relativity theory and statistics as well as in astronomy. He will perhaps be best remembered for his work on differential galactic rotation, carried out independently of Oort's, but leading by somewhat different methods to substantially the same conclusions, namely, that the Galaxy is rotating about a centre some 8,000 parsecs distant towards galactic longitude 325°, at a rate giving one complete turn in 250 million years in the solar neighbourhood. To his credit are also a number of allied investigations into the equilibrium of open galactic clusters, the time-scale of the universe, and absorption of light in interstellar space. His early training as an observer in the Paris Observatory, and, later, his everyday contact with practising astronomers working in the Institut d'Astrophysique under his general direction, combined to confer on his theoretical work a practical insight which lent increased authority to his results.

M. Mineur was awarded the Damoiseau Prize of the Paris Academy of Sciences in 1944 and the Montyon Prize in 1950. He was created Chevalier of the Légion d'Honneur in 1949. A. Hunter

Dr. Loyd A. Jones

Dr. Loyd A. Jones, who died unexpectedly on May 15 at his home in Rochester, New York, a fortnight after his retirement, was well known for his scientific work in photography. He was born in Nebraska in 1884 and, after graduating in the University of Nebraska, was for two years assistant in the Physics Department of that University, assistant physicist at the U.S. National Bureau of Standards for another two years and then joined the Research Laboratories, Eastman Kodak Company, when they were formed in 1912. He soon became chief physicist and head of the Physics Division.

From then onwards Jones's interests were almost exclusively his work on photography and on scientific committees, and his home and garden. He graduated as an electrical engineer, and something of the qualities of an engineer are to be found in much of his published work. This amounts to about eighty papers. His early work was mainly concerned with the measurement of the properties of photographic materials, the provision of instruments for doing so, and related subjects. The major interest was in sensitometry—the measurement of speed and contrast—and tone-reproduction. The culmination of this work was the paper of 1939, "The Evaluation of Negative Film Speeds in Terms of Print Quality", wherein the criterion of correct exposure of the negative was whether the negative gave as good a print as could be obtained from that negative material whatever the exposure. The quality of the prints was estimated by purely visual judgment, without reference to any physical measurements. The process sounds, and indeed was, laborious; but something of the kind is inevitable, and in Loyd A. Jones's hands it led to a physical measurement which correlated well with the observed speed. This way of measuring speed was adopted by the American Standards Association and the British Standards Institution. The same characteristic approach is to be found in his later papers, on graininess and granularity, and on sharpness, wherein the main effort is directed to the discovery of a purely physical measurement which correlates well with some visual estimate.

Loyd A. Jones served on many scientific bodies, notably on the Colorimetry Committee of the Optical Society of America and the sectional committee on photography of the American Standards Association, for many years. Besides the recognition which he received from scientific and photographic societies in the United States, the Royal Photographic Society of Great Britain awarded him its Progress Medal, the Hurter and Driffield Medal and an honorary fellowship. He leaves a wife and many friends to regret his death so soon after retirement. E. R. Davies

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Mr. Hugh Griffiths

The chemical engineering profession has lost a doughty fighter in Hugh Griffiths, who died on June 26, 1954. He was born at Middlesbrough on July 28, 1891, and a very strong influence on his career was his contact there with A. F. van der Heyden, who laid the foundation of his love for mathematics. He took his A.R.C.Sc. in chemistry and was for the most part of his life in consulting practice. His command of the German language and his contacts on the Continent proved most valuable in this connexion.

In 1945 he was elected president of the Institution of Chemical Engineers. As a biography is contained in the *Transactions* for that year, it is now opportune to try to assess his outstanding contribution to the profession. This was undoubtedly his advocacy of the use of the 'Home Paper' as a part qualification for associate membership. He came into the chemical engineering profession as a young man with the practical heritage of the Victorian period behind him. First and foremost with him was the essential engineering background—the need for a practical estimate of the magnitude of the problem and the sizes involved. It was his mathematical and scientific training which then enabled him to apply fundamental conceptions to rule-of-thumb methods, and to develop processes in a manner not dreamt of by his forbears.

His philosophy in supporting the use of the 'Home Paper' for examination purposes was the realization that, if a student is faced with a problem such as, for example, the design of a plant required for the manufacture of 10 tons a day of mono-nitrotoluene, it brings out all that is latent within him and automatically poses to him all the problems which a chemical engineer has to face to be successful. His fierce advocacy of the use of this method of training did sometimes bring him into conflict with his colleagues, as he was always afraid that modifications might result in a lowering of his high standards.

It was in keeping with Griffiths's love of his profession and its heritage that his last public appearance was at Mr. Norman Swindin's lecture in Manchester on the life of that grand old man and founder of chemical engineering, George E. Davis. It was then only too apparent to his colleagues that his life was on the ebb tide. In him they have lost a good friend, and the profession has lost a notable servant.

M. B. Donald

NEWS and VIEWS

Agricultural Physiology at Cambridge: Dr. John Hammond, F.R.S.

Dr. John Hammond, who on September 30 retires from his post as reader in agricultural physiology in the University of Cambridge and his honorary directorship of the Agricultural Research Council Unit of Animal Reproduction, has brought an immense amount of prestige to British agricultural science. While his contribution to fundamental research is widely appreciated, it will be as the prophet—in the proper sense of the word—of the physiology of reproduction that his name will be honoured. Son of a Norfolk farmer and nephew of a veterinary surgeon, he absorbed as a student the teaching of the late Dr. F. H. A. Marshall on the pure physiology of reproduction. The significance of his life's work is that, at a time when animal production was under the influence of pedigree breeders and the auction mart, on one hand, and the pathological outlook of the veterinary profession on the other, he brought to its development a more positive scientific approach. The essence of his teaching was the extent to which production could be increased by studying the normal physiology of farm animals and not merely by removing the adverse effects of disease and abnormal physiology. Further, and this may yet be his greatest monument, Dr. Hammond has enthused a large and influential band of disciples, not only within the British Commonwealth but also throughout the world, to initiate research themselves and apply the newer knowledge to the farming industry. Among a wide range of subjects on which he has worked must be mentioned the reproduction and milk production of the cow, which provided the basis of the artificial insemination movement in Britain, and his study of the effect of nutrition and environment on the growth and conformation of sheep and pigs. If the study of animal husbandry ever becomes a profession independent of either agriculture or veterinary science, it will be largely due to the pioneer work and inspiration of John Hammond.

Registrar of Trade Marks in India: Dr. S. Venkateswaran

Dr. S. Venkateswaran, deputy registrar of trade marks, India, has been appointed as registrar of trade marks in succession to K. S. Shavaksha, who has recently retired. Dr. Venkateswaran, who is a D.Sc. of the University of Madras and a law graduate of the University of Calcutta, was assistant chemist at the Agricultural Research Institute, Pusa, and at the Government Test House, Alipore, during 1922–30, and has worked under Sir C. V. Raman, publishing several research papers on light scattering and Raman effect. He was elected a Fellow of the Indian Academy of Sciences in 1934. Dr. Venkateswaran joined the Indian Patent Office in 1930 as an examiner of patents and was successively special officer for trade marks (1940), assistant registrar (1940–44) and deputy registrar (1944 to date). He has been prominently associated with the enactment of the trade mark legislation in India, and his most important book, "The Law of Trade and Merchandise Marks" (1937), besides being a legal text-book, presents a complete case for trade mark legislation in India. The new Patents Bill is now before the Indian Parliament, and there is a proposal to combine the Patent Office and the Trade Marks Office again, as was the case before their separation in 1943 owing to certain administrative reasons. Although it is now more than fifteen years since trade mark legislation was enacted in India, India has not yet joined the International Convention for Industrial Property and there is no reciprocal arrangement for trade marks between India and other members of the British Commonwealth. It is understood that the Government of India is now actively considering the question of taking early steps to join the International Convention.

Charles P. Daly Medal of the American Geographical Society: Dr. J. K. Wright

DR. JOHN KIRTLAND WRIGHT, geographer–historian, has been awarded the Charles P. Daly Medal of the American Geographical Society for his outstanding contributions to the field of geography through his administrative services, writing and research. Dr. Wright joined the staff of the American Geographical Society in 1920 as librarian, and served in that capacity until 1938, when he became director; in 1949 he resigned his post as director, and since then has devoted his time to research and writing. He was president of the Association of American Geographers in 1946, and during 1949–52 was chairman of the Commission (of the International Geographical Union) on the International Map of the World. The Daly Medal was established in 1902 in accordance with the will of Judge Charles P. Daly, eminent New York jurist and president of the American Geographical Society during 1864–99, and is awarded from time to time (thirty-seven times during the past fifty-one years) for "valuable or distinguished services or labors".

British Abstracts of Medical Sciences

As far back as 1915 the Physiological Society decided that an abstracting service for physiology was essential. It would be no over-statement to-day to say that such a service is absolutely vital for further progress. So voluminous has the literature become that no medical scientist can keep abreast of the publications in his field. With this in mind, a Committee representing the Anatomical, Biochemical, Endocrinological, Nutrition, Pharmacological and Physiological Societies decided that the cessation of *British Abstracts AIII* was unfortunate and that every effort should be made to continue this valuable abstracting service. As a token of goodwill and to ensure that a new journal would be launched, a sum of approximately £3,000 was subscribed by some of the above Societies. This enabled a start to be made, and the January 1954 issue of *British Abstracts of Medical Sciences* was published on January 20. Of the twelve monthly issues, seven have already appeared. The December issue will be an author and subject index, the work for which is already well in hand.

The *ad hoc* Committee of the above Societies decided that for success and security of the enterprise some form of legal entity was essential. This has been done, and the organization responsible for the continuance of *British Abstracts of Medical Sciences* is Biological and Medical Abstracts, Ltd., with registered offices at the Lister Institute. The Council of Management is made up of four representatives of the Physiological Society, two of the Biochemical Society and one each of the Anatomical, Endocrinological, Nutrition and Pharmacological Societies. The editorial office is also at the Lister Institute, where a full-time staff are engaged in the day-to-day running of the journal. In addition, there are twelve honorary specialist editors, chosen by the supporting societies, who supervise abstracting in their respective fields. Indicative abstracts of all significant papers in anatomy, biochemistry, endocrinology, experimental biology, experimental medicine, microbiology, odontology, pathology, pharmacology and physiology are prepared from more than six hundred journals published throughout the world by a large group of helpful abstractors. Every endeavour is made to publish these abstracts within six months of the appearance of the journal. Realizing that abstracts are of little value unless they (and the necessary indexes) are promptly produced, the Council hopes to reduce the time of publication still further. The composition and printing of abstracts is costly, so the price of £10 per annum, including postage, is made possible by the devoted labours of men whose aim is the advancement of their science.

Protection against Betatron and Synchrotron Radiations

THE recommendations made by the National Committee on Radiation Protection, which are published in the United States as National Bureau of Standards Handbooks, serve as guides for protection against general hazards of radiation sources. The development in recent years of high-energy electron accelerators, some of which are now being built commercially, and their widespread use in hospitals and elsewhere make it necessary to provide the operators of these accelerators with a handbook warning them of the potential radiation hazards both to themselves, to patients in hospital and to the public, and of the appropriate precautions that should accordingly be taken. Handbook 55, "Protection against Betatron–Synchrotron Radiations up to 100 Million Electron Volts" (pp. 52. Washington, D.C.: Superintendent of Documents, 1954; 25 cents), prepared by Subcommittee 5 of the National Committee on Radiation Protection, deals with high-energy electron accelerators of the betatron and synchrotron types. The hazards resulting from the various radiations produced by the sources are considered, together with those due to certain associated effects, such as noise, electricity and ozone production. Since the experimental data relating to protection requirements for these sources are far from complete, and thus measurement techniques and systems of units are not well established, the handbook includes an initial section in which definitions of the various technical terms used are clearly stated and listed, and nine appendixes in which detailed discussions are given of proposed units and measurement procedures. The following are dealt with in particular: the choice of the units for radiation intensity (watt/cm.^{2}) and for dose (erg/gm.), thus avoiding the use of the roentgen; the choice of a radiation-intensity secondary standard; a 5-cm. thick 'Lucite' cover for the sensitive element of a survey instrument; and the recommendation for high-energy installations of the standard personnel-monitoring procedures at present in use for radiations of less than 2 MeV.

United States Unclassified Material on Atomic Energy

The United States Atomic Energy Commission has named the Stanford Research Institute, California, as one of three national industrial information depositories of unclassified information concerning developments in the field of atomic energy, the other two depositories being the Atomic Industrial Forum of New York and the John Crerar Library of Chicago. The Stanford Research Institute will serve particularly the western States and Hawaii and Alaska, by maintaining the collection and providing library, reference, photocopy and literature-search services to public interests. It has recently received an initial complement of materials consisting of seven hundred reports of industrial interest selected from 9,500 'basic science' reports filed with the Atomic Energy Commission, as well as a set of reproductions of drawings for a 'swimming pool' reactor, all the back issues of *Nuclear Science Abstracts* and sets of bibliographies of selected reports of value to industry. Mr. William A. Casler has been appointed to take charge of the depository. In December 1952 the Institute opened a Radiation Engineering Laboratory for industrial research with radioactive materials, the source of cobalt-60 provided to the Laboratory by the Atomic Energy Commission being the largest released for such use at the time. The previous year the Institute published results of a study sponsored by the Commission on "Industrial Uses of Radioactive Fission Products".

Financial Estimates for the Department of Scientific and Industrial Research

In reply to further questions in the House of Commons on July 27, the Parliamentary Secretary to the Ministry of Works, Mr. J. R. Bevins, stated that the published estimate of £6·25 million for the Department of Scientific and Industrial Research for the present financial year represented an increase of £578,000 over last year (not £71,440 as stated in *Nature*, August 7, p. 251), of which £230,000 was part of the projected expansion by £900,000 over five years. The gross expenditure had increased from £5·8 million in 1952 to £7 million in the present year. The non-industrial staff, 3,108 on July 1, 1954, compared with 2,500 in 1949, would be increased to 3,900 in 1959, when the general level of activity would be 95 per cent of that projected in the expansion plans of 1947–48. At present the cost of the research on sulphate-reducing bacteria, on which twelve people were engaged at the Chemical Research Laboratory, was about £13,000 a year, and that of the work on corrosion of buried pipes, on which six people were engaged, about £6,000 a year. Studies of marine bacteriology, smoke curing, hygiene of fish handling and freezing at the Torry Research Station were at present held up on account of insufficient staff and inadequate buildings. On July 30 Mr. Bevins also stated that during the period April 1946–July 1954 the Department had made grants totalling £1,621,700 to the universities for the construction of high-energy particle-accelerating machines for nuclear physics research, and that grants of £747,200 had so far been made for running costs during the period August 1952–July 1957.

Survey of Scientific Journals in the United States

The report of a survey of the operations and finances of scientific journals in the United States has been published in a recent issue of *Science* (119, 357; 1954). The survey, by R. Tumbleson and Helen L. Brownson, is based on the 110 replies received to 205 questionnaires distributed by the National Science Foundation to a selected list of periodicals, with circulations ranging from five hundred to sixty thousand or more, seeking information regarding circulation, volume of original research papers published, papers awaiting publication, sources of revenue and expense items. No data are included for periodicals of the American Medical Association or the American Chemical Society; but about 71 per cent of the replies related to the journals of scientific societies, and in this group 58 per cent of subscribers were members; for periodicals with a circulation of four thousand or less, this figure was 50 per cent; for more than four thousand, 68 per cent. This group of periodicals published on the average nine hundred pages of original research material, or about 70 per cent of all papers submitted; many of the others were rejected because they were submitted to the wrong periodical. Seventy of these periodicals had a delay for accepted articles of less than six months; twenty-five, a delay of six months to a year, and five of a year or more, the average being 5·3 months for those publishing five hundred pages or less a year and 1·9 months for those publishing more than two thousand pages; for periodicals publishing articles averaging four pages or less, the delay was 5·6 months compared with 2·1 months for those in which the average article was twenty pages or more. Subscriptions and society contribution in lieu of subscription represented 67·2 per cent of the income for periodicals with a circulation of less than a thousand, 69·8 per cent for those with a circulation of 1,000–7,999, and 45·2 per cent for those with more than 8,000; advertising revenue was 0·7 per cent, 14·2 per cent and 51·5 per cent, respectively. Most editors disliked the idea of a direct subsidy from any sources, including the Federal Government, and many believed that additional income should be obtained from society membership or advertising. Attention was directed to difficulties, expense and delay caused by bad writing and presentation.

Lancaster Royal Grammar School: *The New Biologian*

The third issue of *The New Biologian*, the journal of the Natural History Society of Lancaster Royal Grammar School, has recently been published (June 1954). In the report of the Society's activities, by P. Brindley, it is recorded that a three-day exhibition was held in the biology laboratories, and several lectures given and films exhibited. P. F. Williams and P. E. Walker describe the bird-life of a hundred-acre field, where they concentrated mainly on the two heronries. G. J. Beckett gives an illustrated account of fern-collecting in northern England: it is unfortunate that in the caption of one illustration the word 'spleenwort' is spelt in three different ways. It is a pity that in this article, and indeed in all the other articles, the generic and specific names are printed in the same Roman type as the rest of the text. Other articles recording some excellent field-work include hover-flies by R. Underwood, the birds of Arkholme by A. N. Gardner, the molluscs of Port Erin (I.O.M.) by P. Brindley, and British mountain scenery by F. D. Stell. Other articles include the meteorological summary for June 1953–May 1954 by J. I. Sharp, a description of making prints of leaves, etc., on photographic paper by A. M. Till, trout by G. Smith, collecting bees, wasps, etc., by T. H. Pennington, some observations of *Amoeba* by P. F. Williams, and a short description of giant tadpoles by G. H. Briggs.

Corrosion Technology

Starting in March this year, *Corrosion Technology* was published as a supplement to *Chemical and Process Engineering*, and from June it has appeared as a separate monthly journal, published by Leonard Hill, Ltd., of London (1, No. 4; June 1954. 40s. a year, or 100s. for 3 years). There are now, therefore, two monthly journals devoted to the subject of corrosion, the other being *Corrosion Prevention and Control* (see *Nature*, May 8, p. 853). *Corrosion Technology* carries three columns to a page, 12 in. by 9 in. The journal includes many useful items of news concerning developments in methods of preventing corrosion, in addition to the technical articles by various authorities. These include one on "Corrosion in relation to Welding", by Dr. U. R. Evans, of Cambridge; others deal with the corrosion resistance of welded stainless steel, paint versus corrosion, cathodic protection, corrosion research at the Chemical Research Laboratory, Teddington, rubber linings to protect plant in a new bromine factory, prevention of corrosion by water in oil refineries, non-metallic materials of construction for handling radioactive wastes, radioactive testing of rust preventives, corrosion of aluminium cable sheathing, cutting fluids and corrosion, and corrosion and tablet machinery. The variety of the topics reflects the wide range of the subject of corrosion. The journal is well produced, and it serves a useful purpose in providing corrosion workers, as well as engineers and others concerned with protection against corrosion, with up-to-date news and reviews of recent developments in the subject.

Periodicals in South Asia on the Physical and Biological Sciences

With the assistance of the United Nations Educational, Scientific and Cultural Organization, the Indian Library Association has now published Vol. 1, covering the physical and biological sciences, of a "Union Catalogue of Learned Periodical Publications in South Asia" (pp. 390. Delhi: Indian Library Association; London: George Blunt and Sons. Rs. 25, 9 dollars or 60s.; 1953). It is essentially the work of the Department of Library Science of the University of Delhi, and its publication represents the partial fulfilment of an aspiration of Dr. S. R. Ranganathan, the principal editor, twenty-five years ago; all the collaborators are past or present students of his. The Catalogue covers 175 libraries in India and 74 in Indonesia, Malaya, Burma and Ceylon. It consists of a Systematic Catalogue, arranged according to the Colon Classification, and indicating the status or subject of specialization of the library, as well as the holdings, and of an alphabetical index, in which title words of periodicals are given in heavy type. There is also a schedule of sub-classes of the Colon Classification covered and a key to library numbers. The Catalogue should prove of great assistance to research workers in South Asia.

Society for General Microbiology

The Society for General Microbiology has recently undergone some reorganization and has established a central office at the Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1, to which inquiries regarding applications for membership and payment of subscriptions should in future be directed. Other matters should be communicated to the appropriate officer of the Society, and inquiries about the *Journal of General Microbiology* to the Cambridge University Press. At the last annual general meeting a new set of rules of the Society was passed, which now govern its activities. The nineteenth general meeting is to be held in the University of Reading during September 14–16 and is to include a discussion meeting on the "Principles of Microbial Classification". New officers of the Society are as follows: *General Secretary*, Prof. K. E. Cooper (Department of Preventive Medicine, University of Bristol); and *New Members of Committee*, Dr. B. W. Lacey, Miss June Lascelles and Dr. P. Tate. The remaining officers are: *President*, Mr. H. J. Bunker; *Treasurer*, Prof. R. Lovell; *Editors of the Journal*, Prof. B. C. J. G. Knight and Mr. A. F. B. Standfast; and *Meetings Secretary*, Dr. E. F. Gale (Department of Biochemistry, University of Cambridge).

Biology of the Trout

Regular observations have been made by the Scottish Home Office Brown Trout Research Laboratory, near Pitlochry in Perthshire, on freshwater biology in that area. Under the title of "Spawning Migration, Reproduction and Young Stages of Loch Trout (*Salmo trutta* L.)", Mr. T. A. Stuart has now recorded the results of research on the behaviour, reproduction and development of trout in their natural spawning grounds in three lochs, Lochan an Daim, Dunalastair Reservoir and Loch Moraig (Freshwater and Salmon Fisheries Research, No. 5. Pp. 40. Edinburgh: H.M.S.O., 1953; 7s. 6d. net). While the gonads appear to ripen at approximately the same time each year, the dates of spawning are influenced by the temperature. Prior to the spawning migration, a shoaling habit is formed and the trout congregate at the entrance to the streams chosen for spawning. Shoaling was only in evidence when the temperature of the loch water dropped to about 9° C. The main spawning run took place when the temperature of the streams dropped for the first time to 6–7° C. and was lower than that of the loch. In his observations on the trout's behaviour in forming the redd, Mr. Stuart has made the notable discovery that, apart from selection of gravel of suitable size, appreciation of the current conditions plays a most important part. He has shown that towards the tail-ends of pools, where the gravel slopes upwards, there is a point at which the current flows downwards through the gravel and keeps it free of silt. The trout are evidently aware of this and, after testing movements, come to rest there, probably aided by the slight suction from below. At such points the redds are made. Further interesting observations are recorded on the reactions of the alevins to light, the ventilation of redds by the movement of their pectoral fins, and the re-entering of the gravel by the post-larvæ. This paper constitutes the most objective account of the early life of the trout yet available.

Nigerian Vegetation

IN a short memoir, under the above title, R. W. J. Keay has presented an outline account of the main vegetational types of the very considerable and varied Nigerian territory. His aim is to interest and instruct agriculturists, foresters, naturalists, educationists and others in the botany and geography of Nigeria, no general account of the vegetation of this region having hitherto been available. In this extensive region the vegetation ranges from wet rain forest to very dry thorn savannah, few single African countries presenting such a range of vegetational types. The author rightly reminds his readers that only a relatively narrow coastal belt is covered with rich rain forest, the greater part of the hinterland consisting of savannah. The latter is clothed in tall grasses during the rainy season but becomes bare and open during the dry season, when the grass is burnt. The thorn savannah occupies only a small area in the extreme north, with the Sahara desert over the frontier still farther to the north. The forest regions are described under the headings of mangrove forest and coastal vegetation, freshwater swamp communities, and the lowland rain forest zone; the savannah regions are discussed under four different zones; and an account is given of the montane vegetation with special reference to the very interesting floristic region of Cameroon Mountain (13,350 ft.). The results of various ecological studies have been worked into this, the second edition of this work. Some useful and interesting vegetation profile diagrams and a comprehensive, if as yet provisional, map of the principal vegetation zones are appended to the text. The memoir is published by the Government Printer, Lagos, Nigeria, and can also be obtained from the Crown Agents, 4 Millbank, London, S.W.1.

Pathogens of the Sugar Maple

A FURTHER paper in the extended series of studies in forest pathology in Canada is contributed by V. J. Nordin on the causes of decay in the sugar maple (*Acer saccharum*) in Ontario (*Canad. J. Bot.*, 32, 221; 1954). Decay results in appreciable losses in volume of sound wood. Seventy-four per cent of 606 sample trees had some measure of decay. Twenty-eight fungi were found to be associated with decay in living trees. The most important of these are *Armillaria mellea* (Vahl ex. Fr.) Quél., *Polyporus glomeratus* Peck, *Ustulina vulgaris* Tul., *Fomes connatus* (Weinm.) Gill., *Hydnum septentrionale* Fr., *Corticium vellereum* Ell. and Crag., *Pholiota spectabilis* Fr., and *Fomes igniarius* (L. ex. Fr.) Gill. Several species previously unreported in the literature were found to be associated with decay in sugar maple in Ontario. *Armillaria mellea* is the most serious butt-decay fungus and *P. glomeratus* is the most important trunk-rotting species. Frost cracks are the most important site of entry for fungi. Various discolorations occur in sugar maple. The average extent of decay in living trees is estimated according to the occurrence of sporophores of *F. connatus*, *F. igniarius*, *H. septentrionale* and *U. vulgaris*. The incidence and volume of decay increased progressively with age and diameter. One hundred and nine species of Basidiomycetes are tabulated as occurring on living and dead sugar maple in Ontario. This paper is illustrated by a large number of plates.

Aboriginal Rock-paintings in Australia

UNTIL quite recently there had been little evidence of aboriginal occupation in New South Wales. Investigations by W. H. Kinsela in the area immediately south of Sydney and extending throughout the Illawarra coast and tablelands have shown that, besides the well-known kitchen-middens, there are several groups of rock-paintings (*Aust. Mus. Mag.*, 11, No. 4). In the Avon River valley, for example, one group of paintings contained many figures drawn in black, the dominant one being a woman with exaggerated breasts. Some others, including a wombat, were in red. Among the charcoal pictures is the realistic side-view of a human, in silhouette, with a genuine attempt to put natural shape into body and limbs. The paintings throughout the whole of this 'new' area of the South Coast tablelands are typical of the species, style and technique seen elsewhere in eastern New South Wales. There is, however, a marked absence of the mass-patterns of stencilled-hand paintings which are seen so frequently in Hawkesbury Sandstone areas north from the South Coast. The majority of the paintings visited are fairly faint, and difficult to reproduce by photography.

Colonial Development Corporation: Report for 1953

THE annual report and accounts of the Colonial Development Corporation for the year ended December 31, 1953 (pp. 50. London: H.M.S.O., 1954; 2s. net), records the initiation of five new projects, the abandonment of seven projects and the termination of the East African ramie investigation, the Kenya fish farms and the Vitingini lead investigation, leaving fifty continuing projects and investigations. Capital sanctioned increased from £39,400,000 in 1952 to £43,512,000 in 1953, mainly for productive projects, of which agriculture, animal products, forestry and minerals now account for 54 per cent, or 56 per cent of the £25,349,000 employed, and several agricultural/forestry projects now in early phases of development will eventually need large expenditures to bring them to completion. A further substantial reduction in head-office administration costs was effected during the year, the United Kingdom staff being reduced from 248 to 183 and regional offices staff from 114 to 106, but further reduction is unlikely at the present scale of operations. For most projects the local labour is fairly efficient, though in some areas it is low, due mainly to poor physique, malnutrition, debilitating diseases and lack of education. In agricultural research a panel of agricultural scientists established in London in March 1953, with Sir Charles Darwin as chairman, has been of great help, and the Corporation's experiences and problems are made known to those who allocate Colonial Development and Welfare funds for agricultural research, affording an indication of priorities in this field.

National Museum of Wales: Report for 1952–53

THE forty-sixth annual report of the National Museum of Wales, Cardiff, covering the year 1952–53 (pp. 63; from the Museum, Cardiff; 1953), is the first to appear in the new format. The smaller size is more interesting and handier and is to be commended as a type of production to be copied. It is stated that unfortunately there is no possibility of a licence being obtained for the extension to the west wing of the Museum, though, on the other hand, it is possible that one may be issued for a smaller building to serve as a beginning of a museum block at the Welsh Folk Museum, St. Fagans. This would permit the removal to St. Fagans of folk-life material and lead to a reorganization of the first-floor galleries at Cardiff. The freeing of the circular gallery for temporary exhibitions would be a welcome action. Work in the geological gallery has been devoted towards improving the appearance but not the essential range and purpose of the exhibits. At the Welsh Folk Museum the chief activity has been again the re-erection of buildings. The Montgomeryshire house is now thatched and wattled, and the stone house from Gower is nearing completion. An upland farmhouse from Dyffryn Claerwen, Radnorshire, has been accepted and will provide the Museum with its first complete unit of stable, cowhouse and dwelling.

National Research Council of Canada: Awards for 1954–55

The National Research Council of Canada has granted 236 scholarships for 1954–55, totalling in value 283,200 dollars. These scholarships include 75 bursaries worth 800 dollars each, 103 studentships worth 1,100 dollars each and 21 fellowships worth 1,400 dollars each, all of which are to be held in Canada. Special scholarships awarded for study abroad include twenty awards worth 1,900 dollars each, which will be held in the following countries: ten in the United States, eight in the United Kingdom, one in France and one in Sweden. Seventeen overseas postdoctorate fellowships worth 2,500 dollars each have been granted for work in the following countries: twelve in the United Kingdom, two in Sweden, one in Denmark, one in France and one in the Netherlands.

Colonial Service: Recent Appointments

The following appointments have been made in the Colonial Service: D. W. Malcolm (principal assistant secretary, Tanganyika), secretary for agriculture and natural resources, Tanganyika; A. F. Mackenzie (deputy director of agriculture, Sierra Leone), director of agriculture, British Guiana; F. E. Hughes (deputy chief conservator of forests, Gold Coast), chief conservator of forests, Gold Coast; I. G. John (assistant director, Malayan Meteorological Service), director Malayan Meteorological Service; N. S. Sandeman (assistant game warden, Uganda), game ranger, Kenya; A. J. Vincent, assistant conservator of forests, Federation of Malaya; A. Crosbie, veterinary officer, Northern Rhodesia; Miss E. R. Blydenstein, meteorologist, East Africa High Commission; J. O. Goss, agricultural officer, Nigeria; B. G. Hoare, agricultural officer, Gold Coast; A. R. Longhurst, scientific officer, West African Fisheries Research Institute, Sierra Leone; W. G. Owen, geographer, Hydrological Survey Department, Uganda; J. F. Truswell, geologist, Nigeria.

Announcements

The Atomic Energy Authority announces that Mr. W. R. J. Cook, chief of the Royal Naval Scientific Service since 1950 (see *Nature*, 166, 135; 1950), has been released from his present post to take up that of deputy director of the Atomic Weapons Research Establishment, Aldermaston, the director of which is Sir William Penney.

The Lister Medal for 1954, which is given in recognition of distinguished contributions to surgical science, has been awarded to Mr. Victor Ewings Negus, consulting surgeon to the Ear, Nose and Throat Department of King's College Hospital, London, in recognition of his services to the advancement of knowledge in the surgery of the nose and throat by means of his researches into the comparative anatomy and physiology of the larynx and para-nasal sinuses. This is the eleventh occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.

The College of Physicians of Philadelphia has awarded the Alvarenga Prize for 1954 to Dr. DeWitt Stetten, jun., associate director in charge of research, National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Maryland, for his outstanding contributions to knowledge of metabolic diseases. The Alvarenga Prize was established by the will of Pedro Francisco DaCosta Alvarenga, of Lisbon, an associate fellow of the College, to be awarded annually on the anniversary of his death on July 14, 1883.

The Faraday Society will be holding a general discussion on "Coagulation and Flocculation" in the Department of Chemistry, University of Sheffield, during September 15–17, under the chairmanship of Prof. R. G. W. Norrish, president of the Society. The twenty-nine papers to be presented will be divided into three groups, with introductory addresses for each group by the following: classical coagulation, Prof. J. T. G. Overbeek (Utrecht); coacervation, Dr. A. S. C. Lawrence (Sheffield); and biological systems, Dr. J. R. Marrack (Cambridge). Advance proofs of all the papers will be available about the end of this month. Applications for accommodation (to be made not later than September 6) and all other inquiries should be sent to the Secretary of the Faraday Society, 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

The Oil and Colour Chemists' Association will be holding a symposium on "Rheology and Settlement of Pigmented Systems" on September 23 in the Chemistry Theatre of University College, Gower Street, London, W.C.1. In the morning Prof. Stacey G. Ward will give a lecture on properties of well-defined suspensions of solids in liquids, and Mr. J. Pryce-Jones on the rheological state of a suspension as a criterion for the study of the flow and settlement of paints. The afternoon session will be devoted to a discussion on these two papers. The symposium will be open to non-members on application to the general secretary of the Association, R. H. Hamblin, Memorial Hall, Farringdon Street, London, E.C.4, from whom further information can be obtained.

The ninth Annual Calorimetry Conference in the United States will be held in the General Electric Research Laboratory, The Knolls, Schenectady, New York, during September 17–18, under the chairmanship of Dr. E. J. Prosen (National Bureau of Standards, Washington, D.C.). The conference is open to all, without registration fees. Further information can be obtained from Dr. Warren DeSorbo, General Electric Company, Metallurgy Research Department, Research Laboratory, P.O. Box 1088, Schenectady, New York.

INSTITUTION OF ELECTRONICS EXHIBITION IN MANCHESTER

THE ninth Annual Exhibition of Electronic Devices, organized by the North-West Branch of the Institution of Electronics, was held in the Manchester College of Technology during July 14–20. The Exhibition was as large and efficiently organized as any of its predecessors, and was as deservedly popular. It included, in addition to exhibits in the commercial and research sections, a programme of general and specialized lectures, and a number of illustrative film shows. For an affair of this size—some forty exhibitors were represented—a detailed review cannot be given; the writer must restrict his attention to a few of the features which he found most interesting.

The commercial section was impressive chiefly for its evidence of steady progress in the development of known techniques. Applications of television were prominent, and there were on view no fewer than three industrial closed-circuit television channels (by Pye, Philips Electrical, and J. Langham Thompson). Low-inertia integrating motors were shown by Electro Methods, Ltd.; these motors have practically straight voltage-speed characteristics, and are used for time integration of minute voltages. The Saunders–Roe exhibit included some interesting and, incidentally, very handsome strain gauges. These are made of metal foil etched into suitable strain-sensitive patterns, and mounted on an epoxy resin lacquer backing. They are more robust than conventional wire gauges, and permit a higher input current without compromising stability. Part of the large Mullard exhibit consisted of a formidable array of ultrasonic devices. Among them was an ultrasonic drill press, designed for the drilling or machining, by the action of an abrasive slurry between the vibrating tool and the work, of such intractable materials as glass. Equipment for the ultrasonic cleaning of fragile or inaccessible objects, and an ultrasonic soldering-iron capable of dealing with aluminium, were also demonstrated.

Prominent in the research section were the stands of the British Rayon Research Association. Among the recently developed instruments on display was an ingeniously simple autocorrelogram computer, used for the separation of periodic from random irregularities in yarns. The same exhibit included a demonstration of equipment used in flash photolysis. In this technique an intensely bright flash of short duration is used for irradiating a specimen, and after a selected interval of 20 μsec. or more, a second, less bright, but shorter, flash is used to record the absorption spectrum of the specimen. In this way the presence and decay of short-lived products of irradiation can be studied.

The Institute of Cancer Research exhibited ultrasonic echo-locating equipment, used for the examination of brain structure. When the equipment is in use, a quartz transducer in acoustic contact with the head emits a narrow, pulsed beam of ultrasound. Any echoes incident on the transducer are transmitted as pulses through amplifier and display circuits, and appear on an oscillograph screen. The position of the pulse on the screen gives a measure of the distance of the source of the echo from the transducer. At present, observations are being compared with what is known of the 'normal' brain, with the view of the possible identification of abnormal structures. In view of the drastic effects of ultrasonic vibrations, as demonstrated in the Mullard exhibit, it should be mentioned that the power output of the transducer is only 30 μW. Since the vibrations suffer considerable attenuation on entering and leaving the skull, it is clear that high sensitivity is required of the amplifiers.

A portable twelve-channel toposcope, designed as an aid to the increasingly important subject of electroencephalography, was exhibited by the Burden Neurological Institute. The complete study of the simultaneous electrical activity associated with a number of points on the head, for a significant period, is bound to be almost prohibitively time-consuming. The purpose of the toposcope is to restrict severely the type of information to be studied, and to present it in a rational manner. The equipment can be set for a desired frequency, or alternatively it can be made to set itself servo-mechanically for the predominant signal frequency of any selected channel, and in this condition it is sensitive only to that frequency or its harmonics. The display panel consists of a number of cathode-ray tubes, and each of these indicates for one of the channels (that is, for one of the selected points on the head) which, if any, of the harmonics of the driving signal is present, and what its relative phase is. A larger version of the equipment has been in use at the Burden Institute for the past two years, and has proved to be of particular value in research on the functional anatomy of the brain.

The Exhibition as a whole has proved to be of the highest interest to very many visitors, and due credit must be paid to the exhibitors and organizers alike.

A. W. HANSON

BRITISH CAST IRON RESEARCH ASSOCIATION

OPEN DAY

THE British Cast Iron Research Association, Birmingham, held an open day on July 7 for representatives of member-firms, some three hundred of whom attended, being welcomed by the president, Sir Frederick Scopes. The next day some hundred and fifty attended from other research associations, government laboratories, trade associations, technical institutions, universities, technical colleges and schools.

The extensions last reported (*Nature*, 170, 153; 1952) have been fully brought into use, except for the new melting shop, which has yet to be equipped, but which in the meantime is being used for work on foundry atmospheres. The Association has been negotiating with the Department of Scientific and Industrial Research with respect to arrangements for its new grant period, during which it is hoped a further stage of expansion will be reached.

A feature which attracted considerable interest was a display of art castings in moulded iron, involving very advanced skills in pattern-making and moulding. The importance of maintaining these skills is indicated by the adoption in recent years of such medieval methods as the lost wax process for producing jet engine parts which have to be cast to very accurate tolerances, and to their final dimensions, since they are frequently too hard to machine.

The experimental work on view included the study of the mechanism of blister formation on porcelain-enamelled cast iron, the gas originating the blister defect being removed during heating in a stream of argon and measured by an infra-red gas analyser. The application of strain gauge techniques to measure stresses set up in actual castings in service was illustrated. An important section related to work on white and chilled cast irons as used in the roll-making industry and referred to the effect of various conditions, composition and temperature, affecting the depth of chill.

Considerable advance was shown in the section on moulding and core sands tested at the elevated temperatures to which they are subjected in practice by induction heating, and the mechanism of the formation of defects due to sand failure was shown by a working model. A train for the production and casting of shell moulds of resin-bonded silica sand, about 5 mm. thick, was demonstrated, together with a newly devised arrangement for testing the material itself. Other work on moulding sands related to their effect on the shrinkage characteristics of the cast metal and on surface finish. The pore size of sand aggregates has been shown to affect heat transfer, mould permeability, gas flow during pouring and metal penetration.

The vacuum fusion method has been developed to yield quantitative information on the gases present in cast iron, especially oxygen and nitrogen, and the vacuum heating principle is used for the determination of hydrogen. Gamma-radiography was demonstrated for determining unsoundness in castings. The use of cathodic protection for cast iron pipe lines in aggressive soils and for propellers in sea-water was shown. In the analytical block a variety of demonstrations was in progress on chemical methods of examination and on spectrographic analysis, the latter including foundry slags.

Although no formal programme on the problem of brittle fracture has existed, since this problem mainly concerns the steels, a useful result has emerged from parallel studies of two aspects of the properties of ferritic nodular iron castings—properties at low temperatures and properties under impact. It appears that the ferritic nodular irons are better suited to resist the phenomenon of brittle fracture than many steels. Transition temperatures for ordinary ferritic nodular iron may be as low as −50° C., and with specially chosen raw materials this could be reduced to −100° C.

The work of the Foundry Atmospheres Team has made considerable progress. The control of dust on practically every type of rotating wheel used for cleaning and grinding castings, many of which are common to a wide range of other industries, has been established, and some devices are in commercial production. A systematic study of the behaviour of dust-laden air streams at the knock-out, where castings are normally separated from their sand envelopes, has been begun. A satisfactory design of wet spark arrester for cupola furnaces has been evolved and will assist in dealing with external atmospheric pollution.

J. G. PEARCE

BRITISH COLONIAL TERRITORIES

REPORT FOR 1953–54

If the proposals of the White Paper entitled "Re-organization of the Colonial Service" (Colonial No. 306. London: H.M.S.O., 1954; *4d.* net) are implemented, the recently published report on "The Colonial Territories 1953–54"* may be the last survey to appear under that title. It is proposed to constitute from October 1, 1954, an Oversea Civil Service which will include all those officers now in the Colonial Service who have been selected for their present posts by the Secretary of State for the Colonies whether or not the territory in which they are serving attains self-government. Should the territory attain self-government, their conditions of service and pension rights will be safeguarded by formal agreement between the Government in the United Kingdom and the Government of the territory. When the new Service is in being, any offer of appointment will include a clear statement whether it carries membership of the Oversea Civil Service or whether the officer's contractual relationship will be solely with the territorial Government. Officers in either category will be expected to regard themselves as being in all respects responsible to the territorial governments under which they are serving.

The new form of Service is intended to safeguard the interests of existing officers as well as to overcome political difficulties or prejudices which are more fully indicated in the review of constitutional and administrative developments in "The Colonial Territories 1953–54" report than in introductory paragraphs of the White Paper. It is also intended to encourage qualified men and women to continue to come forward in a spirit of confidence, enthusiasm and partnership and to assist the social, economic and political progress of the overseas governments and peoples. The present decisions are not intended to exclude the constitution of a Commonwealth service or an overseas service directly employed by the British Government, but the Government has not yet reached any conclusions on the complicated administrative and constitutional, as well as financial, problems involved in such proposals.

Apart from providing a very convenient conspectus of the political, economic and financial, and social developments in the Colonial territories for prospective candidates for appointments in the Colonial Service, whether scientific or not, "The Colonial Territories 1953–54" is also of interest to the man of science as providing the background against which progress in Colonial research, for developments in education, in health and welfare, and in communications and industry in these territories are appropriately considered. In particular, the surveys of constitutional and of economic and financial developments should facilitate both responsible criticism of particular developments and a general understanding of the extent to which economic and social developments, as well as the application of the results of the research at present in progress, depend on education.

In all branches of education the expansion of facilities continued during 1953–54, and special stress is laid on the increased provision for training teachers, alike in Malaya, Singapore, and Hong Kong, in the larger West African territories (where in view of the rapid expansion in primary education determined efforts are being made to maintain standards of efficiency), in Kenya and in Tanganyika. In Uganda, where the output of trained teachers is to be increased to about 1,150 by 1956, the British Government has allocated £8 million from the African Development Fund over the period 1953–60 to implement the recommendations of the de Bunsen Committee as well as £2 million for the development of technical education. In Northern Rhodesia, the establishment of a unified African teaching service was finally approved, and £1,250,000 was allocated from Colonial Development and Welfare Funds for the establishment of Rhodesia University College, the foundation stone of which was laid at Salisbury by the Queen Mother on July 13, 1953. During the academic year 1953–54 there were 3,639 full-time students at the three universities and four university colleges, and steps were taken during the year to strengthen the intimate relations between the Colonial institutions and other universities, particularly through a Colonial Development and Welfare grant to facilitate secondment of staff to the Colonial universities and colleges, and the extension of the Commonwealth Interchange Scheme to cover visits to and from Colonial institutions. Educational exchange was also assisted under the Fulbright Agreement, nineteen men and women from the Colonial territories receiving travel grants under this scheme for study or research in the United States, and thirteen American lecturers, research scholars or students being selected for attachment to Colonial universities. Of nearly eight thousand Colonial students in the United Kingdom and the Irish Republic at the end of 1953, 1,965 were scholarship holders, and the report again pays tribute to the work of the British Council in finding accommodation for these students. In higher technical education, the Nigerian College of Arts, Science and Technology had its first major entry of students. A Commission was appointed to make recommendations for the development of Fourah Bay College in relation to the educational requirements of Sierra Leone at all levels, and Major-General C. Bullard took up his post as first principal of the Royal Technical College of East Africa, Nairobi.

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* Colonial Office. The Colonial Territories 1953–54. (Cmd. 9169.) Pp. xii+196. (London: H.M. Stationery Office, 1954.) 6s. net.

No widespread epidemic occurred during 1953, and available figures point to an almost universal fall in mortality-rates and a general rise in the expectation of life. Human trypanosomiasis is now fairly well under control in Africa but only as a result of constant vigilance and the maintenance of active control measures. In Fiji, where filariasis is very prevalent, an attempt was made at control by mass administration of 'Hetrazan' in conjunction with a campaign against the mosquito vector. Yaws is fast disappearing from closely settled areas, and the scientific application of insecticides eliminated relapsing fever from the Somaliland Protectorate. Tuberculosis, however, remains a grave problem, and while treatment with modern drugs and antibiotics has proved very effective, present facilities for diagnosis, treatment and control are inadequate. Spectacular progress has been made in the control of malaria and leprosy; but much research is still needed to elucidate the provocative factors in the epidemiology of kala azar, of which three thousand cases were reported in Kenya up to the end of 1953.

The review states that the flow of recruits to the Colonial Medical Departments is insufficient, and although an increasing number of doctors of local origin are becoming available for service in their own territories, recruits from the United Kingdom are urgently needed, particularly for Nigeria and the Pacific. On December 31, there were 230 scholarship holders and 595 other students from Colonial territories in the medical schools of the United Kingdom and the Irish Republic as well as 97 students of dentistry, most of whom were expected to return to work in their own countries, while considerable numbers of doctors are also being trained in the Universities of Malaya and Hong Kong and the University Colleges of the West Indies and Ibadan. Training schemes for medical auxiliaries remain an urgent priority, and although the number of Colonial student nurses in training in the United Kingdom continues to increase rapidly, recruitment of nursing sisters from the United Kingdom and Commonwealth countries was difficult and new appointments did not keep pace with resignations. The scheme for the provision of a panel of medical visitors to the African territories has proved a success, and it is hoped that the scheme will be continued and a similar scheme introduced in other areas.

Expenditure on development and welfare schemes and on research was again approximately £14 million. In addition, a loan of £2,390,000 for the development of the East African parts of Mombasa and Tanga was made from sterling Counterpart funds by the United States Government. Fifty-nine research schemes, estimated to cost £741,000, were approved during the year, thirty-one new appointments were made on Colonial Research Service terms and seven research studentships were awarded. The progress in research, which is summarized in the chapter on "Research and Surveys", is to be covered more fully in the subsequent report "Colonial Research 1953–54", and it will suffice here to note that the West African Government has agreed to set up a Permanent Standing Advisory Committee for Agricultural Research, and that the establishment of a Regional Research Centre in the West Indies is receiving attention. Most of the Colonial governments have now agreed to the establishment of a Colonial Road Research Station, though only a few to the establishment of research funds in the Colonial territories. Arrangements are now being made to establish a Colonial Road Research Section at the Road Research Laboratory, Harmondsworth, and also the proposed Advisory Committee. The West African Regional Standing Advisory Committee for Medical Research has been converted into a Council for Medical Research, and administrative measures are in hand for a similar organization in East Africa. The establishment of a new entomological research station in Benin Province of Nigeria will permit an intensive study for the first time of those species of tsetse which occur in the high forest belt. At the West Africa Rice Research Station in Sierra Leone good progress was made with investigations on the development of mangrove swamps for rice-growing. In Nigeria the sealing-off policy in combating swollen-shoot disease of cacao did not prove completely effective, and further research on the behaviour of the virus is being carried out at a sub-station of the West African Cacao Research Institute opened at Ibadan. Successful research on the use of copper sprays has led to a large-scale campaign in Nigeria for the control of black-pod disease of cacao. Arrangements are being made to open a sub-station of the West African Institute for Oil Palm Research in Sierra Leone; but although the Institute continued its work on the establishment, nutrition, breeding and diseases of oil palms, lack of staff made its Plant Physiology Division inactive. Thirty-one new appointments were made to the Colonial Research Service and seven research studentships were awarded to train candidates for research appointments.

Recruitment of field staff for geodetic and topographic surveys kept just ahead of transfers and resignations; but thirty-two new appointments to the cartographic staff were offset by thirty-seven resignations dismissals or call-up to national service. Nevertheless, very satisfactory progress was made with geodetic surveys. The overseas scientific staff of the Colonial Geological Surveys increased from 190 to 197 during 1953, and although there were still some twenty vacant posts, satisfactory progress continued in all branches, including geological mapping, the investigation of mineral resources, and in the geological aspects of engineering and water-supply projects.

Besides the expenditure from Colonial Development and Welfare Funds, the United Kingdom contributed approximately £20,200,000 from the Vote for Colonial Services during 1953–54, and the present report sounds a warning note in respect of finance. While public expenditure has continued to rise, as well as the total of Colonial government general and development reserves in London, financial prospects in many territories are not encouraging. Revenues in Nigeria and the Gold Coast continued to rise sharply as a result of the steady increase in cocoa prices, but in Malaya revenue was 20 per cent lower than in 1952. Tanganyika's revenue fell by more than 10 per cent, mainly as a result of the fall in sisal prices, while those of North Borneo and Sarawak also fell. Generally, the picture has been one of a flattening-out of the curve of revenue increases.

While capital goods have been easier to obtain, though not cheaper, and capital expenditure and development are at present limited rather by shortages of administrative and technical staff, it is clear from this report that developments in future may no longer be able to count on an almost automatic increase in revenue. More governments are likely to be faced with deficiencies in the near future if the present trends of revenue and expenditure continue, and the report emphasizes that the increase in government commitments and costs since 1939, particularly in the maintenance of the expanded social services, makes any decline in revenue a cause of alarm.

HYDRAULICS RESEARCH STATION

REPORT FOR 1953

THE report for 1953 of the Hydraulics Research Board* describes work done during the year at the Hydraulics Research Station, Wallingford, and also in the field. It covers a range of activities, including investigations, mainly by models, into the design of harbours, jetties and other coastal works, beach surveys, special investigations arising from the east coast floods of January 31–February 1, 1953, and a preliminary study, based on charts and maps, of drainage and reclamation works in the Wash.

Two parties from the Research Station visited a number of places on the east coast of England from Margate to Scarborough during the four days February 3–6, their main objects being to examine the damage to sea defences and beaches and to take photographs, before repair works were started or the return to normal conditions had obliterated the effects of the storm on the beaches. Experiments carried out on a pilot model of the Thames Estuary, at the request of the Waverley Committee, showed that if the freshwater flow had been at its maximum value of 20,000 cusec. at Teddington Weir, instead of the low value of 2,600 cusec. actually existing at the time, the high-water level in London would have been increased by 9 in., a result in good agreement with previous estimates.

An example of work carried out for other countries of the British Commonwealth is that done on two models of Lyttleton Harbour, New Zealand. The object of the investigation is to assess the merits of various proposed designs of harbour extensions from the point of view of protection from waves, susceptibility to ranging and the amount of dredging required. The tests carried out so far have been designed to reproduce the existing conditions. On the larger model, that of the inner harbour, the distribution of wave heights throughout the harbour has been plotted for several wave periods, and the response at a given point as the period of the waves is varied has also been examined experimentally. Another overseas project was the design of a weir block to prevent waves passing up the discharge channel for cooling water at the thermal power station recently constructed at Dekhelia in Cyprus.

The facilities for research on models will be increased when the first stage of the main hall of the Station, which will have a floor area of 300 ft. by 200 ft., has been completed; work on this was proceeding during 1953, and it is hoped that it will be ready for use early in 1955. One of the models to be housed in it will be a large model of the Severn Estuary, on which the effects of the proposed Severn Barrage can be examined. In the meantime, preliminary experiments are being made on a pilot model, which is largely a replica of that built by Prof. A. H. Gibson.

An investigation of a somewhat different kind has been started on land reclamation and drainage in the Wash, at the request of the Ministry of Agriculture and Fisheries. While training works, constructed at various times during the past hundred and fifty years to improve the outfalls of the four principal rivers, have had the desired subsidiary effect of increasing the area available for reclamation, they have been less successful in achieving their primary object, because of deterioration of the estuaries to seaward of them. By treating the Wash as a whole, it is hoped to be able to design extensions to the training works which will improve the outfalls and also result in an additional fifty thousand acres of saltings becoming available for reclamation.

While most of the work described was undertaken in connexion with specific engineering projects, an item of more fundamental research was that carried out in the wave tank on the effect of a vertical wall on a beach in front of it. After the beach had become stable under the action of waves and tides, the wall was inserted in a position between the high-water mark and the highest point reached by the swash.

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* Department of Scientific and Industrial Research. Report of the Hydraulics Research Board with the Report of the Director of Hydraulics Research for the Year 1953. Pp. vi+58+8 plates+4 maps. (London: H.M.S.O., 1954.) 7s. 6d. net.

When the wave and tidal action was continued, the level of the sand against the wall fell until, after thirty-three tides, it was approximately at low-water level.

During coastal surveys in the Southwold and Christchurch areas, observations were made with drift indicators which showed that swell, accompanied by gentle or offshore winds, set up a drift which was shoreward near the bed and seaward at the surface. With steep waves accompanied by onshore winds, however, it appears that these directions are reversed. Among the new instruments developed is a miniature current meter for measuring the flow in models at velocities down to 0·25 in./sec.; this consists of a small plastic propeller the revolutions of which are timed electronically, making use of the change in conductance produced by the passage of each blade of the propeller between two electrodes.

K. F. BOWDEN

DRYING OF BIOLOGICAL CULTURES

JUDGED by replies to a questionnaire sent out in 1948, only twenty-five of ninety-five laboratories in the United Kingdom then used some form of drying technique for the maintenance of their stock cultures. Since that time the method has been applied much more extensively, and last September the British Commonwealth Collections of Micro-organisms arranged a discussion of the principles and methods of applying freeze-drying to culture maintenance to which home and visiting scientists were asked to contribute. The proceedings of the meeting have now been published*. In the event the discussion centred more on methods than on principles, about which we seem to be woefully ignorant.

Many methods are available for drying cultures on a small scale; but the only one readily applicable to the production of a large number of ampoules are those developed by R. I. N. Greaves from his experience of drying blood products. The designer's view is that the biologist is unnecessarily exacting, and to meet his requirements apparatus has become unduly expensive. Plant has to be designed to satisfy the biologist on three major points: the temperature of drying, the speed of drying and the rate of freezing; each of these is profoundly affected by small changes in technique, such as by increasing slightly the volume of material in each ampoule. The biologists are not prepared to accept the engineer's view that further developments lie with the bacteriologist; the best possible machine for the job has not yet been produced.

Of biological factors affecting survival of micro-organisms after drying, P. J. Fisher's work shows that the culture age is important, old cultures surviving better than young: it was suggested that autolytic breakdown products, such as deoxyribonucleoprotein, might have a protective action. The suspending fluid affects survival in at least two ways: during freezing, crystallization of salts may be injurious; but the main killing effect of the freeze-drying process takes place when the water is first taken off under vacuum. The ultimate survival-rate is improved by the addition of 7·5 per cent glucose to the suspending fluid, and, as survival also seems to depend on the residual moisture content of the dried product, it has been argued that glucose automatically controls the residual moisture. Unfortunately, moisture determination is technically difficult, but apparatus recently developed may so simplify the procedure that it will become part of the drying routine. With apparatus of this type it has been shown that, when solutions containing glucose are dried, moisture removal continues for three months. After sealing, there is an increase in vapour pressure in the ampoule which can be shown by a high-frequency discharge tester producing a glow inside the ampoule and not in the glass wall, and it is possible that there is a redistribution of moisture from the slow-releasing glucose to the protein which had been rapidly desiccated. In vessels closed with rubber stoppers there may be a re-hydration from diffusion of moisture through the rubber.

Freeze-drying may have some effect on the metabolism of surviving cells, and strains used for the production of antibiotics have been found to lose the ability to produce the dehydrogenase enzyme notatin. However, the experience of most of those taking part in the discussion was that, for bacteria and fungi, freeze-drying is the best method of keeping in stable form the metabolic activities which determine the biochemical reactions, antigenic patterns and the virulence of pathogens.

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* British Commonwealth of Nations Scientific Liaison Offices, B.C.S.O. (London). A Discussion on the Maintenance of Cultures by Freeze-drying. Pp. ii+48+1 plate. (London: H.M. Stationery Office, 1954.) 5s. net.

THE FUTURE FOR TECHNOLOGICAL STUDIES

IN his Messel Memorial Lecture to the Society of Chemical Industry at Liverpool on July 14 (*Chem. and Indust.*, 940; July 31, 1954), Lord Cherwell suggested that recognition by the large chemical firms in Great Britain of the fact that fundamental research is essential to progress is the main reason why the British chemical industry has been able to develop so rapidly and to overcome its handicaps. No other industry in the country has shown so much foresight and understanding of the vital importance of fundamental investigation which at first sight might seem to have no relation with practical applications. First among the industry's handicaps is the lack of facilities in Britain for higher technological education. In spite of their efficiency and merit, the existing university departments of chemical engineering cannot meet all our requirements. In industrial atomic power the efficiency of the chemical recovery determines whether or not the plant is an economic proposition, and many more like Sir Christopher Hinton and his team are needed to tackle such novel and difficult problems. It is not possible in Britain, said Lord Cherwell, for a young man to study at university institutions the first principles of technology and the disciplines on which it is based before deciding which particular technology to follow, and it is wrong to confine teaching of the highest branches of technology to ordinary universities. Lord Cherwell argued again for a technological university—with some three thousand students and fifty or more professors—such as no existing university could accommodate without distorting its balance of studies.

The main obstacle to such a proposal, he urged, is intellectual snobbery regarding technology which still pervades Britain, although it takes just as much brains to become a first-class technologist as to become a first-class lawyer, and probably more. Since this battle which he has fought for the past twenty years has been unsuccessful, Lord Cherwell found the reason for his being awarded the Messel Memorial Medal in his early work on physical chemistry, dating from that with Prof. W. Nernst in Berlin more than forty years ago. Nernst was then mainly concerned with the heat theorem known as the third law of thermodynamics, and Lord Cherwell showed briefly how a suggestion by Einstein regarding the derivation of Planck's formula led to the discovery that action could only be transferred in units of a minute but finite size. The processes for synthesizing ammonia or petroleum depend, in fact, on the reinstatement in a space–time description of the conjugated dynamical co-ordinate.

The world is now entering an epoch of nuclear chemistry, continued Lord Cherwell, about which our knowledge is as rudimentary as that of chemistry itself a hundred and fifty years ago. No one can say whether the building up or the breaking down of nuclei will play the predominant part in generations to come. Even in classical chemistry there are problems of which we have only scratched the surface, such as the extraction of the uranium and the plutonium after irradiation from the rods full of lethal fission products and the disposal of these intensely active products. Whether we can utilize the energy potentially available has yet to be seen, and meanwhile man for the first time has it in his power to destroy all life on this planet. The question is whether he will be able to avoid some such form of universal suicide, and it is a sad reflexion on our political achievements and mental processes that, despite the universal wish for peace, man has not been able so to arrange his affairs as to avoid war and the continuing threat of war.

STANDARDS AND LEVELS OF LIVING

A COMMITTEE of United Nations experts has concluded that most of the short-cut methods for comparing levels of living in different countries are unsuitable and sometimes misleading. For example, both national income *per capita* and real wages have serious defects as indexes of levels of living*.

To present useful comparison the committee recommends a pluralistic approach by analysis of various 'components' of living which are amenable to quantitative treatment and reflect internationally accepted values or aims. The twelve components listed by the experts are: health, including demographic conditions; food and nutrition; education, including literacy and skills; conditions of work; employment situation; aggregate consumption and savings; transportation; housing, including household facilities; clothing; recreation and entertainment; social security; and human freedoms.

In addition, the report includes a series of more specific statistical indicators that should be used as a guide in measuring the various components; these indicators are chosen with the view of availability of information. In view of deficiencies of data in many countries, however, the report gives a minimum list of 'priority indicators'; it indicates how they may be obtained and adds another set of indicators to illustrate lines of further improvement.

Members of the committee recognized that an international analysis of levels of living, in terms of the components and indicators they proposed, would nevertheless fall short of giving a complete and balanced picture of the total situation. They stressed the importance of the use of descriptive materials and background information, particularly in the form of social and cultural analyses. A more direct and comprehensive assessment may be attainable by 'family living surveys' carried out by the use of sampling methods and designed to ensure international comparability.

The committee was appointed by the Secretary-General of the United Nations, jointly with the International Labour Organization and the United Nations Educational, Scientific and Cultural Organization. Members came from six different countries and represented various disciplines of social sciences and statistics. They were Prof. Raymond Firth, professor of anthropology in the London School of Economics and Political Science; Prof. Philip M. Hauser, professor of sociology in the University of Chicago; Mr. Erland v. Hofsten, chief of the Statistical Section, Social Welfare Board of Sweden; Father Louis Joseph Lebret, editor of *Economie et Humanisme*, France; Mr. O. Alexander Moraes, acting secretary-general of the Inter-American Statistical Institute of the Organization of American States; and Mr. V. K. R. V. Rao, director of the Delhi School of Economics, University of Delhi.

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* Report on International Definition and Measurement of Standards and Levels of Living. (Report of a Committee of Experts convened by the Secretary-General of the United Nations, jointly with the International Labour Office and Unesco.) Pp. xii+96. (New York: United Nations; London: H.M. Stationery Office. 1954.) 0.80 dollars; 6s.; 3 Swiss francs.

MANAGEMENT COSTS

THE costs of managing industrial firms have traditionally been regarded as an incidental class of expenditure. These costs have been rising rapidly and, to-day, administrative costs have become a major expense in the operation of industrial firms. By 1948, for example, of every hundred production workers in British industrial firms, twenty were administrative employees; in 1907 the number was only eight.

Information collected by Seymour Melman shows that, in Great Britain at least, there has been no correlation between increases in administrative overheads and the growth of productivity. (*Manchester Guardian* "Survey of Industry, Trade and Finance", 1954). In the United States, on the other hand, output per worker man-hour rose by 232 per cent from 1899 to 1947 while the administrative overhead ratio increased by over 40 per cent. In Great Britain the output per worker man-hour increased by 73 per cent from 1907 to 1948 while the ratio of administrative overheads grew by 133 per cent. It has been assumed that the growth in the cost of managing necessarily yields some economy in production; there is no evidence of any relationship of this kind.

Various reasons have been put forward to explain the growth of administrative costs in view of increasing mechanization and systematization. Melman suggests that increasing costs are due to the development of new managerial functions. Industrial management has chosen solutions to its problems which also involve the extension of formal managerial controls over ever-widening areas. The extension of managerial controls is the common feature of the growth of new functions in industrial management, including sales, accounting, cost accounting, personnel and industrial relations, as well as the addition of staff specialists trained in economics, psychology and similar disciplines. This growth in administrative staffs represents more than the trend of a business cost. It is also a social cost owing to its bearing on the effective productivity of industrial man-hours. The growth of administrative overhead will be stopped or reversed only when its development becomes the source of pressing problems to one or more of the important groups closely concerned with industrial production: that is, management, labour or government. Only then will there be a search for alternative ways of industrial decision-making which would simplify and reduce the costs of managing.

EXPERIMENTS ON THE CAUSE OF DORSIVENTRALITY IN LEAVES

In a recent article, R. and M. Snow[1] reported experiments bearing on the cause of dorsiventrality in leaves, the results of which differed from those which I had obtained[2]. If, in my experiments, the position at which a leaf primordium was about to arise at the shoot apex of potato was isolated from the remainder of the apical meristem by a single vertical incision, the leaf which arose on the isolated panel of tissue was radially symmetrical[2], and I concluded that dorsiventrality of the leaves is induced by the activity of the apical meristem of the shoot.

It is this conclusion that the Snows question. They have repeated this experiment using potato shoots, and in only one instance, when the apex suffered from loss of turgidity after the incision was made, did the isolated leaf develop as a radial structure; in all other shoots the leaf formed was dorsiventral. However, they state that in *Epilobium hirsutum*, but not in other species, radially symmetrical leaves arose when the central part of P_1, the youngest leaf primordium, or the presumptive position of I_1, the next leaf to arise, was confined at its sides by two vertical incisions which left them continuous with the stem apex towards the centre. (In potato shoots dorsiventral leaves emerge between such pairs of incisions.) R. and M. Snow[1] suggest that a radial leaf may develop, in *Epilobium* at least, from an area which is in some way weakened, or is insufficiently large to give rise to a dorsiventral leaf. If this conclusion is valid then intrinsic factors, in the leaf primordium itself, would be operative in determining the symmetry of the leaf.

The following experiments, performed on potato apices, are relevant in that they permit a distinction between the two hypotheses of intrinsic and extrinsic determination of leaf dorsiventrality. If the centre of the apical meristem is punctured with a fine needle new leaves continue to emerge on the apical flanks. In some shoots up to eight new leaves have emerged in normal phyllotactic sequence while the puncture remained at the summit of the meristem. In every case the new leaves so formed were dorsiventral, and of normal size. In other experiments, a newly emergent P_1 primordium, or the presumptive position of I_1, together with a small adaxially situated panel of meristematic tissue not used in leaf formation, was isolated by a vertical incision from the centre of the apical meristem[3]. The isolated P_1 and I_1 primordia developed as dorsiventral leaves.

The position of the isolating incision in relation to the presumptive position of the leaf is critical. When the incision is close to the presumptive position of the leaf, the leaf is radially symmetrical[2]; when farther away, as in the experiments just described, the leaf is dorsiventral. Thus, if dorsiventrality is induced in the leaf primordium by the shoot apical meristem, the induction can be carried out by small areas of the meristem, approximately one-sixth of the meristem being sufficient[3]. This may explain the variation between results obtained by R. and M. Snow and myself. It seems probable that the incision by which they isolated the I_1 presumptive position was not close to the I_1 position, but was sufficiently far from it to include on the isolated panel some small portion of the apical meristem of the shoot, for they state[1] that in their experiments "radial leaves developed from small unoccupied areas of tissue that were left over somewhere between the isolated I_1 leaves and the stem". From the experiments described above it would be expected that I_1 would be dorsiventral when so isolated.

That the hypothesis of apical control of leaf dorsiventrality is reasonable is shown in the following series of experiments. When the I_1 presumptive position in potato is isolated from the remainder of the apical meristem, I_1 develops as a centric organ[2]. On the isolated panel, and lying on the cathodic (P_1) side of the I_1 presumptive position, is a small group of cells which were part of the apical meristem. These cells undergo differentiation and do not produce a new shoot meristem when so isolated, apparently being unable to compete successfully with the larger bulk of the terminal part of the meristem[3,4]. If, however, the emergent leaf primordia P_1 and P_2, and the terminal part of the apical meristem of the shoot are excised, leaving only the isolated I_1 panel, then the meristematic cells on the panel lateral to the I_1 presumptive position regenerate a new shoot meristem, and when I_1 emerges it does so as a dorsiventral leaf, orientated towards this new meristem, and deflected by approximately 90° from its expected orientation in an intact apex. If the excision of P_1, P_2, and the terminal part of the shoot meristem is delayed for 24–48 hours, by which time I_1 is just beginning to emerge as a centric organ, and the meristematic tissues lateral to it have begun to differentiate, no shoot meristem is regenerated on the panel, and I_1 develops as an enlarged centric organ encroaching over most of the panel surface. These enlarged centric I_1 primordia have a well-developed and extensive solenostelic vascular cylinder, and may be taller than dorsiventral leaves of the same age. They do not, therefore, appear to be the result of nutritional depletion in the leaf-forming area. It thus seems that factors extrinsic to the leaf primordium are effective in determining leaf dorsiventrality and, for dorsiventrality to occur, the leaf-forming area must be in direct continuity distally with cells of the apical meristem.

This explanation does not in its present form account for the emergence of radial leaves between two lateral incisions in *Epilobium*; however, the apical control of leaf dorsiventrality in the fern *Dryopteris aristata* has been experimentally demonstrated by Wardlaw[5] and more recently by Cutter[6], who has shown that even young emergent leaves in this species may be caused to develop as radially symmetrical buds bearing leaf primordia when they are isolated by an incision from the apical meristem. Centric organs in potato have always been determinate in growth; nevertheless the radial symmetry of such isolated organs in members of two widely different taxonomic groups suggests an essential homology of underlying processes, involving participation of the apical meristem, in the determination of leaf dorsiventrality.

These experiments were carried out in the Department of Cryptogamic Botany, University of Manchester, and I am indebted to Prof. C. W. Wardlaw for his guidance and encouragement.

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Since Dr. Sussex now considers that his views are supported by experiments in which the summit of the apex or growing-point was destroyed and dorsiventral leaves continued to be found on the apical cone below, it appears that he now thinks that the dorsiventrality of the leaves is induced in potato shoots not by the summit of the apex, but by apical tissue between the summit and the zone where leaves are determined. He seeks to explain the dorsiventral I_1 and I_2 leaves which we obtained when we isolated the presumptive areas of these leaves by supposing that our cuts were too close to the summit of the apex, so that they included some apical tissue on the isolated piece above the presumptive leaf area.

But in isolating I_1 in potato shoots we regularly placed our cuts *farther* from the summit of the apex, and closer to the I_1 than did Dr. Sussex according to his description. For he has stated[1] that his cuts extended from an edge of P_2 to an edge of P_1, as also his diagram indicates, whereas our cuts extended from the same edge of P_2, or from only just within it, to a certain point on the periphery of the apex well short of the edge of P_1. We isolated I_2 in a similar manner. So pieces such as Dr. Sussex isolated would be rather larger than ours, and would also be not entirely at the correct angular position, in our potato apices at least. For the radii through the centres of such pieces would be considerably cathodic from the normal centre of I_1—considerably closer, that is, to P_1. This is clear from the fact that P_1 and I_1 are successive leaves, and successive leaves, as we find, do not make contact in potatoes. Moreover, five of the dorsiventral leaves which developed from our isolated pieces had no axillary bud on the isolated piece, and two others had only a very small axillary bud on it, if any. This makes it unlikely that the cuts isolating these pieces were even as close to the growing point as the upper boundary of the isolated presumptive area; and it is even less likely that these cuts included on the isolated piece any tissue still closer to the summit of the apex, as Dr. Sussex suggests. (It should be explained that when the presumptive area of a leaf is isolated, its axillary bud develops either on the isolated piece or not at all: it does not develop on the axis[2].)

Also, even if in some of the other isolations a little surplus apical tissue may possibly have been included with the isolated I_1 or I_2, it seems unlikely that such tissue could induce dorsiventrality in these leaves by any physiological process. For any surplus isolated apical tissue which does not develop into an organ becomes disorganized and ceases growing. Only in a very few of the isolated pieces did we find tiny radial leaves which had apparently been formed from surplus apical tissue, and these were rather to one side of the dorsiventral isolated leaf and its axillary bud, not directly above them.

However, Dr. Sussex also states that among his own isolations of I_1 those in which the cuts were closer to the summit of the apex, so that the isolated pieces were larger, gave dorsiventral leaves instead of radials. But it should at least be considered whether the explanation of this difference is perhaps not that the larger isolated pieces included more apical tissue than the presumptive area of the leaf isolated, but that the smaller isolated pieces included less than that area, especially since, as pointed out, they appear to have been not quite correctly centred upon the angular position of I_1. For the farther the cut from the summit of the apex, the less will be the lateral extent of the piece isolated; and we have already pointed out[3] that in *Epilobium hirsutum* a lateral restriction of I_1 or of P_1 can make it develop into a radial leaf.

It is now becoming clear that isolated I_1 or I_2 presumptive areas develop very differently in different species of flowering plants. For in *Lupinus albus* we found that they developed only into dorsiventral leaves with leaflets[4]. Yet many of these leaves were very small, and most of them had no axillary bud (see, for example, ref. 4, Fig. 11). It is therefore probable that the isolated pieces from which they developed were smaller than the presumptive areas of the leaves isolated, and these pieces can scarcely have carried any surplus apical tissue.

In *Epilobium hirsutum* we find that isolated I_1 areas develop usually into radial leaves, though we have sometimes found dorsiventral leaves to develop from what were in effect isolated I_1 areas[5]. Potato shoots seem at present to be intermediate, since in them the I_1 areas which Dr. Sussex isolates develop into radial leaves, provided that the pieces isolated are not too large, while the I_1 and I_2 areas which we isolate develop into dorsiventral leaves, even when the pieces isolated are rather small.

We do not think that this discrepancy will be explained until both sets of results are illustrated with exact drawings, showing the positions of the cuts, and are also fully reported with details of the cultural conditions, the size of P_1 at the time of operation, and the variety of potato. Ours was King Edward. Nor do we think that the new experiments now reported by Dr. Sussex can profitably be discussed until they are similarly reported in detail. Only one point concerning them will be made here. The very large radial I_1's which he mentions were presumably large because their growth was freed from inhibition from the apex and from P_1 and P_2, which had all been removed, and not because they arose from specially large bases. So they do not really seem relevant.

We are continuing our experiments, and the situation seems complex. It may be necessary to onsider whether there is an apical influence orienting aves that would have been dorsiventral even withut it, as distinct from an apical induction of orsiventrality.

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METAPHOSPHATE IN MYCOBACTERIAL METABOLISM

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DURING work on the effect on the metabolism of *Mycobacterium smegmatis* of some anti-tuberculosis compounds synthesized in these laboratories, attention became directed towards the phosphorus-containing constituents of this and other Mycobacteria.

In our experiments, quantities of *M. smegmatis* (of dry weight about 40 mgm.) were extracted with 10 ml. chilled acetone for several hours, twice with ice-cold 5 per cent trichloracetic acid for a total of 8 hr., twice with 5 ml. ethanol at 19° C., and refluxed with 5 ml. of 3 : 1 ethanol–ether. On extraction of the residues with 10 ml. trichloracetic acid at 90° C. for 15 min., most of the remaining phosphorus went into solution, leaving a residual amount assumed to be phospho-protein. The results of one such series of extractions are given in Table 1.

Table 1. PHOSPHATE CONTENT OF EXTRACTS OF *M. smegmatis*

Three-day old culture on Proskauer and Beck medium. 8·68 per cent nitrogen and 2·04 per cent phosphorus on dry weight basis

Method of extraction	Acetone	Cold trichlor-acetic acid	Ethanol, ethanol–ether	Hot trichlor-acetic acid	Residue
% of total phosphorus	0·6%	17·7%	3·9%	75 0% (nucleic acid phosphorus, 36 9%)	2·8%

Ultra-violet absorption studies on the hot trichloracetic acid extract showed that less than half the phosphorus in it was present as nucleic acid. The excess phosphorus could be extracted from the cells by milder agents than hot trichloracetic acid (see below), and studies were made on these extracts to determine the nature of this component. It could largely be precipitated by barium at pH 2·5, and was entirely hydrolysed to inorganic orthophosphate in 7 min. by N hydrochloric acid. This strongly suggested inorganic metaphosphate[1], which was confirmed by the fact that the extracts gave a metachromatic reaction with toluidine blue[1], and by paper chromatography[3]. The chromatographic results suggested that the inorganic metaphosphate originally had a high degree of polymerization. It is not known in what manner it is held in the cells; but from the difficulty experienced in extracting it separately from pentosenucleic acid it would appear that it is bound in a similar manner.

Three extraction methods were used in an attempt to extract the nucleic acids and the inorganic metaphosphate separately: (1) repeated extraction with trichloracetic acid at 19° C. for 12 or 24 hr. periods; (2) extraction with saturated urea at 37° C. for 24 hr.[3], followed by repeated extractions with 10 per cent sodium chloride at 19° C. for 12-hr. periods; (3) extraction for 12-hr. periods with $M/100$ bicarbonate buffer (pH 9) at 19° C. Each of these methods was, however, found to extract both pentosenucleic acid and inorganic metaphosphate, though at different rates. The first method was the most satisfactory, most of the pentosenucleic acid coming out in the first extract, while the inorganic metaphosphate was extracted much more slowly, and the deoxypentosenucleic acid was extracted only by hot trichloracetic acid. Table 2 illustrates this.

Table 2. EXTRACTION OF PENTOSENUCLEIC AND DEOXYPENTOSENUCLEIC ACIDS AND INORGANIC METAPHOSPHATE FROM *M. smegmatis* CELL RESIDUES (INITIALLY CONTAINING 3 00 mgm. NITROGEN) AFTER EXTRACTION WITH ACETONE, COLD TRICHLORACETIC ACID, ETHANOL AND ETHANOL–ETHER

Method of extraction	First extraction: trichlor-acetic acid at 19° C. for 24 hr.	Second extraction: trichlor-acetic acid at 19° C. for 24 hr.	Third extraction: trichlor-acetic acid at 19° C. for 24 hr.	Fourth extraction: trichlor-acetic acid at 90° C. for 15 min.
Metaphosphate phosphorus	92·1 μgm.	97 7 μgm.	66 1 μgm.	96 0 μgm.
Pentose-nucleic acid phosphorus	121·1 μgm.	49 8 μgm.	13 8 μgm.	None
Deoxypentose nucleic acid phosphorus	None	None	Trace	32 0 μgm.

Considerable amounts of pentose-containing substances (presumably polysaccharides[4]), and smaller amounts of substances estimating as deoxyribose by the Dische reaction, were present in the extracts, especially in the hot trichloracetic acid extract. Consequently, in differentiating pentosenucleic and deoxypentosenucleic acids, use had to be made of the difference in their absorption curves after heating in trichloracetic acid[5]. Afterwards, the use of the above trichloracetic acid extraction at 19° C. and then 90° C. provided a satisfactory method for the separation, and thus for the estimation, of the two nucleic acids in *M. smegmatis*. Since it was not practicable to separate either of the nucleic acids from inorganic metaphosphate, in studies with phosphorus-32 it was necessary to calculate their specific activities indirectly, having determined the content of deoxypentosenucleic acid (or pentosenucleic acid) and inorganic metaphosphate in an extract, and having determined the specific activity of the latter, isolated as the barium salt by precipitation at pH 2·5. The Schmidt–Thannhauser method did not give reliable results with this organism.

Similar results were obtained for the phosphorus components of *M. tuberculosis* RIRa (Table 3).

The presence of metaphosphate has been recorded in a number of lower organisms, for example, yeasts[6], corynebacteria[7,8], moulds[10] and algae[9], and its association with the metachromatic granules in these organisms has been pointed out. The subject has been reviewed recently[10]. After the work described in the present communication had been done, a paper by Ruska *et al.*[11] came to our attention in which the

Table 3. PHOSPHATE CONTENT OF FRACTIONS OF *M. tuberculosis* BIRa

14-day old culture on Lowenstein medium

Fraction	Soluble in cold trichlor-acetic acid	Lipide	Pentose nucleic acid	Deoxy-pentose nucleic acid	Inorganic meta-phosphate	'Phospho-protein'
% of total phos-phorus	27·0%	6·0%	29·8%	6·0%	27·0%	5·3%

presence of metaphosphate in *M. avium* was demonstrated, and its association with the polar granules in this organism shown.

The content of metaphosphate in *M. smegmatis* increases with the age of the culture, and the metachromatic granules correspondingly increase in frequency and size (Table 4). It has been found possible to cause the inorganic metaphosphate content to increase to a much higher level than was found normally. When lightly ground material from a 3- or 4-day old culture in Proskauer and Beck medium[12] was aerated at 37° C. in the same medium without the nitrogen source (asparagine), over a period of several hours only a very slight increase in the inorganic metaphosphate content of the cells occurred. If, however, 2·5 per cent tetrahydrofurfuryl alcohol was added, the inorganic metaphosphate per cell was doubled in 3 hr. and was increased threefold in 5 hr. The granules grew to an inordinate size. Studies using phosphorus-32 showed that increased formation of inorganic metaphosphate took place and consequently that the effect was not due to decreased utilization.

Table 4. VARIATION OF COMPOSITION OF *M. smegmatis* WITH AGE

Age of culture	2 days	3 days	4 days	6 days
mgm. nitrogen/ mgm. phosphorus	5·52	5·13	4·60	3·41

No other striking changes in cell composition or behaviour were observed. Respiration was scarcely affected by tetrahydrofurfuryl alcohol under these conditions, although in the absence of other substrates it caused an increased respiration-rate. Similar, but much smaller, effects on metaphosphate content have been obtained with both 2 per cent ethanol and 2 per cent tetrahydrofuran.

When the cells were aerated at 37° C. in the full Proskauer and Beck medium for five hours, the dry weight, total nitrogen, respiration, acid-soluble phosphorus, and pentosenucleic and deoxypentosenucleic acids increased, as expected. (The deoxypentosenucleic acid increased more slowly than the pentosenucleic acid at first—an increase in the latter was apparent after 1 hr., in the former only after 3 hr.; after five hours, the pentosenucleic acid had increased by a factor of 1·73, deoxypentosenucleic acid by a factor of 1·34; but by this time the rate of increase of the latter exceeded that of the former.) There was a slight falling off in the inorganic metaphosphate content which indicated a distinct drop in the amount per cell. The granules became smaller and partly hidden in a cytoplasm which now stained deeply with neutral red. When the experiment was carried out under the same conditions, but with the addition of 2·5 per cent tetrahydrofurfuryl alcohol, dry weight, nitrogen, respiration and pentosenucleic acid all increased at about the same rate as before, but acid-soluble phosphorus and deoxypentosenucleic acid increased more slowly. The inorganic metaphosphate showed a striking increase, almost as great as that in the absence of nitrogen. There was a corresponding increase in the size of the granules. Thus the novel situation was obtained in which actively growing cells, which normally allow their inorganic metaphosphate to drop, were instead increasing it far beyond the level normally attained in old cultures.

No stimulation of formation of inorganic metaphosphate in yeast was caused by tetrahydrofurfuryl alcohol.

The function of inorganic metaphosphate in the organisms in which it occurs is by no means clear. It is obviously a reservoir of phosphate, and has been shown to be partly used up during growth, and more completely in phosphate-starvation, and to be rapidly replaced when phosphate was provided[1,9]. The view was held[9,10] that the high inorganic metaphosphate content of 'resting' cells was due to the fact that it was not being used for synthetic purposes, as it was in growing cells. We have found this pattern to be followed up to a point in *M. smegmatis*, but the finding that in the presence of tetrahydrofurfuryl alcohol cell growth can occur without any substantial reduction in a very rapid rate of inorganic metaphosphate accumulation would seem to show that, in this organism at least, the pattern is more intricate than that suggested above. Our results suggest that inorganic metaphosphate is not rapidly used up by growing cells.

It seems open to doubt that inorganic metaphosphate exists only as a reservoir of phosphate, since it is unlikely that cells would keep a supply of phosphate sufficient to last for a couple of generations. It has been suggested[9] that, as a form of 'high-energy' phosphate[14], inorganic metaphosphate forms an energy reservoir. The energy stored in this form, however, would seem only to be equal to that liberated by cell respiration in about a minute. Attempts made in this laboratory to show that inorganic metaphosphate could provide energy for synthesis have not so far been successful.

Thus this work still leaves without a definite answer certain important questions. What is the main function of inorganic metaphosphate in mycobacterial and other cells? Is its high energy content of importance? In addition, new questions are raised. How does tetrahydrofurfuryl alcohol stimulate the formation of inorganic metaphosphate to such an astonishing extent, and interfere with the normal cycle of change of the metaphosphate content with the age of cultures?

Details of this work will be published elsewhere.

In conclusion, we wish to thank Dr. V. C. Barry for encouragement and for stimulating and critical discussion; Prof. E. J. Conway, of University College, Dublin, for providing facilities for work with radioactive phosphorus; and Arthur Guinness Son and Co., Ltd., for generously providing financial assistance.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Oxygen and Hæm in Invertebrates

THE quantity of hæmoglobin in solution in the blood of *Daphnia* is inversely proportional to the dissolved oxygen content of the water in which the animals live[1,2]. In the course of a few days *Daphnia* can change in tint from almost colourless to red, or the reverse, by the synthesis or breakdown of hæmoglobin. This occurs, too, in other branchiopod Crustacea (for example, Estheria, Apus, *Artemia*). Since a gain of blood-hæmoglobin with fall of external oxygen pressure is known also in man at high altitudes and fishes in poorly aerated water, one may ask if it occurs in all animals with hæmoglobin.

One of the most familiar invertebrate animals with abundant hæmoglobin in solution in the blood is the larva of the midge *Chironomus*. It lives in a mucous tube embedded in mud at the bottom of ponds. Keeping larvæ with well-aerated and poorly aerated water above the mud was found to have no influence on their hæmoglobin content. This may have been because the larvæ control the oxygen content of the water in their tubes; they draw in water by undulatory body movements, which are intermittent, the intervals becoming longer when the water is well aerated[3]. An attempt was therefore made to keep the larvæ without mud, but it failed because larvæ kept thus die in a few days. Young larvæ, however, freshly hatched from the egg, can live without mud. Fed on *Chlorella*, they grew and made mucous tubes, but frequently left them to swim in the water. These young larvæ formed more hæmoglobin in poorly than in well-aerated water. The partially and fully grown larvæ of another midge, *Anatopynia varia* (Fabr.), which make no tubes, also had more hæmoglobin in poorly aerated water.

The most familiar mollusc with hæmoglobin in solution in its blood is the ramshorn pond snail, *Planorbis corneus* (L.). Keeping adults for a month in water of high or low oxygen content had no effect on the redness of the blood; but newly hatched young reared in poorly aerated water became, in less than a month, redder than those grown in well-aerated water. It was not, however, found possible to influence the hæmoglobin content in the blood of annelid worms by changes in external oxygen concentration.

In the vertebrates hæmoglobin is found in muscle cells as well as in the blood. In invertebrates hæmoglobin occurs not only in blood and muscle, but also in nerve, fat and tracheal cells, cœlomic corpuscles, ova, parenchyma of rhabdocœles and bodies of Protozoa[4]. In mammals it is uncertain whether there is an increase in muscle hæmoglobin at high altitudes[5], but muscular exercise has this effect[6], owing perhaps to local oxygen deficiency. It was found that hæmoglobin increases and decreases in concentration in muscles and nerve ganglia of cladoceran and conchostran Crustacea just as it does in the blood, in response to paucity or sufficiency of oxygen in the environment. There was, however, no such effect of oxygen on the hæmoglobin content of pharyngeal muscles in the pond-snail *Physa*, or of the parenchyma in the rhabdocœle worm *Phænocora*.

Thus, among the invertebrates, in some but not all instances, hæmoglobin of blood or tissue cells fluctuates in quantity inversely as the oxygen pressure in the environment. Finally, cytochrome, detectable with the microspectroscope in muscles of *Daphnia* and Conchostraca, increases and decreases in concentration, like the hæmoglobins of blood, muscle and nerve, as the oxygen in the water decreases or increases. In mammals, too, an increase in the quantity of cytochrome in muscle occurs in response to a low atmospheric pressure[7]. It is curious, however, that the increase of cytochrome in mammals and Crustacea in response to diminished oxygen is the reverse of what occurs in baker's yeast, where the synthesis of cytochromes *a*, *b* and *c* is stimulated by air and inhibited by its absence[8,9].

A full account of this work will be published in the *Proceedings of the Royal Society*.

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Passage of Glucose and Glycerol across the Red Cell Membrane

DURING recent years, increasing evidence has accumulated indicating that the passage of glucose across the human red cell membrane and of glycerol across the human and rabbit membranes is not a process of simple diffusion. The results of Wilbrandt and Rosenberg[1], Lefevre[2] and Widdas[3] show that the kinetics are not those of a simple diffusion process, and the effect of enzyme inhibitors indicates that at least specific adsorption sites are involved. The work of Lefevre[4] showed the inhibiting action of —SH agents; for example, *p*-chloromercuribenzoates, iodine and mercuric ions on glucose and glycerol transfer, the work of Jacobs and Corson[5] showed the inhibition of glycerol transfer by copper, and Wilbrandt[6] showed that glucose penetration is inhibited by lachrymators whereas glycerol remains unaffected. The passage of both glycerol and glucose is inhibited by phloridzin[4].

Though at first sight it would appear that the process is an active transfer involving an enzymic reaction providing energy other than thermal agitation, this is not necessarily so; and the process is perhaps better regarded as facilitated diffusion[7]. In this case the process differs from simple diffusion in being restricted by both structural and steric factors, and energy may be required for maintenance of structural units. It has been pointed out[7] that the distinction between active transport and facilitated diffusion may be one of degree only.

The present investigation was an attempt to study more closely the relationship between enzyme inhibition and the inhibition of facilitated diffusion by using irreversible inhibitors of the latter and showing strict parallelism to enzyme inhibition. The irreversible inhibitor chosen was 2–4 dinitrofluorobenzene. This substance was developed as a reagent for protein end-groups by Sanger[8] and also as a cytochemical agent by

Table 1

Inhibitor or added substance	Type of red cell	Effect on glucose		Effect on glycerol		Effect on sodium and potassium ions
		Entry	Exit	Entry	Exit	
Dinitrofluorobenzene	Rabbit			Nil	Nil	Very slight inhibition
	Human	Inhibits	Inhibits			
Dinitrobenzene	Human	Nil				Nil
Dinitrochlorobenzene	Human	Nil				Nil
Dinitrophenol	Human	Nil				
Diazonium hydroxide of *p*-nitraniline	Human	Nil	Nil			Apparent loss of potassium ions and gain of sodium ions
	Rabbit			Nil	Nil	
Phloridzin	Human	Inhibits	Inhibits			
	Rabbit			Inhibits		Nil
Eserine	Human	Nil	Nil			Potassium ions apparently lost slowly
	Rabbit			Nil	Nil	

Danielli[9]. It can react with —SH groups, $—NH_2$ groups and tyrosine. So as to make the information more specific, a second inhibitor was used—the diazonium hydroxide of *p*-nitraniline. This substance combines irreversibly with histidine, tyrosine and tryptophan, but not with —SH groups.

The effect of these two compounds and related substances on the entry and exit of glucose and glycerol into human and rabbit cells is summarized in Table 1.

The results are a strong indication that —SH groups are involved in the entry and exit of glucose but not in the passage of glycerol. It also appears as though tyrosine, tryptophan and histidine are not involved in either case.

In a consideration of the enzyme to which the dinitrofluorobenzene was attached, two possibilities were immediately suggested, namely, the esterases cholinesterase and phosphatase. The possible role of cholinesterase was considered because of the importance of this enzyme in the permeability of cells to sodium and potassium[10]. Preliminary investigations on the effect of the inhibitor eserine on the penetration of glucose and glycerol indicate, however, that cholinesterase is not involved in these cases. The second enzyme, phosphatase, has been thought to be of importance in glucose transfer in the red cell because of the inhibiting action of phloridzin and because of the similarity to glucose transfer in the kidney and intestine, where phosphatase is often considered to be the enzyme involved. The facilitated diffusion of glycerol is also inhibited by phloridzin, but as dinitrofluorobenzene inhibits the passage of glucose and not that of glycerol, different mechanisms for the two substances are probable. Thus, further work on the importance of phosphatase is indicated.

My thanks are due to Prof. J. F. Danielli for his suggestions, and to the Nuffield Foundation for a scholarship.

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Independence of Delayed Fertilization and Spontaneous Triploidy in Mouse Embryos

IN the early mouse embryo, spontaneous[1] o experimentally induced[2] triploidy is thought to aris by fertilization of an unreduced diploid egg by haploid normal sperm. The possibility has not bee wholly excluded that the extra set of chromosome is derived instead from the male[3]—for example double fertilization or diploid sperm—or after delaye fertilization[4]. In the rat and rabbit, Austin an Braden[5] showed that experimentally delayed fertilization causes polyspermy; in the rat, chromosom counts at the first cleavage division showed that som dispermic eggs were triploid. It was suggested[6] tha some of the spontaneously triploid mouse embryo might have arisen in this way, and not by doublin of the maternal chromosomes.

To investigate this possibility in the mouse œstrus and timed ovulation were induced by th method of Runner and Gates[7]. Three- to four-wee old hybrid mice were brought into œstrus by tw intraperitoneal injections, the first a priming injectio of 2 I.U. of pregnant mare's serum, and then 36 hr later an ovulating dose of 2 I.U. of chorionic gonadotrophin (kindly supplied by Organon Laboratorie Ltd.). With the time of ovulating injection referre to as zero hour, egg recoveries from a large series o mice showed that ovulation was initiated and in al probability completed between 11 and 13 hr. Th injected females were then exposed to males eithe at 9–12 hr. (little or no imposed delay in fertilization) or at 17–22 hr. (delayed fertilization). Coitus wa scored by examination for vaginal plugs at 1- o 2-hr. intervals. Females without a vaginal plug a 23 hr. were left overnight with males (further dela in fertilization). In each daily series, some mice were subjected to delayed fertilization, some to undelayed, and a few were sacrificed at 11 and 12 hr. without mating, to detect any day-to-day variation in hormonal stimulation and time of ovulation. Eggs were recovered from all mated females at 3½ days fro the estimated ovulation time. Fertilized egg (morulæ and blastocysts) were analysed chromosomally as Feulgen squash preparations.

Absence of triploid embryos in mature females. Normal matings of sexually mature females of the same strains as used before indicated the level of spontaneous triploidy in uninjected mice. Of the 152 analysable embryos from 59 females, 148 were diploid and none triploid.

Immature females—ovulation time. Autopsies showed that ovulation had not begun by 10 hr. after the ovulating injection (16 mice), nor by 11 hr. (18 mice). Of thirty-eight mice autopsied at 12 hr., hirty-three (87 per cent) had ovulated. Of the mice utopsied after 13, 14 and 18 hr. (twenty mice per roup), all but one had ovulated. There was no ignificant difference in the mean numbers of ova per female between these last three groups, nor did hey differ significantly from the mean number of ggs, fertilized and unfertilized, recovered at 3½ days n the main experiment. The mean number of ova ecovered from ovulated mice at 12 hr. was one-half he number recovered at each later time. These esults indicate strongly that ovulation is initiated oon after 11 hr., reaches a half-way mark at 12 hr., nd is completed by 13 hr. from the time of the ovulatory injection. These limits are more narrowly defined, but within the same time-range as previously reported with different material and half our priming injection[8].

Immature females—incidence of triploid embryos after undelayed fertilization. Among the thirty-eight immature females placed with males at 9–12 hr. after ovulatory injection, nineteen exhibited vaginal plugs between 10–13 hr. (mean 11⅓ hr.). This group representing an 'immature control' series without imposition of delayed fertilization. Of the analysable embryos recovered at 3½ days, 127 were diploid; three (2·4 per cent) were triploid—two from a 10-hr. plug, one from an 11½-hr. plug. The high yield of eggs (mean, forty-three per female) is characteristic of superovulation in these immature hybrid mice. The relatively low number of analysable eggs is accounted for by those uncleaved, lost during preparation or not analysable.

Immature females—incidence of triploid embryos after delayed fertilization. Of the females exposed to males 17–22 hr. after ovulatory injection, seventeen showed vaginal plugs at 18–24 hr. (mean 19 hr. 20 min.). If 1½–3 hr. is allowed for sperm transport, sperm ripening, and time for penetration of the ovum, and with ovulation at 11–13 hr., these seventeen mice show a delayed fertilization of at least 5½ hr. and at most 16 hr. Of the analysable embryos, sixty-four were diploid and two (3 per cent) triploid, the percentage being higher than in immature controls, but not significantly so. Of females showing no vaginal plugs by 23 hr., six of those left overnight with males exhibited plugs the next morning. There can be little doubt that fertilization was substantially delayed in this group. An obvious retarded development and reduced fertilization-rate in eggs after late insemination gave internal evidence that fertilization had really been delayed. Yet of the twenty-three analysable embryos, twenty-two were diploid and none triploid, the incidence of triploidy being this time below that in immature controls, though not significantly so.

In summary (see Table 1), this experiment indicates, first, a slight non-significant incidence of triploidy in embryos from superovulated immature hybrid mice. Secondly, delayed fertilization by 5½ hr. or more has not resulted in an increased incidence of triploid embryos. Little or none of the spontaneous triploidy[1,2] reported among mouse embryos seems to be explained by Austin and Braden's suggestion of delayed fertilization. Either, contrary to their interesting findings in the rat and rabbit, delayed fertilization in the mouse does not lead to polyspermy; or polyspermic eggs which may have occurred did not become transformed into triploids; or triploids of such origin cannot be scored at 3½ days. Further, in experimentally induced triploidy in the mouse[3], delayed fertilization may be ruled out as a major intermediary between the stimulus imposed and the observation of triploids at 3½ days.

Table 1. MICE EXAMINED AND EGGS RECOVERED IN ADULT CONTROLS AND IN INJECTED IMMATURE FEMALES WITH OR WITHOUT DELAYED FERTILIZATION

	Adult ♀♀ controls	Immature ♀♀ with undelayed fertilization (mean 11⅓ hr. from ovulatory injection until plug seen)	Immature ♀♀ with delayed fertilization (mean 19⅓ hr. from ovulatory injection until plug seen)	Immature ♀♀ with extreme delay in fertilization (>20<37 hr. from ovulatory injection until plug seen)
Females used	59	19	17	6
Females with eggs	55	19	17	6
Females with analysable embryos	45	17	15	3
Females with triploid embryos	0	2	2	0
Egg classification				
Uncleaved, lost and not analysable	377	678	715	294
Diploid	148	127	64	22
Triploid	0	3	2	0
Others (tetraploid, aneuploid and chromosomal mosaics)	1+3?	1+2?	1+2?	1

We are indebted to Prof. C. H. Waddington for facilities for, and interest in, this work, which was carried out with financial support from the Agricultural Research Council (R. A. B.), and from the Jackson Memorial Laboratory, Bar Harbor, Maine, U.S.A. (A. H. G.).

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A Possible Endocrine Mechanism controlling Locust Pigmentation

IT has been suggested that the changes in the coloration of locusts associated with swarming may be partly controlled by an endocrine mechanism[1], although until recently no experimental work has been available to support this view[2].

It is interesting to note, therefore, that injection of blood obtained from fourth-instar crowded (phase *gregaria*) hoppers of *Schistocerca gregaria* (Forsk.) into isolated-reared (phase *solitaria*) hoppers induces an increased black pattern and yellow or yellow-green background pigmentation in the next instar, that is, a change towards a *gregaria*-type coloration. When *solitaria* hoppers are injected as controls with an equal volume of insect Ringer or Tyrode's solution, or with blood from other *solitaria* hoppers, they retain the normal green background pigmentation with small amounts of brown or black melanin pattern.

The injection of *gregaria* blood into *gregaria* hoppers also produces no response.

It has been found that the degree of response to blood injections is dependent on the age of the insect; thus, maximum change in both pattern and background is obtained when mid-fourth-instar hoppers are injected. The compound (or compounds) involved in the change is not inhibited by acid or alkali and resists heat, though not prolonged boiling; its properties are therefore similar to those of other known insect hormones[3]. Ether-extraction of the *gregaria* blood suggests that the compound is ether-soluble, since this fraction was found to be as active in inducing changes in *solitaria* coloration as the non-treated blood, while the ether-insoluble fraction had little effect.

The present work, while tending to supply evidence of a blood-borne factor controlling phase pigmentation, does not preclude the possibility of genetical and environmental factors combining to determine the final type of the coloration, but tends to elucidate the physiological mechanism by which such factors are co-ordinated within the insect. The variation in the degree of colour change, according to the age of the hopper, emphasizes the importance of the relationship between hormone and tissue response in the system as a whole.

I wish to thank Prof. J. F. Danielli of King's College, London, and Drs. B. P. Uvarov and T. H. C. Taylor of the Anti-Locust Research Centre, for advice and criticism of this work, which is being done with a grant from that Centre.

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Apparent Induced Enzyme Formation due to Co-enzyme Deficiency

Previous studies by Happold and Hoyle[1] and Dolby, Hall and Happold[2] made it appear certain that the enzyme tryptophanase was induced in cultures of *Escherichia coli* only in response to the presence of tryptophan in the medium in which the cell was grown. It was not developed in a complete amino-acid medium which also contained glucose but, as was shown by Evans, Handley and Happold[3], the tryptophan content of the medium remained unchanged, so that it was presumed that the fermentation of the carbohydrate gave conditions of culture comparable to the total absence of tryptophan in the medium. These studies were made either with enzyme preparations or with washed cells incubated with the substrate in the presence of toluene, which procedure reduced tryptophanase activity only slightly but did render the cells non-viable.

In recent experiments, in order to study different relationships, we have carried out a great number of experiments with washed cells which were still viable and which had been grown with forced aeration at 37° C. for 16 hr. on a basal medium of sodium succinate, 20 gm.; ammonium sulphate, 1 gm.; potassium sulphate, 1 gm.; sodium sulphate, 0·5 gm.; potassium dihydrogen phosphate, 9 gm. pe 975 ml. distilled water, to which after sterilizatio and adjustment to *p*H 7·0, 25 ml. of a sterile solutio of magnesium sulphate ($MgSO_4.7H_2O$) (10 per cen w/v) was added.

When grown on this medium, harvested and incubated with tryptophan, certain strains of *Escherichia coli*, particularly those recently isolated, showe a lag of 15–40 min. before indole production occurred whereas others showed an immediate but weak tryptophanase activity which remained for som considerable time. Neither type of cell suspensio produced a high tryptophanase activity within th space of two and sometimes three hours. The us of amino-acid media which were free from tryptopha also resulted either in cells which showed initial la or which possessed tryptophanase activity *ab initio* such cells, however, either developed or possesse greater enzyme activity than did those cells which ha been grown on the previously described basal medium

In the present communication, we record result of experiments performed two years ago relating t this problem of lag since we feel they throw light upon current studies in related fields. Tryptophanas is an enzyme dependent upon pyridoxal phosphate; any deficiency in the synthesis of pyridoxine derivative by the cells might produce a lag in indole formation. Similarly, a competitive utilization of pyridoxal phosphate by the amino-acid decarboxylases, which are so highly active in *Escherichia coli* grown in the amino-acid medium containing glucose, could also result in a lag in indole formation when such cells were incubated with tryptophan. We had previously tried the effect of adding pyridoxal phosphate to cells grown in the presence of glucose, with negative results, but unfortunately had not associated these experiments with our findings[2] that the glucose-induced lag was markedly reduced by reducing the concentration of sodium ions and increasing that of potassium ions in our system. The recent findings of Happold and Struyvenberg[4] that ammonium ions are better as activators of the tryptophanase system than potassium ions, and the latter than rubidium ions, changes the picture. Lichstein, Gunsalus and Umbreit[5] have shown that *S. faecalis* grown in media supplying DL-alanine instead of vitamin B_6 did not carry out transaminations; Gale[6] that such cells did not decarboxylate tyrosine unless pyridoxal or pyridoxal phosphate was added; Holden, Feirman and Snell[7] that cells grown in the presence of D-alanine contained not more than 5 per cent of the amount of vitamin B_6 present in organisms grown in the absence of D-alanine. Separate additions of L-alanine and DL-alanine to a concentration of 10^{-3} *M*, of DL-phenylalanine to 5 × 10^{-4} *M* and of tryptophan to 3 × 10^{-4} *M*, were made to the basal medium in order to test the effect of each of these additions in the induction of the tryptophanase system.

The cells from such cultures have been separated from the culture medium, washed in *M*/75 phosphate buffer *p*H 7·8 and resuspended in a further portion of the buffer solution. The cellular mass of the suspensions was standardized by determining the dry weight of 1-ml. samples of all suspensions tested; they varied from 2·5 to 6 mgm. per ml. In order to test their ability to produce indole from tryptophan (tryptophanase activity) a number of replicates were always prepared which contained 1 ml. of cell suspensions and 2 ml. *M*/75 phosphate buffer *p*H 7·8 (with or without 3 μgm. pyridoxal phosphate) and which were incubated at 37° C. for 10 min., after

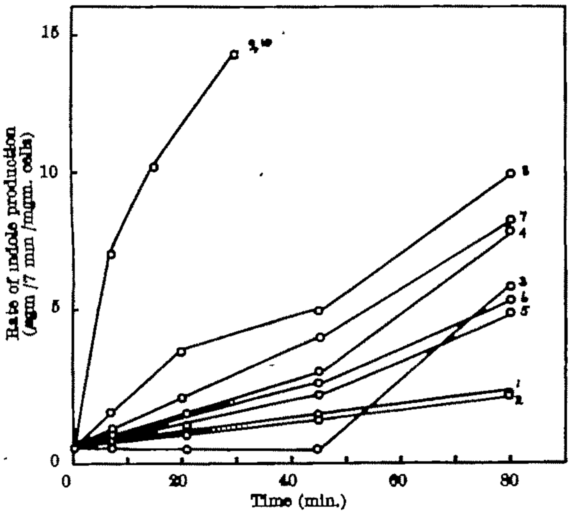

Fig. 1. Effect of the addition of certain amino-acids to a basal medium on the tryptophanase activity of cells of *E. coli* grown thereon.

Indole production per mgm. dry wt. of cells of *Escherichia coli*. 1, Cells from basal medium; 2, cells from basal medium + 3 μgm pyridoxal phosphate; 3, cells from basal medium + 10^{-3} *M* DL-alanine; 4, cells from basal medium + 10^{-3} *M* DL-alanine + 3 μgm. pyridoxal phosphate; 5, cells from basal medium + 10^{-3} *M* L-alanine; 6, cells from basal medium + 10^{-3} *M* L-alanine + 3 μgm. pyridoxal phosphate; 7, cells from basal medium + DL-phenylalanine; 8, cells from basal medium + DL-phenylalanine + 3 μgm. pyridoxal phosphate; 9, cells from basal medium + tryptophan; 10, cells from basal medium + tryptophan + 3 μgm. pyridoxal phosphate

which 2 μgm. l-tryptophan in 1 ml. buffer (also at 37° C.) was added. The indole produced was then measured at intervals from 7 min. to 180 min. after the onset of incubation. The results are presented in Fig. 1.

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A Virus associated with Canine Encephalomyelitis

WE have recently isolated from the tissues of a dog dying of encephalomyelitis a transmissible agent which appears to differ in several significant respects from the known etiological agents of canine encephalitis.

The natural case was a four months old fox terrier which developed nervous symptoms and died one month after distemper prophylaxis by the virulent virus – hyperimmune serum technique. It was not examined clinically. Histopathological examination revealed an acute demyelinating encephalitis without evidence of formation of inclusion bodies.

The experimental disease is characterized clinically by a continuous high fever with the subsequent development of various symptoms referable to the central nervous system. Tremor, weakness, ataxia, disturbed reflexes and epileptiform seizures have been seen. The histopathological lesions are those of a demyelinating encephalomyelitis. In addition, in one case there was an interstitial pneumonia. In no case have inclusion bodies been found in the brain or elsewhere. The sera of experimentally infected puppies (including one which survived forty-nine days *post inoculationem*) have shown no development of complement-fixing antibodies when tested against canine distemper virus and contagious canine hepatitis virus.

The experimental disease has been set up by the inoculation of tissue suspensions treated with 500 units of penicillin and 100 micrograms of streptomycin per ml. administered in intrathecal and intraperitoneal routes. In no case has any evidence of cultivable bacteria been found. Attempts are being made to cultivate the agent in the chick embryo; the results to date are equivocal.

The findings reported herein are of interest as they tend to incriminate a virus or virus-like agent distinct from those known to be capable of causing canine encephalitis. Much work will be required before such a hypothesis can be adequately supported; meanwhile, it is believed that the subject of the etiology of canine encephalitis is of sufficient general interest to warrant publication of these preliminary observations.

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Preservation of Bacteria

BACTERIA may be preserved by drying suspensions either from the frozen or from the liquid state. Of these two methods, the former, particularly in the form of centrifugal freeze drying[1], has been widely used because of its efficiency and convenience.

A method which differs from previous ones and which appears to be worth serious investigation is at present being studied. In outline, it consists of dehydrating the viscous product which results when a small volume of bacterial suspension is incorporated in a mass of previously freeze-dried material.

The results shown in the table were derived from some early experiments with this method.

Organism	Survival (per cent)			
	1	2	4	8 months
Sh. flexneri	93	100	83	82
Salm. stanley	91	82	85	70
Salm. typh.	87	87	91	80
Str. viridans	80	80	69	63

Glass ampoules of 8 ml. capacity were found to be convenient for quantitative studies. A mixture of 6 per cent peptone (Evans) and 1 per cent soluble starch (B.D.H., 'Analar') was sterilized by autoclaving and dispensed into the ampoules in 1·5 ml. quantities. After freezing the mixture at – 20° C. for at least 5 hr., it was dried *in vacuo* for c. 18 hr., the water vapour being condensed on a refrigerated coil at – 40° C. The solids were left in the form of compact cylindrical plugs c. 13 mm. in diameter and c. 10 mm. in depth. The ampoules were stored in air-tight jars.

The manifold on which the inoculated ampoules were dried was a simple brass model with side-arms of rubber tubing which could be opened or closed with steel spring clips. Before the ampoules were inoculated, the manifold with the arms closed was connected to a 'Speedivac' pump with a phosphorus pentoxide trap. By means of a small leak in the manifold, the pressure was adjusted to c. 10 mm. mercury.

The suspensions used for the inoculation of the plugs were prepared by diluting nutrient broth cultures of the organisms 1 : 250 with 5 per cent glucose. Cultures at or near the end of the logarithmic phase were used. By means of a capillary pipette tipped with paraffin wax to which a syringe was attached, a single drop (c. 0·02 ml.) of the suspension was discharged on to the surface of each plug. As soon as each ampoule had been inoculated it was connected to a manifold arm which was then opened. Usually, 12–18 ampoules were inoculated at a time. Approximately 5 min. after the last ampoule had been connected, the leak was closed and high vacuum (c. 0·01 mm.) was established. The ampoules were taken off one at a time, constricted, replaced on the manifold and finally sealed off *in vacuo* after 1 hr. The ampoules were stored at room temperature in the dark.

The immediate effect of the inoculation of the freeze-dried plug is a localized viscous solution of the solids. Wetting of the entire plug is prevented by subsequent rapid removal of water by the pump. The exposure of the plugs to the higher pressure (10 mm.) induces a mild foam which may rise 1–2 mm. above the surfaces of the plugs; at the lower pressure (0·01 mm.) dehydration of this viscous foam proceeds very rapidly.

Some preliminary experiments have shown that the method may be simplified where percentage estimates of survival are not required. Smaller plugs (0·25 ml.) in tubes of ¼ in. diameter have been 'stab' inoculated by means of a straight wire charged with bacterial suspension. With such modifications no visible foaming of the peptone has occurred under reduced pressure, and drying *in vacuo* has been achieved by exposure of the plugs to high vacuum as soon as they have been inoculated.

At present a number of factors are being investigated in relation to the method. Meanwhile, it is of interest that the survival-levels shown in these early experiments compare favourably with those obtained by previous drying methods.

I am indebted to the Medical Research Council for a personal research grant.

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Egg-laying in Ctenophora

WHILE occupied with field-work on Siphonophora, I placed six small *Pleurobrachia* sp. measuring about 2·5 mm. in length in a watch-glass at 1100 hr. on April 29. An hour later I noticed that eggs were being extruded through the ectoderm over the gastrovascular canals. Since the fertilization membrane was present as the eggs were being extruded, it would appear that fertilization took place inside the meridional canals. By 1430 hr. the first and second cleavages of the majority of the eggs were taking place as in *Beroe*. By 1830 hr. the numerous micromeres were covering the macromeres by epiboly and many of the larvæ had reached the stage of gastrulation. Within twenty-four hours of extrusion the larval ctene-plates could be seen beating within the egg envelope. The same phenomenon was witnessed with another batch of *Pleurobrachia* on May 7, when less than half the eggs segmented.

A recent text-book states that ripe sex cells in Ctenophora are discharged through the mouth except in *Coeloplana* and *Ctenoplana*, in which the testes open on the aboral surface by ducts.

I am informed by Miss M. A. Harvey, who confirmed my observations of April 29, that she has observed eggs being extruded through the ectoderm in a similar way in *Beroe ovata* and *Lampea pancerina*; but in the former, development of the eggs did not take place, while the eggs of the latter were not kept.

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Permeability to Water of the Lamprey Integument

THE relationship between the anadromous lamprey, *L. fluviatilis*, and the purely fresh-water form, *L. planeri*, has been the subject of much discussion, and doubt has sometimes been expressed as to whether they should be regarded as distinct species. As Weissenberg[1] showed, although there are profound differences in the biology of the two forms, there are no important morphological criteria (other than size) by which they may be differentiated. It is therefore of especial interest to find that significant physiological differences exist between these species in regard to the permeability to water of the integument.

The rate of osmotic uptake in fresh water has been determined by weighing at intervals animals in which the urino-genital papilla has been ligated. In the sexually mature animal, the possibility of water absorption in the gut can be excluded, since the fore-gut is no longer patent. Expressed as percentage increases of weight, the mean rate for *fluviatilis* was found to be 1·1 per cent per hr. in tap water at 13·5° C., compared with 5·1 per cent per hr. for *planeri* in tap water at 12° C. As measured by the thermoelectric method, the osmolar concentration of the blood of *fluviatilis* at the time of the experiments varied from 135 to 150 m*M* with a mean value for six animals of 143 m*M*; the corresponding mean value for a large number of determinations on *planeri* was 110 m*M*. The osmotic gradient in tap water is therefore rather greater for *fluviatilis*, and hence the difference in permeability between the two forms would appear to be even greater than is indicated by the rates of uptake of water.

The rate of flow of urine implied in these figures is, for *planeri* at least, far in excess of that recorded for any other aquatic vertebrate in fresh water, and even the reduced rate in *fluviatilis* is about twice that of the eel[2], the skin of which bears a resemblance to that of the lamprey.

These results are in general agreement with those obtained for the rate of loss by osmosis in hypertonic solutions. In Fig. 1, the mean percentage hourly

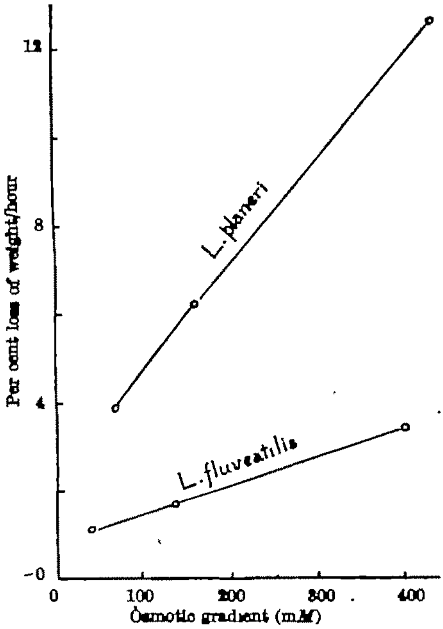

Fig. 1. Osmotic loss of water in sea water and sea water dilutions

losses of weight have been plotted against the approximate osmotic gradients in the various concentrations of sea water used. Interpolating from these curves, the osmotic losses for concentration gradients similar to those experienced in tap water (but in the reverse direction) are for *planeri* 4·6 per cent/hr. and for *fluveatilis* 1·7 per cent/hr.

Such differences between the two species are sufficient in themselves to explain the much greater tolerance shown by *fluveatilis* to direct transfer from fresh water to sea water. Whereas *planeri* survives only for a few hours in sea water diluted with two volumes of tap water and succumbs in an hour or so in pure sea water, *fluveatilis* will often survive indefinitely in equal parts of tap water and sea water and may live for several hours in pure sea water. But, although the lower water permeability of *fluveatilis* offers some immediate relief from the difficulties encountered in moving from fresh to salt water, it may well be that this characteristic would be of greater significance for an animal returning to fresh water from the sea. It seems reasonable to suppose that for *planeri* in fresh water the kidney is working close to the upper limits of its capacity, and that substantial increases in the concentration gradient could not be tolerated. It is perhaps for this reason that ammocoetes and adults in which the internal concentration has been raised by a period in hypertonic saline solutions sometimes die when returned to tap water. There are reasons for believing that the osmolar concentration of the blood of *fluveatilis* when it first leaves the sea on its spawning migration would be considerably higher than in the animals employed in these experiments, and a lower level of permeability to water may therefore be essential to their survival during this phase of the life-history.

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The Wet-film Indian Ink Method for examining Micro-organisms

RECENT experience with the wet-film indian ink method, used by Duguid[1] for demonstrating bacterial capsules and slime, suggests that it can be used for examining the structure of a wide range of living micro-organisms. To be effective for this purpose, an ink should have very small, uniformly sized particles, should spread evenly and should not coagulate too readily. These requirements are met by 'Pelican' black drawing ink, though it does coagulate to some extent in acidic suspensions. Several other inks proved unsatisfactory, chiefly because of larger and more variable particle-size.

With small unicellular organisms it is generally best to mount in undiluted ink. A drop (about 0·01 ml.) is placed on a clean slide, and the organism, preferably from a young growth on a solid medium, is gently mixed into it with a loop. Where it proves difficult for any reason to obtain a satisfactory density or distribution of organisms, a suspension may be prepared in a small loopful of water prior to mixing with the ink. A No. 1 coverslip is placed on the suspension which is then further spread out by pressing slide and coverslip firmly between blotting paper. The optimum thickness of film varies with the size of organism and may be determined by trial; in general, portions of film medium to dark brown in colour are satisfactory for examination with 1/12 oil-immersion objectives.

Such preparations may be used for demonstrating not only bacterial capsules, as Duguid showed, but also bacterial spores. Stages in spore formation may be seen, for example, with *Bacillus megatherium* grown on potato agar at 27° C. for 18–24 hr. With this species it is possible to see other details of internal cell structure. The structure of yeast cells can be seen by mounting in indian ink, and rewarding preparations can be made of a species such as *Schizosaccharomyces octosporus*, grown on malt agar at 25° C. for seven days, to demonstrate stages of ascospore formation. One important advantage of this wet-film method is that artefacts are largely avoided; further, there is little evidence that the ink is toxic to organisms, since in dilute suspensions motile bacteria remain active for some time.

Preparations provide good subjects for photography: motion of cells induced by intense Brownian movement of the ink particles, which might interfere, can be limited by adjusting the thickness of the film so that cells are just held between slide and coverslip. Mounts can often be preserved for 24 hr. or more in a moist chamber at 5° C.

With fungi, it is usually desirable first to obtain mycelial growth over a glass coverslip or square of 'Cellophane' lying on an agar medium. Mycelium is best mounted in ink diluted 1 : 5 to 1 : 10 with water, one convenient method being to make an ordinary water mount and then to introduce a loopful of ink which can be dispersed with a minimum of disturbance to the material. Coverslips with mycelial growth may be mounted directly, only slight pressure being applied to slide and coverslip to spread the diluted ink suspension. Mycelial growth on 'Cellophane' can sometimes be transferred directly to a slide (by placing it face downwards, pressing gently, and then stripping the 'Cellophane' off); but where this is not possible, a small piece of 'Cellophane' is cut from the square and placed face upwards on the slide. In either instance the mount is made with diluted ink. By this means preparations can be made of a variety of fungal material, including that obtained directly from infected plants, results being particularly valuable when such material is delicate and subject to distortion by fixing, as, for example, with asci of *Eremascus*.

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Cambridge. May 15.

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The Cuticle of Nematode Larvæ

The infective larval stage of many nematode parasites is ensheathed in the uncast cuticle of the second stage. The sheath is regarded as having some protective function in a larval stage which is more resistant to environmental fluctuations than the earlier stages. A method has been devised for separating the sheaths from larvæ, and it has been found that their protein complement is water-soluble. In this communication, the amino-acid composition of these proteins is discussed.

Mixtures of third-stage larvæ of *Oesophagostomum*, *Ostertagia*, *Chabertia*, *Haemonchus* and *Trichostrongylus* from sheep were examined. Pure samples of *Haemonchus contortus* larvæ were also used.

Exsheathment was obtained *in vitro* using solutions of sodium hypochlorite, as described by Lapage[1]. As soon as exsheathment occurred the larvæ were centrifuged, the supernatant removed and the cuticles separated from the active larvæ by differential centrifugation in saturated sodium chloride. The cuticles were then washed five or six times in distilled water and placed in sealed tubes at 105° C. for 12 hr. This caused the solution of the cuticles in distilled water, leaving a slight residue which microscopically was seen to be plant debris and which gave a negligible ninhydrin reaction after acid hydrolysis.

The cuticles in solution were hydrolysed in sealed tubes at 105° C. in 6*N* hydrochloric acid for 24 hr. The hydrolysate was examined by two-dimensional paper chromatography using 80 per cent ethanol and water-saturated phenol as solvents.

By comparison with a prepared map of known amino-acids, the presence of nine amino-acids was demonstrated in the hydrolysates of both mixed collections and pure samples of *Haemonchus contortus*. These amino-acids in approximate order of the amounts present were proline, hydroxyproline, aspartic acid, cysteic acid, glutamic acid, alanine, leucine, glycine and valine. This order was obtained on considering the size of the spot and the sensitivity of the different amino-acids to ninhydrin as estimated by Dent[2]. The first four were recognized by their position, colour and conformation. The presence of leucine and valine was verified using a marker procedure. Proline was detected by its colour in ninhydrin and isatin; hydroxyproline by its similar colour in ninhydrin and isatin and its specific red colour on the application of Ehrlich's reagent after isatin. Glycine was recognized by its colour, and though its position on the map could have been shared with arginine and serine, these two amino-acids were proved to be absent by other tests. Tests for cystine and tyrosine also gave negative results.

The presence and composition of water-soluble exoskeletal protein in the Invertebrata has been firmly established in the Insecta by several workers, most recently by Hackman[3]. The presence of somewhat similar water-soluble protein in the nematoda has also been demonstrated in the cuticle of *Ascaris* by Chitwood[4] and the amino-acid composition of an 'albumen' in the outer layer of fertilized *Ascaris* eggs has been demonstrated by Kreuzer[5]. It seems probable that water-soluble exoskeletal proteins may occur over a wide range of the invertebrate animals.

I am indebted to the Science and Industry Endowment Fund of the Commonwealth Scientific and Industrial Research Organization for a personal grant. Assistance provided by the Agricultural Research Council is also acknowledged.

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May 14.

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Newly Fallen Snow and Air Temperature

The physical features of a layer of fallen snow at a given time are chiefly dependent on (1) meteorological conditions while the snow is falling, and (2) meteorological factors which occur later causing metamorphosis of the snow.

Some observations I have made in the Italian Western Alps have shown that the apparent density of newly fallen snow is variable and depends on air temperature during the fall. On account of the lack of systematic high-altitude observations in Italy showing low negative temperatures (centigrade), I have worked on the accurate data gathered at the Weissfluhjoch (2,540–2,660 m.), near Davos (Switzerland), already published[1]. Excluding the cases of new snow less than 10 cm. deep and snowfalls occurring with strong wind (causing *Schneetreiben*), as well as those with air temperature reaching or near 0° C., it was found that the apparent density of the newly fallen snow depends upon the mean air temperature during the fall (see Fig. 1). The mean values of the air temperature are somewhat approximate, as deduced from the maximum and minimum temperatures, as well as from observations at 7 hr. 30 min., 13 hr. 30 min. and 21 hr. 30 min., during the time of snowfall; however, they are referred to the

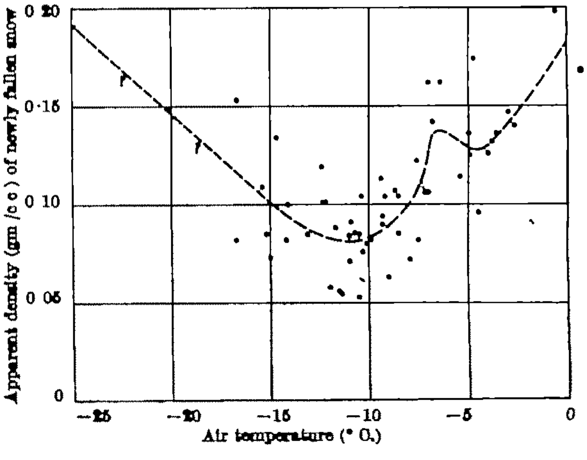

Fig. 1

separate values of the apparent density, because this was obtained from the top of the new snow and from the corresponding water content, both observed only at 7 hr. 30 min.

Although the cases considered are only 53 (+ 2 near 0° C.), Fig. 1 indicates that at Weissfluhjoch the maximum frequency of snowfall occurs with air temperature near − 11° C. For air temperatures less than − 17° C. snowfall seems very rare, and only one case was recorded with a temperature at nearly − 25° C. (on March 4, 1949).

As regards the apparent density of the newly fallen snow, Fig. 1 indicates that it reaches a minimum value near − 11° C. However, the behaviour between − 5° and − 7° C., where the scattering is great, is uncertain; but the extrapolated curve appears the most probable. It is to be noted that near − 4° C. the points reveal a minimal dispersion.

The results obtained are believed not to be restricted to the Weissfluhjoch, where the position of the observatory nearly at the top of the mountain assures that there is little difference from the free atmosphere at the same height during snowfall. Indeed, from laboratory investigations, W. Rau and other authors[2] demonstrated that the greatest frequency in the spectrum of the ice-forming-nuclei occurs between − 10° and − 12° C., while a secondary maximum lies near − 4° C. As the ice nucleation in the atmosphere is the same as in the laboratory[3], it is obvious that the greatest frequency of snow should occur near − 11° C. when the appropriate meteorological condition for precipitation exists in the atmosphere. (*Note added in proof*. Using the meteorological observations made in different observatories at the top of high mountains (cf. Bossolasco, *Geofisica pura e appl.*; in the press) the above results have been proved to be general.)

With reference to the corresponding minimum apparent density of the newly fallen snow, E. Wall and U. Nakaya have already pointed out that the form of ice-crystals also changes with temperature. Near − 11° C. the stellar form prevails, and this explains the minimum density of the snow at this air temperature.

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April 20.

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Solar Tides in the Lower Stratosphere

WHILE methods of representing the 100-mb. wind field were under investigation, diurnal and semi-diurnal variations were detected in winds observed at the 100-mb. level from British upper air stations. These periodic variations of wind appear to be associated with the atmospheric solar tides. 100-mb. wind observations are particularly suitable for study in connexion with tidal oscillations, since, at least between latitudes 30° N. and 60° N., the synoptic variations of wind are considerably smaller at that level than in the upper troposphere. The lower stratosphere is also free from the smaller-scale effects which may mask tidal wind variations occurring in the lower troposphere.

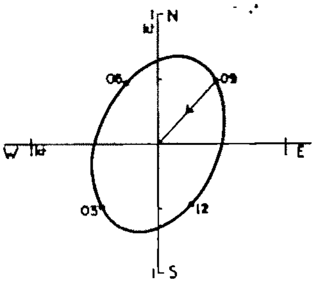

Fig. 1. Vector diagram giving the wind velocity due to the semi-diurnal oscillation. The wind velocity at any time is defined by the line joining the appropriate point on the ellipse to the origin

The deviations of the annual mean south and west 100-mb. wind components at 0300 G.M.T., 0900 G.M.T., 1500 G.M.T. and 2100 G.M.T. from the respective overall annual mean wind components were computed from two years wind observations made using *G.L.*III radar equipment. Similar deviations for 0600 G.M.T., 1200 G.M.T., 1800 G.M.T. and 2400 G.M.T. were obtained from unpublished 150-mb. observations supplied to me by H. W. L. Absalom. The latter refer to four years of wind observations made, for the most part, by radio direction-finding techniques. Harmonic analysis yielded the following expressions for the annual mean oscillation of each component:

$$100\,S = -54\cos(\theta + 32°\,14') + 67\cos(2\theta + 44°\,24');$$
$$100\,W = 51\cos(\theta + 84°\,24') + 51\cos(2\theta - 29°\,3');$$

where S and W are the south-wind and west-wind components in knots and θ ranges from 0 to 360° as time varies through 24 hr. from 0300 G.M.T. The third and fourth harmonics were not statistically significant.

The semi-diurnal oscillation is illustrated by Fig. 1, which is a vector diagram giving, for any time, the wind velocity due to the oscillation. The stratospheric oscillation is approximately in phase with the surface wind oscillation derived theoretically by Bartels[1] from Simpson's expression[2] for the semi-diurnal variation of surface pressure. Such a relationship is to be expected from tidal theory[3]. The amplitudes of the lower stratospheric wind component oscillations, 0·67 knot and 0·51 knot for the south- and west-wind components respectively, are of comparable magnitude to the amplitude of Bartels's derived surface-wind component oscillations in latitude 55° N., namely, 0·87 knot for the south component and 0·85 knot for the west component.

The diurnal oscillation is given by Fig. 2. The amplitudes of the diurnal and semi-diurnal oscillations are similar in the lower stratosphere. Fig. 3 gives the resultant wind velocity due to the combined diurnal and semi-diurnal oscillations.

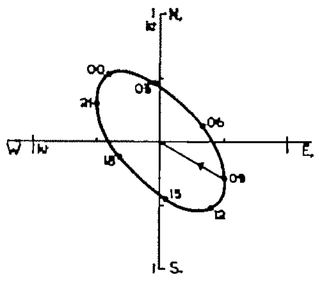

Fig. 2. Vector diagram giving the wind velocity due to the diurnal oscillation. The wind velocity at any time is defined by the line joining the appropriate point on the ellipse to the origin

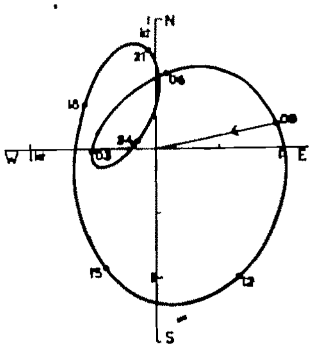

Fig. 3. Vector diagram giving the resultant wind velocity due to the combined diurnal and semi-diurnal oscillations. The wind velocity at any time is defined by the line joining the appropriate point on the curve to the origin

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April 27.

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Electron Irradiation of Polythene

CONSIDERABLE attention has recently been given to the effects of high-energy radiation on polymeric substances[1]. The effects would appear to be of the same fundamental character whether X-rays, electron bombardment, or the mixed radiations of the atomic pile are used; it is reported that in the absence of oxygen the dominant reactions are either cross-linking or chain-scission, and polymers have been classified according to their behaviour in these respects when irradiated. Some of the most interesting effects have been observed in polythene, where cross-linking causes major changes in physical and mechanical properties, particularly at temperatures above the crystalline melting point.

Experimental work to date has of necessity been performed with whatever source of radiation was available, and this has sometimes imposed severe restrictions on the scope of the investigations. When X-rays are used little energy dissipation occurs in the material and very long exposures are required, while use of the atomic pile imposes a fixed and high ambient temperature, exposures are still long, and often specimens can only be withdrawn when the pile is opened for other purposes. Bombardment of a specimen directly by means of an electron beam, on the other hand, gives good energy dissipation and experimental conditions may easily be controlled. It is required, however, that both the electron energy and the current density should be high, so that thick specimens can be treated with short exposure times. The development of the travelling-wave linear accelerator has provided an equipment which fulfils these requirements. Machines of this type operating at 8 MeV.[2] and at 4 MeV.[3] are being used as X-ray generators for clinical purposes, and one of the latter units has been adapted for the electron irradiation of specimens by extracting the electron beam through a thin copper window.

At the nominal maximum rating of the machine, 500 W., a mean current of 125 μamp. is obtainable, and for experimental purposes the window scatters the beam so as to give almost uniform coverage over an area 20 cm. in diameter at a distance of 70 cm. from the window. Further, it is found that the effect of irradiation throughout the specimen may be fairly uniform, varying only by about ± 10 per cent over a substantial part of the electron range (about 2 cm. in polythene for 4-MeV. electrons).

A detailed investigation of the behaviour of polythene when bombarded by 4-MeV. electrons is now in progress, and some of the preliminary results are indicated below.

It is well known that a sufficient degree, α, of random cross-linking produces from an initially soluble polymer a gel fraction the magnitude of which, x, is determined by the original molecular weight distribution, $W(m)$. For polymers cross-linked by radiation, the relationship between these three parameters is often complicated by chain-scission. If, as is probable, this is a random process occurring to an extent proportionate to α, then x has been shown to approach a limiting value, x_L; this limiting value is determined by the ratio, β, of main chain-scissions to atoms cross-linked[4]. In practice, however, x_L can only be measured at reasonable degrees of cross-linking on the often uncertain assumption that the initial polymer contains little low-molecular weight material.

The development of a soluble fraction can, on the other hand, be clearly observed when the extracted gel fraction of a lightly cross-linked polythene is further irradiated (see Fig. 1).

This experiment gives a positive demonstration of the occurrence of chain-scission; and the results suggest that the limiting soluble fraction lies between 2·4 and 2·8 per cent. This value is appreciably less than that previously suggested for polythene irradiated in an atomic pile on the basis of an assumed simple exponential distribution of molecular weights[5]. Corresponding to the range of values observed for the limiting soluble fraction, the value of β lies between

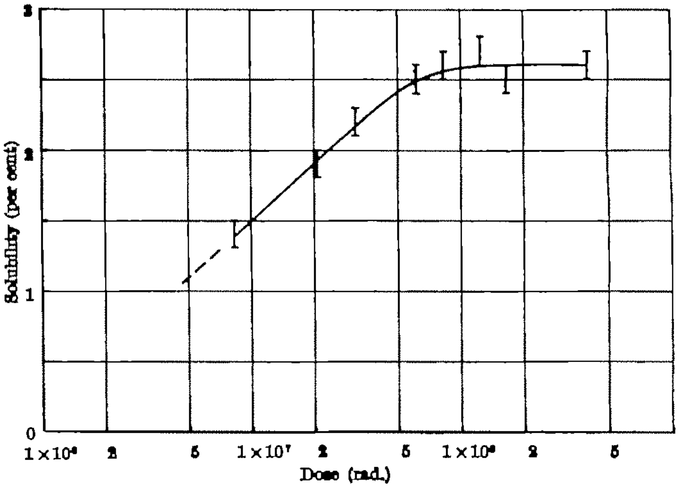

Fig. 1. Soluble material formed by the irradiation of a polythene gel fraction
Note. Soluble fraction of original gel is 0·4 per cent; dose is expressed in rads. (see *Nucleonics*, 12, No. 1, 11). 1 rad. = 100 ergs./gm.

0·18 and 0·20. With this knowledge, it is possible to estimate with reasonable accuracy the gel fractions which would be obtained if no chain-scission occurred. One of us (A. C. B.) has applied this information to the calculation of the original molecular-weight distribution-functions of a series of polythenes, with the necessary exception of the low-molecular weight tails. The results obtained suggest that polythenes have wide molecular-weight distributions, such as have been indicated by a comparison of number-average molecular weights with weight-average molecular weights determined by light scattering[6]. This work will be reported more fully elsewhere.

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Surface Films of Poly-di-methyl Siloxanes on Organic Liquid Substrates

IN contrast with organic compounds, there is evidence that small quantities of silicones are capable of exerting marked surface activity when incorporated in organic liquids. Often this activity is manifest even when the silicone is immiscible with the organic liquid. Such effects could imply that the activity arises, not through adsorption at the air/solution interface, but rather through the existence of insoluble films analogous to those established for aqueous substrates.

This communication records some preliminary evidence for the existence of such films of a poly-di-methyl siloxane of viscosity 20 centistokes. This material of average molecular weight about 2,000, corresponding to a chain of twenty-five di-methyl-siloxane units, was applied as a solution in ether, in small quantities, to the surface of a number of liquid substrates, and the surface tension lowering was determined by the Wilhelmy method, the force being measured by means of a torsion wire and a suitable optical system.

Initially, a large lowering of tension resulted after addition of the silicone to the surface, which decreases usually in about ten minutes to a steady value; in isolated cases this value remained steady within 0·25 dyne overnight. As a proof of the existence of these films the surface pressure could be raised or lowered by varying the area of the film with a specially constructed barrier consisting of a strip of brass thick enough to extend below and above the interface by a few millimetres and sealed to the brass sides of a rectangular trough by mercury–brass amalgam. Changes in area resulted in hysteresis in the pressure such that, for example, compression gave immediately a high pressure which decayed to a lower value, while on returning to the original compression the final pressure was lower by less than 1 dyne from that at the beginning of the cycle. Variation in compression of the film-free side of the barrier gave no evidence of changes in pressure. In spite of this barrier method, and because of the ever-present danger of leakage across the mercury barrier, most of the measurements were made on a constant area by varying the amount of silicone added.

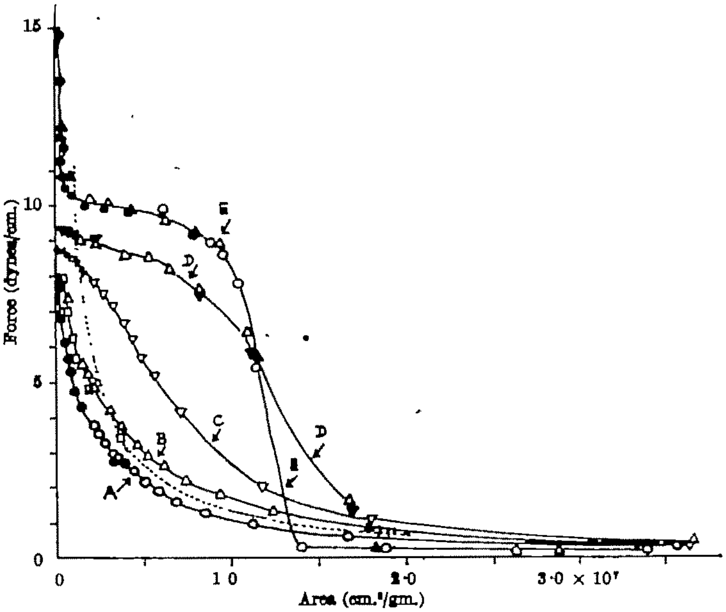

Fig. 1. Force–area curves for poly-di-methyl siloxane (*D.C.*200) at the interface of air and various substrates: (*A*) oleic acid; (*B*) olive oil; (*C*) tri-acetin; (*D*) ethylene glycol; (*E*) distilled water. The dotted curve is calculated for a gaseous film of molecular weight 2,000

Fig. 1 shows some typical force-area diagrams for a number of substrates. It is clear that the substrate has a marked influence in varying the compressional behaviour of the film, varying from that suggestive of a gaseous state to that suggesting phase transitions. Examination of the films by dark-field illumination at the highest compressions and even with a spread drop of the undiluted siloxane failed to reveal any so-called 'point structure' or patches[1] of unspread material.

Some observations were also made on the spreading of drops of the undiluted siloxane. On all the substrates examined, the drop lost its identity immediately and the spreading film at intermediate thicknesses gave readily observable interference fringes of remarkable regularity, which finally disappeared with continued spreading. Lycopodium powder was found to be the most generally useful means of detecting the presence and location of films, and was used for measuring the rate of advance of a spreading film. The substrate was contained at a depth of about 0·5 cm. in a rectangular trough of length 95 cm.

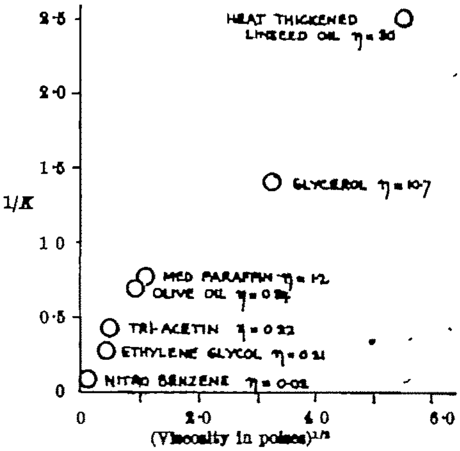

Fig. 2. Relationship between spreading-rate constant and viscosity of substrate

and width 2 cm. A drop of siloxane was placed on the surface at one end and the distance spread at different times indicated by movement of a small quantity of lycopodium powder gently blown on to the surface. It was found that for all the liquids examined the distance l travelled in a time t was accurately represented (for distances of at least 50 cm.) by $l = kt^{1/2}$, and of particular interest is the dependence of the rate constant k on the viscosity of the substrate.

General considerations suggest that k might be expected to show an inverse dependence on the square root of the viscosity of the substrate; that this is approximately so is demonstrated in Fig. 2. This relationship is remarkable when one considers the variation in chemical nature of the substrates and that their viscosities vary by some 1,500-fold.

The bearing of these results on the mechanism of spreading will be elaborated in a fuller publication of this work.

I wish to acknowledge some preliminary measurements made by Mr. J. Beasley, and also the assistance of Mr. R. Golledge in some of the spreading measurements. This communication is published by permission of the Director and Council of the Printing, Packaging and Allied Trades Research Association.

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Randalls Road,
Leatherhead, Surrey.
April 30.

Angle of Contact of Mercury against a Moving Tungsten Wire

DURING preparations for the measurement of the density of mercury by weighing in it a cube of tungsten carbide of known volume, it was necessary to measure the surface tension force exerted by the mercury on the 0·002-in. diameter tungsten wire used to suspend the cube. The method developed for measuring the angle of contact and the behaviour of the angle of contact against an oscillating wire may be of more general interest.

The mercury surface around the point of entry of the wire was photographed through an optical system such that no light entered the camera from those points of the surface at which θ, the angle of inclination of the surface to the horizontal, exceeded a value ψ governed by the geometry of the optical system.

At a distance x from the axis of the wire,

$$\sin \theta = \sin \theta_0 \,.\, K_1 (bx)/K_1 (ba),$$

to a very good approximation. θ_0 is $(\alpha - \pi/2)$, where α is the angle of contact at the wire; $b = (g\rho/\gamma)^{1/2}$ where ρ is the density and γ the surface tension of mercury; and $K_1(bx)$ is the modified Bessel function of order unity. When $\theta = \psi$, x is the radius of the unilluminated part of the image of the mercury surface. Hence, from x measured on the photograph, θ_0 can be deduced. This method of finding θ_0 should be applicable to other liquids and other forms of boundary (although the equation to the surface would then be different). The method should be especially useful when the surface is inaccessible.

The balance from which the tungsten carbide cube was suspended was set oscillating (the period being about 32 sec.) and photographs were taken at intervals of 2 sec. The variation of angle of contact, shown in Fig. 1, was periodic but not sinusoidal. The form of the curve appears to indicate that there is a non-linear frictional contact force. A frictional contact force has been postulated by Yarnold[1] (following Adam and Jessop[2]) to explain his results on the hysteresis of the angles of contact of the surfaces of mercury indexes moving in glass tubes and of the surface of mercury against steel balls. Our results differ from his in that, among other respects, they show angles of contact of less than 90°. Our value for the static angle of contact, about 135°, agrees with his.

The surface of the mercury in our experiments was cleaned by sucking off the dust and upper liquid. Our results were quite reproducible, but neither the wire nor the mercury were specially cleaned apart from forming a fresh surface on the mercury for each run of photographs, since the observations were not undertaken to investigate surface phenomena.

We are indebted to Mr. J. W. C. Gates of the Light Division of the National Physical Laboratory for advice and to Mr. G. F. Miller of the Mathematics

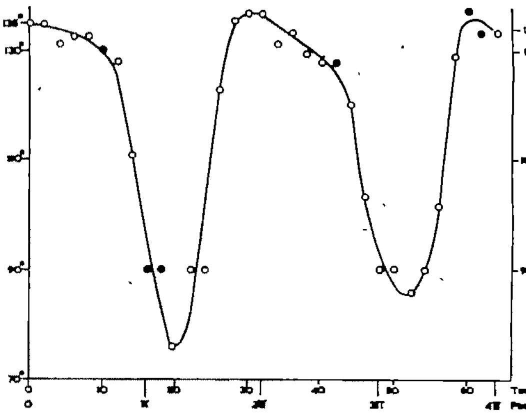

Fig 1. Variation of angle of contact of mercury against a tungsten wire moving vertically with damped simple harmonic motion of period 32 sec.

Abscissa: Above, time in seconds measured from instant when wire is passing downwards through mid-point with maximum velocity; below, phase measured from same instant.
Ordinate: Angle of contact, degrees.

Division for obtaining the expression for the form of the mercury surface. The experiments described above are part of the research programme of the National Physical Laboratory and this communication is published by permission of the Director.

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N. W. B. Stone

Metrology Division,
National Physical Laboratory,
Teddington.
May 19.

---

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[2] Adam, N. K., and Jessop, G., *Trans. Chem. Soc.*, 127 (Pt. 2), 1863 (1925).

Use of a Gaseous Discharge as an Identifiable Radar Target

The use of gaseous discharges as generators of radio noise has been widely reported in the literature, and work in this field is in progress at this Laboratory. Due to the high conductivity of gaseous discharges at microwave frequencies, a major problem in the design of a 'noise source' is a suitable means of introducing the discharge plasma into the electromagnetic field of the radio transmission circuit to provide a reflexionless match. It is readily demonstrated that a sudden introduction of a gaseous discharge into the path of an electromagnetic wave will produce a large reflexion of the incident power, and this fact has been used to produce a variable reflector of radio-frequency energy, thus providing in effect a modulated radar target.

It can be shown that a standard fluorescent light tube operating from the 50 c./s. mains supply will reflect 3-cm. radio waves, the reflected signal having a 100-c./s. modulation. By placing such a tube at the focus of a parabolic cylinder, the total reflected signal is considerably increased due to the larger amount of energy being intercepted by the parabola, and depending on the condition of the discharge tube for its reflexion.

The mechanism of the process is interpreted simply as follows. Energy intercepted by the parabola is focused on to the discharge tube. If the plasma is present, then because it has a high conductivity it reflects most of the incident power, and a large signal is returned. If, however, the discharge is extinguished the reflexion of power is from the glass of the tube and is of much less magnitude. At intermediate levels the reflexion depends on the current in the discharge. It has been found that excellent square-wave modulated returned signals are obtained if the discharge tube is suitably driven, that is, if a square wave-form of current is produced through it.

It has been found equally effective to arrange a similar discharge tube along the axis of a paraboloid. In this case the position of the tube is not critical over most of its length, although when the end of the tube is near the focus the additional effect of the electrode acting as a reflector behind the portion of plasma at the focus appears to give an improved total reflexion.

Further experiments have also been carried out with a 'beehive' neon lamp. In this case, the effective portion of the discharge is the cathode glow, and it is thought that the mechanism in this case may be the opposite of the earlier example, with the metal structure in the lamp normally acting as the reflector but screened by the discharge when the lamp is switched on.

No marked polarization sensitivity was observed with the discharge tube placed along the axis of a paraboloidal reflector. In the case of the parabolic cylinder with the discharge tube on the line focus, a considerable increase in performance was obtained at 3 cm. wave-length, with the electric field perpendicular to the axis of the discharge tube.

The device is of use in adjusting continuous wave radar sets where some form of fluctuating target is required, and may possibly have applications in providing a means of identification for the usual corner reflector types of target used in association with pulse radar systems.

G. W. G. Court

Dominion Physical Laboratory,
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April 15.

Non-isothermal Plasmas in the Rare Gases

Kenty[1] noticed, many years ago, the finite lapse of time occurring between the termination of current flow in a low-pressure discharge in argon and the occurrence of maximum visible intensity of the afterglow. He suggested that the latter was due largely to radiative electron-ion recombination, and that the time-lapse was necessary for the electron temperature to fall to a value comparable with the gas temperature when the afterglow intensity would have reached a maximum, since recombination would continually reduce the electron and ion density. Bayet[2] and others have noticed a similar phenomenon and attribute it to the same cause. Also, an analogous effect due to pickup, in the afterglow, of electron energy from a microwave beam has been elegantly demonstrated by Goldstein and his collaborators[3].

Bayet[2] suggests that effects due to metastable excited atoms may be ignored at sufficiently high pressures. Moreover, Biondi[4] has shown that increased afterglow ionization due to metastable atom collision processes would tend to increase with increasing pulse-length (up to a limiting pulse-length, set by the time required to establish a full metastable atom population); this is in contrast with our results (Fig. 1), which show a decreasing afterglow light peak at increasing pulse-lengths.

For some years we have observed these effects in the rare gases, and the purpose of the present communication is to present preliminary data which are consistent with the recombination mechanism and which enable a recombination coefficient to be estimated. In view of the current interest in recombination processes, summarized by Massey[5], any method capable of yielding results of potential value may be worth investigation.

We have worked mainly at 1 atmosphere pressure in cylinder neon and helium, with rectangular current-pulses of a few microseconds duration, in contrast with the damped-condenser discharges used by Bayet[2], Olsen and Huxford[6] and others which render afterglow results more difficult to interpret. In high-pressure discharges, for example in helium, where the electron-atom energy transfer may be effected rapidly, the heating of the gas may be so great that there is a finite rate of electron production in the afterglow. This may be demonstrated by the non-

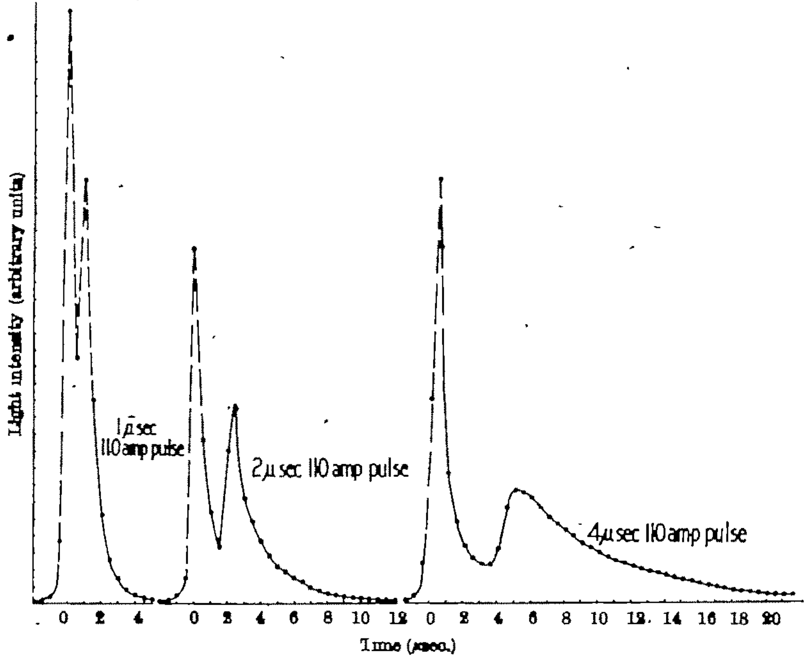

Fig. 1

linearity of the (light intensity)$^{-1/2}$ – time curve, which is necessarily linear for afterglows where radiative (two-body) recombination predominates, as Mohler[7] has shown. It is assumed, of course, that the recombination coefficient is constant throughout the time of observation. A recent discussion of the low-pressure work has been given by Massey and Burhop[8].

Our results show that the gas-heating effect is less, other things being equal, in neon than in helium, and that afterglows following pulses 1 microsec. long in neon show the requisite linear plot (Fig. 2*a*). Pulses of 4 microsec. (Fig. 2*b*) show non-linearity, also noticeable even in 0·8 microsec. discharges in helium. A recombination coefficient may be deduced if the electron density is known at any instant in the curve Fig. 2*a*. Measurements of the Stark effect have been made in this laboratory in helium and hydrogen; but for neon drift-current densities (averaged over the whole discharge channel, as a first approximation) give the electron density at 1 microsec. as $\sim 10^{14}$/c.c., and the resulting afterglow recombination coefficient as $\sim 10^{-10}$ cm.^{3}/sec. This value is appreciably less than the (dissociative) recombination coefficients ($\sim 10^{-6}$ cm.^{3}/sec.) obtained in ultra high-frequency studies[3], and may be attributable to dielectronic[5,6] or to electron-ion recombination.

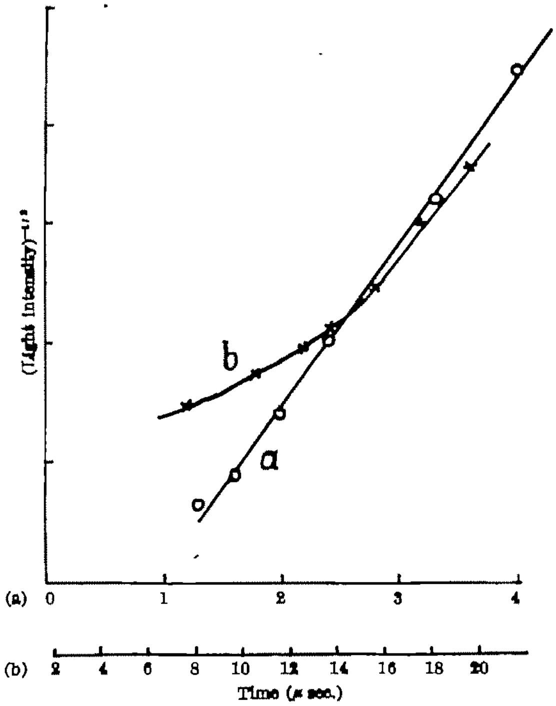

Fig. 2

R. D. Craig*
J. D. Craggs

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April 29.

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[1] Kenty, C., *Phys. Rev.*, 32, 624 (1928).

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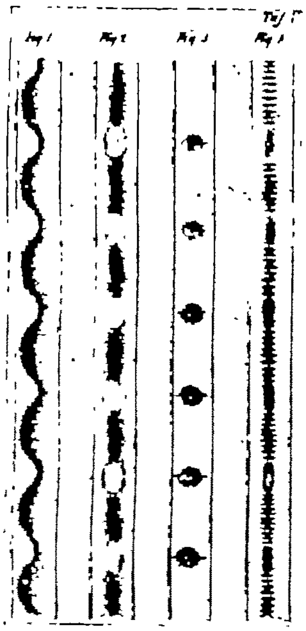
Powder Ridges in a Sound Field

I have found that the distance between powder ridges, formed on a flat surface in a sound field[1], increases rapidly with the size of the particle. Those who describe Kundt powder ridges make no mention of this fact. My results, however, appear to be a 'rediscovery' of some of Kundt's[2] original observations which, in view of their importance, are reproduced in the accompanying illustration. Whereas his fine striæ were formed with lycopodium spores of diameter 20 μ, the wider *Rippen* shown on their right consisted of fine sand grains of peak diameter c. 200 μ.

Such results can be explained in terms of Andrade's[3] vortex theory (which has superseded Koenig's hydrodynamical theory) and may link up eventually with other studies in which there is relative oscillatory motion between viscous fluids and powders. Bagnold[4], for example, in his experiments on powder 'ripples, formed under oscillating water, found that the inter-ridge distances varied approximately as the square root of the diameter of the grains.

In my own observations, when there is more powder present, the ridges are wider and farther



apart, and this effect can be recognized also in Fig. 4 of the illustration; compare the eight ridges between the central two nodes with the eleven ridges between the bottom two nodes.

The above facts must also be important at higher frequencies, especially in ranges where the inter-ridge and internodal distances may become comparable to one another. It is interesting to note that Soellner and Bondy[5], working on the subject of coagulation by ultrasonics, found that the distances between 'nodal lines' were strongly influenced by the size of the particles.

MARY D. WALLER

5 Gloucester Gate,
London, N.W.1.
May 10.

[1] Waller, *Nature*, 166, 961 (1950).

[2] Kundt, *Ann. Physik*, 127, 497 (1866).

[3] Andrade *Proc. Roy. Soc.*, A, 134, 445 (1931); *Phil. Trans.*, A, 230, 417 (1932).

[4] Bagnold, *Proc. Roy. Soc*, A, 187, 1 (1946).

[5] Soellner and Bondy, *Trans. Farad. Soc.* 32, 616 (1936).

Fluorescence of Naphthoquinones

ATTEMPTS to devise a method for the identification of vitamin K_1 and other naphthoquinones by filter-paper chromatography led to the chance observation that some of these compounds exhibit a characteristic fluorescence which can be used for their detection. 10 μgm. of vitamin K_1 was chromatographed in a 75 per cent (v/v) aqueous ethanol solution on Whatman No. 1 filter-paper impregnated with silicone. When the paper was dried and held before an ultra-violet lamp (3665 A.), an area of red fluorescence was seen at R_F 0·20. With prolonged exposure to the ultra-violet radiation (45–60 sec.), the red fluorescence changed irreversibly to an intense, green fluorescence which was stable for at least four months. When sprayed with alcoholic potassium hydroxide, the green fluorescence changed to an orange fluorescence.

Although necessary for proper separation of the substances, silicone-coated paper was not necessary for fluorescence. Spraying the chromatogram with alcoholic solutions of nickel chloride or ammonium iodide, substances that often quench fluorescence[1], had no effect.

Of nineteen alkyl, hydroxyl or chloro substituted 1,4-naphthoquinones observed on filter-paper, all fluoresced red. 1,4-Naphthoquinone itself had no obvious fluorescence, and neither 1,2-naphthoquinone nor its methyl derivatives fluoresced. None of the substances tested fluoresced in petroleum-ether or ethanol solutions, although some of the crystalline compounds in the solid state did. These observations suggest that substituted 1,4-naphthoquinones may react in the same way as those substances, tabulated by Pringsheim[1], some of which fluoresce only in the solid state, others in rigid media.

A detailed report of reversed-phase partition chromatography on filter paper of the naphthoquinones and their detection by fluorescence will be published elsewhere.

I thank Prof. Henrik Dam for his encouragement and support of this work.

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* Fellow of the Life Insurance Medical Research Fund.

[1] Pringsheim, P., "Fluorescence and Phosphorescence" (Interscience, New York, 1949).

Liquid-State Equation for Normal Paraffins

BASED on measurements of liquid density and of heats of vaporization of the normal paraffin hydrocarbons, a very simple relationship has been deduced that appears to be of general applicability to this family of chemical compounds. The equation is as follows:

$$\frac{\rho - \rho_c}{\rho_0 - \rho_c} = \left[\frac{(1 + \alpha T)(-E/V)}{(-E/V)_0}\right]^{2/4},$$

where ρ is liquid density at the temperature of measurement[1]; ρ_c is critical density[2]; ρ_0 is liquid density extrapolated to absolute zero[3]; $(-E/V)$ is cohesive-energy density of the liquid at the temperature of measurement[4]; $(-E/V)_0$ is cohesive-energy density of the liquid extrapolated to absolute zero; and α is a constant (= 0·00125 for the *n*-paraffins).

The above relationship has been applied to the normal paraffins at atmospheric pressure over a range of temperatures from − 190° to + 345° C., and over a range of molecular weights from 44 to 283. The standard percentage error for the 78 points is:

$$100 \left\{\frac{\Sigma\,[(y_{\text{calc.}} - y_{\text{obs.}})/y_{\text{obs.}}]^2}{n}\right\}^{1/2} = 0{\cdot}57 \text{ per cent},$$

where $y = \dfrac{\rho - \rho_c}{\rho_0 - \rho_c}$ and n is number of measurements.

Work is in progress to investigate a large number of non-polar liquids to determine whether or not they also conform to this simple equation. Compressibility data on the normal paraffin hydrocarbons are being taken for us by Arthur D. Little, Inc., of Cambridge, Mass., and a study by them of the compressibilities of other liquids is contemplated. At a later date this research will be extended to polar liquids in the hope that their behaviour also may be characterized by some modification of this relationship.

ARTHUR K. DOOLITTLE

Carbide and Carbon Chemicals Company,
South Charleston, West Virginia.
March 23.

[1] Dornte, R. W., and Smyth, C. P., *J. Amer. Chem. Soc.*, 52, 3546 (1930). Doolittle, A. K., and Peterson, R. H., *J. Amer. Chem. Soc.*, 73, 2145 (1951).

[2] Critical density values taken from smoothed curve representing results reported by Doss, M. P., "Physical Constants of the Principal Hydrocarbons" (Texas Co., New York, 1943).

[3] Doolittle, A. K., *J. App. Phys.*, 23, 1471 (1953)

[4] API Res. Proj. 44, Carnegie Inst. Tech., "Selected Values of Properties of Hydrocarbons", Table 20m (April 30, 1949). Values at other temperatures interpolated or extrapolated by method described in Hildebrand, J. H., and Scott, R. L., "The Solubility of Nonelectrolytes", 434 (Reinhold, 1950).

FORTHCOMING EVENTS

Monday August 23—Saturday, August 28

Comité International de Photobiologie (at Amsterdam).—Fourth International Congress.

Wednesday, August 25—Wednesday September 1

Midlands Society for Analytical Chemistry (at the University, Birmingham).—Symposium on "Analytical Chemistry".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Metallurgists or Physicists (2) (with a first- or second-class honours degree in metallurgy or physics, and several years postgraduate experience), one to work on casting and working of rare metals used in nuclear power reactors, and the other to work on the arc melting and welding of these metals—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/134 (August 27).

Assistant Experimental Officer (preferably with a degree) with the Agricultural Research Council, Unit of Biometrical Genetics attached to the Department of Genetics in the University of Birmingham, for genetical work on fungi—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 28).

Chemist (with some knowledge of bacteriology, biochemistry, or the chemistry of soils or sewage) in the Chief Engineer's Department at London Headquarters, to study the effects on rivers of power station operations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting NAT/499 (August 28)

Principal Scientific Officer (with an honours degree in science or civil engineering and a knowledge of applied mathematics and physics, and preferably with experience in the application of soil mechanics to civil engineering design and construction), with the Air Ministry at Wellesbourne Mountford, Warwickshire, for work on soil mechanics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1 (August 28).

Lecturer (with an honours degree and a knowledge of advanced physical metallurgy, and an interest in X-ray metallography) in the Department of Metallurgy; and a Lecturer in Dental Bacteriology—The Registrar, The University, Liverpool (September 1).

Lecturer (with special qualifications in plant physiology) in Botany—The Secretary, University of Durham, 38 North Bailey, Durham (September 1).

Microanalyst in the School of Chemistry—The Registrar, The University, Leeds (September 1).

Assistant Lecturer (with an honours or special degree in geography) in Geography—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1 (September 6).

Lecturer (Grade II) in the Department of Mathematics, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 8).

Assistant Lecturer or Lecturer in Medical Biochemistry—The Registrar, The University, Leeds (September 13).

Chemist (with a first- or second-class honours degree with chemistry as the main subject, and preferably with a knowledge of the natural rubber industry), to operate the advisory service of the Chemical Division, to rubber-producing planters in Malaya, and to investigate problems arising from this work; and a Biochemist (with a first- or second-class honours degree, and able to produce evidence of sufficient postgraduate research experience on biochemical problems to carry out independent investigations), at the Rubber Research Institute of Malaya, Kuala Lumpur, to undertake research work on the biochemistry and enzymology of natural rubber latex, with particular reference to the naturally occurring non-rubber substances—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (September 13).

Leverhulme Fellow and Lecturer (with considerable experience of research work in nuclear physics, and preferably between the ages of 26 and 35 years) in the Department of Physics—The Registrar, The University, Liverpool (October 16)

Aerodynamicists and Aeronautical Engineers (with a first- or second-class honours degree or equivalent in mathematics, physics or engineering, and preferably with research or experimental experience of aircraft problems (Ref. A.215/54A); and Electrical Engineers (with a first- or second-class honours degree or equivalent in electrical engineering, and experimental or research experience in light electrical or electronic fields) (Ref. D 420/54A), at Ministry of Supply Research and Development Establishments, mainly in southern England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W 1, quoting appropriate Ref No

Chemist, Scientific Officer or Senior Scientific Officer grade, to work on new problems arising from the genetics of (1) plant pigments and (2) enzymes in high plants and fungi—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts.

Experimental Officer (with qualifications equivalent to a pass degree in pure or applied science, and ability to prepare articles describing scientific and technical work in a simple and attractive manner, and preferably with experience in technical writing for industry or in a technical information service), in the Headquarters Office of the Department of Scientific and Industrial Research, for publicity work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 207/54A.

Lecturer in Agricultural Science, including Chemistry, at Winmarleigh Hall, near Garstang—The Principal Agricultural Officer, Lancashire County Institute of Agriculture, Hutton, Preston.

Lecturer (preferably university graduate in science with honours in zoology) in Economic Entomology, at Massey Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C 1.

Physical Chemist or Physicist (with some experience in research) in the Department of Chemical Engineering, to undertake research on the hydrogen–oxygen fuel cell—The Secretary, Department of Chemical Engineering, University of Cambridge, Tennis Court Road, Cambridge.

Plant Physiologist, and an Agronomist (with good honours degrees), in the Research Division of the Ministry of Agriculture, Sudan Government—The Sudan Agency in London, Sudan House, Cleveland Row, St. James's, London, S.W 1

Professor of Organic Chemistry—The Registrar, University of Adelaide, Adelaide, South Australia.

Regional Trials Officer (with a degree in botany or agriculture or equivalent qualification, and with practical experience in crop production), for work possibly in Hampshire—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

Research Assistant (graduate in agricultural chemistry or chemistry), to undertake work in the field of plant nutrition; and a Demonstrator (graduate in agricultural chemistry or chemistry) in the Department of Agricultural Sciences—The Registrar, The University, Nottingham.

Research Assistant in the Department of Aerodynamics, to assist in research on freon as a medium for high speed wind tunnels—The Recorder, College of Aeronautics, Cranfield, Bletchley.

Research Scholar (with a degree in chemistry) in the Department of Applied Chemistry, to work on the constitution of tars—The Head of the Department of Applied Chemistry, Northampton Polytechnic, St. John Street, London, E.C.1.

Senior Biochemical Technician (Fellow of the Institute of Medical Laboratory Technology, or with a degree in chemistry or equivalent qualification) in the Department of Pathology, to be responsible for routine biochemical investigations—The Hospital Secretary, Canadian Red Cross Memorial Hospital, Taplow, near Maidenhead.

Statistician (with a good degree in mathematics or statistics and some postgraduate training in statistics, and preferably a diploma in statistics, with experience of, or training in, statistical methods as applied to agricultural field experiments), in the Department of Agriculture, Kenya, to advise on the design of field and other experiments conducted by the Department including sampling, investigations and surveys, and to assist in the statistical analysis of results—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.63/7/03.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Coal Tar Research Association. Review of Coal Tar Technology. July–December 1953. Vol. 5, Part 2. Pp. ii+79–168. (Gomersal, Leeds: Coal Tar Research Association, 1954.) 7s. 6d. to non-members. [296

Aero Research Technical Notes. Bulletin No. 138: Epoxy Resins. By R. A. Johnson. Pp. 8. (Originally published in *Electronic Engineering*.) (Duxford: Aero Research Limited, 1954.) [296

A General Survey of the British Pharmacopoeia 1953. (A series of lectures by members of the British Pharmacopoeia Commission 1948–1953.) Pp. iv+44. (London: Pharmaceutical Press, 1954.) 4s. 6d. [296

British Welding Research Association. Ninth Annual Report, 1953–54. Pp. 48. (London: British Welding Research Association, 1954.) [296

Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. Pp. 56. (Cmd. 9138.) (London: H.M. Stationery Office, 1954.) 1s. 9d. net. [17

Other Countries

Survey of India. Technical Report 1951. (From 1st April 1950 to 31st March 1951.) Part 1: Topographical and Other Surveys. Part 2: Map Publication and Office Work. Pp. v+48. (Dehra Dun: Office of the Geodetic and Training Circle, Survey of India, 1953.) 5 rupees; 8s. [17

Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1952. Pp. xi+57. (Hyderabad-Deccan: Osmania University Press, 1954.) [17

Annals of Library Science. Vol. 1, No. 1 (March 1954.) Pp. 1–64. (Published March, June, September and December.) (Delhi: K. D. Puranik Times of India Press, 1954.) 20s. per year. [17

Australia Commonwealth and Industrial Research Organization: Division of Fisheries. Technical Paper No. 2: Commercial Trawling Tests in the Great Australian Bight, 1949–52. By T. W. Houston. Pp. 18. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1954.) [17

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TECHNICAL COLLEGES AND INDUSTRY

AT the Conference on Technical Colleges and Industry in Britain arranged by the Federation of British Industries, and held during May 5–7 (see *Nature*, July 31, p. 210), Sir Arthur Smout strongly criticized the present position of technical education and its subordination to local and party politics. In particular, he proposed the establishment of a Technical College Grants Committee comparable with the University Grants Committee, so as to free the administration and finance of at least the major technical colleges from such influence; this indeed might help to secure the essential academic independence and properly constituted governing bodies for which Dr. P. F. R. Venables pleaded at the North of England Educational Conference held in January. To be successful, however, it might also require the responsibility for technical education, except in so far as training for unskilled or semi-skilled occupations is concerned, to be removed from the Ministry of Education.

Sir Arthur Smout's forthright comments on salary-scales support arguments advanced by representatives of the teaching staff in the technical colleges, and the impossibility of drawing any sharp distinction between technical and technological education is a further reason for some such change. The expansion of technological education in the five centres proposed by the Government will still make it necessary to continue the provision made in the remaining university departments of technology and in the technical colleges. Dr. Lincoln Gorden, in addressing the Union of Lancashire and Cheshire Institutes last October, for example, expressed the view that the expansion of existing university departments, the development of existing colleges of technology and the establishment of one or more independent institutions, along the lines of the Massachusetts Institute of Technology, even if pushed to the furthest practicable limits, would not surpass the growing needs. Even if the useful suggestion made by Dr. Venables at the Federation of British Industries Conference were adopted and the use of the term 'technological education' be limited to postgraduate education, the overlap between technical and technological education—and indeed between the functions of the universities and the technical colleges—would not be eliminated; nor indeed may it be desirable that it should be.

Any body responsible for technical education would accordingly necessarily be concerned with technological education, and it should be considered whether the responsibility for both could not be effectively discharged by the technological education sub-committee of the University Grants Committee. Such a step might have the advantage of encouraging parity of status and esteem between the technical colleges and university departments. It should be noted that in arguing again for the establishment of a technological university Lord Cherwell, in his Messel Memorial Lecture on July 14, once more referred to the lack of esteem which careers in science and technology still receive in many grammar schools and public schools and universities. That contention, however, finds no support in the discussion on higher technological education at the Congress of the Universities of the Commonwealth at Cambridge last year, where it was fully recognized that the universities should play a part in the production of technologists and that technological education must take its place with the other and older disciplines. Admittedly, to do so, universities require a much closer knowledge of the nature and purpose of industry and of the needs of industry in respect of personnel. Moreover, it was recognized there that in technological education we are concerned with the acquisition of knowledge for the purpose of achieving industrial or commercial objectives, rather than, as in a scientific education, primarily with the acquisition of knowledge and the mastery of objectives.

Nevertheless, whether in the university department or in the technical college, the emphasis must be on education, as distinct from training. It is the mastery of theoretical knowledge which later can be combined with skill and experience in applying it to immediate ends; and the training in that process is a function which must largely depend on the co-operation of industry itself. For that reason, an alternative to Sir Arthur Smout's suggestion deserves consideration, particularly in view of the close dependence of industrial development and technological advance on both technical and technological education.

The increasing interest now being taken in the educational responsibilities of the research associations is only one indication of the readiness of industry to associate itself with technical education and training, and has already led to the suggestion that the Advisory Council for Scientific Policy might be the appropriate body for watching over the development of the technical colleges in the national interest. To make that body responsible for the distribution of grants for technological and technical education would involve, however, a major disturbance to the existing arrangements. What is really needed is some sufficiently authoritative body which is competent to formulate a real policy and see that it is implemented, and that the procrastination of the Ministry of Education is no longer tolerated.

Effective means are required of fostering co-operation between the universities, the technical colleges, the professional institutions, the local education authorities and industry and commerce, of formulating policy in place of piecemeal decisions and of implementing it in a way that wins consent. An overall plan for technological and technical education is required to avoid waste of resources and to command approval of the sacrifices which will be involved; but it is equally true that no such plan will work effectively without understanding and co-operation at all levels, local as well as regional. Now that Mr. R. A. Butler has lifted the veil on the Government's intentions, much constructive thinking is required as to the best means of dealing with the many complex issues that arise within the broad framework laid down. Three specific points appea to require early attention, and they are inter-related the extent to which the training of technicians an technologists can be carried out in industry itself the balance between research and teaching, in th universities and in the expanded colleges of technology; and the relation between supply an demand for scientists and other graduates. All i turn react on a fourth problem, namely, the suppl and distribution of trained man-power available fo such developments, quite apart from the question c finance and material resources, and disregarding th situation in regard to technical colleges disclosed b the twelfth report of the Estimates Committee fo the session 1952–53 last autumn.

It is to be regretted that the Parliamentary an Scientific Committee has seen fit to publish th memorandum* on higher technological educatio which it had already drafted when the Chancello made his statement on July 13, instead of examinin carefully the implications of that statement an making constructive proposals to deal with thes issues. As it stands, the memorandum is essentiall a summary of known views on the expansion o higher technological education, which indicates som of the essential factors but makes no positive con tribution for the solution of any of the intricat problems involved. This is particularly true i respect of the reconciliation of clashing interest where the Committee might have been expected t be most helpful. Indeed, the memorandum lacks an appreciation of the fact that the improvement o technological and technical education, urgent an important as it is, will demand sacrifices elsewhere To be effective, the developments now proposed b the Government will make heavy demands on resources, apart from money, which are already scarce—good teachers, buildings and equipment. At the intake end they affect the redistribution o students over courses; to ensure that the proposed new facilities are fully used when available may entail an educational campaign in the schools and elsewhere, as a recent report from the Advisory Council on Scientific Policy indicated.

It may be necessary, as Mr. F. H. Perkins suggested in a paper before the recent meeting of the Associations of Technical Institutions and of their Principals, to divert a larger proportion of those who have taken classics and the arts courses at schoo into scientific courses, to place in the technical colleges more of the 'patient plodders' of the present university population, who are regarded by Mr. J. F. Wolfenden as unsuited for a university education and who might develop better in such courses, and to adopt improved methods of selecting and training those who seek a career in science and technology but did not receive a university education. The response to such measures will, however, depend in part on the readiness with which industry absorbs the increased output of scientists and technologists. Any considerable amount of unemployment among particular types of technologists or scientists when scientific establishments, both government and industrial, cease to expand, and new scientists and technologists are wanted chiefly to replace losses through retirement and like causes, could adversely affect the numbers leaving school prepared to take up careers in applied science.

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* Parliamentary and Scientific Committee. Memorandum on Higher Technological Education. Pp 16. (London: Parliamentary and Scientific Committee, 1954.) 2s.

This aspect of the problem merits much more areful examination than it has yet received. Until much more reliable evidence is available on prospective demand, it would be wise to follow Sir Philip Morris's advice and concentrate on ensuring that alent of varying kinds is given the maximum opporunity to develop according to its bent. That is not merely an argument for a variety of institutions for higher technological education: it is equally a reason for promoting much more effective co-operation between technical colleges, universities, professional institutions, industry and commerce. The establishment of a common field of interest in common problems and common objectives, and a recognition by all concerned that others have their indispensable contribution to make in achieving the desired objectives are the first steps. The Federation of British Industries and the Department of Scientific and Industrial Research have already, through their conferences, done something in this direction; but more is required. On industry, on the universities and on the technical colleges especially, lies the responsibility for seeking urgently to devise appropriate means for closer and more intimate relations while the Government is formulating policy and the means for securing the overall co-ordination of the distribution of resources.

The balance of research and teaching obviously turns in part on this question of supply and demand, but still more on the extent to which we succeed in introducing more breadth into the teaching of science and technology, both at the universities and the technical colleges. It is not a multiplication of highly trained specialists that the nation needs, least of all young men and women who are the creatures of their skills rather than the masters of them. Industry and society need rather more men and women who have been equipped by a broad and humane education with the knowledge, skill and adaptability to seize the opportunities of development that scientific and technical advances offer to industry.

Much that Prof. E. C. Stoner said in a lecture at Leeds on the balance of teaching and research in universities is highly relevant to the question of research in technological colleges. If it is true that more opportunities are desirable for the teaching staff to engage in both research and consulting work, and for a technical college to encourage, in co-operation with industry, a wide range of applied research of high quality, it is not the students only, even postgraduate students, who will profit by engaging in such research. For the good of the community and of themselves, many such would be better occupied otherwise, and this factor should be kept in mind in determining the pattern of expenditure at technical colleges and at universities.

Prof. Stoner estimates university expenditure on research as about 35 per cent of the total, the remainder being broadly on undergraduate teaching. It is arguable whether it should be allowed to run anything like as high in the technical colleges, even if it is admitted that costly large-scale projects in applied research which, as Prof. Stoner points out, would be out of place in the universities, might fittingly be encouraged in the larger colleges of technology where these colleges are suitable equipped. Even so, it is probably true that such projects are more appropriately and conveniently, if not more effectively, carried out by the industries themselves or by research associations. Indeed, the danger of distorting the work and structure of the departments concerned and the unbalancing of their relationship with the rest of the college may well be even greater than in the department of technology of a university, and all the more if the technical colleges show a like caution in accepting candidates for postgraduate research to that which Prof. Stoner suggests for universities, and limit their choice to those who show promise of powers to advance their chosen field farther not simply as assistants but as originators of new lines of thought and investigation.

Any such policy implies a more balanced view of their responsibilities in the development of the young men and women whom the technical colleges educate, such as Sir Charles Morris urged on the universities in his Joseph Payne Memorial Lectures. Such a balanced view is necessary to secure the co-operation, which is so important, between industry, the universities and technical colleges. It could be decisive in determining the distribution of trained man-power available for the development of technological education, whether in the universities or in the technical colleges.

On this last issue the memorandum of the Parliamentary and Scientific Committee seems strangely unrealistic. The memorandum suggests that the universities could increase their output of scientists and technologists without increasing the present total number of students, without detriment to present standards and indeed with some increase in breadth of studies. It nowhere recognizes fully that such a change in balance would make quite appreciable demands for staff as well as buildings and equipment, and would be in competition with the expansion of the colleges of technology. Nevertheless, the report contemplates the expansion ultimately of some twenty such colleges, though admittedly of only "a few" at first, and it pursues the chimera of a new award; 'bachelor of technology' is suggested, without pausing to consider where the teaching staff, for example, is to be obtained, or at what sacrifice elsewhere.

Teaching staff of high standard, academic autonomy, adequate equipment and buildings are the conditions that must be secured before any new award can even begin to win the prestige that will give it any value, and the Committee passes too lightly over the question of co-operation and the means by which it is to be achieved. Its memorandum gives little hope that any serious attempt is being made to help Parliament to understand clearly the price which has to be paid for the expansion of technological and technical education, or the necessity of regarding such expansion and developments as part of a concerted policy for the promotion of education at all levels, from the university to the schools. A realistic and comprehensive view, however, is essential, both for the formulation of policy and the wise allocation of resources as between the universities, including their technological departments, the colleges of technology, technical colleges and the schools. If the main responsibility in that respect lies on the Government, the implementation of that policy depends on the co-operation and goodwill of industry and commerce, the professional institutions, and the local authorities, as well as of the universities and colleges directly concerned. While the Government has still a long way to go in elaborating policy and allocating resources reasonably, there is much that could be done in the meantime by all such bodies to assess needs and priorities and ways and means of meeting them locally, and in devising appropriate forms of co-operation. Finally, it will be necessary to educate public opinion to hold a higher level of general esteem for careers in technology and to accept the fact that sacrifices will be required in an expansion so vital for the industrial and economic future of Britain.

ORGANIC CHEMICALS

Dictionary of Organic Compounds

The Constitution and Physical and Chemical Properties of the Principal Carbon Compounds and their Derivatives, together with the relevant Literature References. Edited by Sir Ian Heilbron and H. M. Bunbury. Vol. 1: Abadole–Cytosine. Pp. xvi+654. Vol. 2: D.A.–Hystazarin. Pp. xvi+845. Vol. 3: Ibogaine–NW-Acid. Pp. xvi+838. Vol. 4: Obaculactone–Zymosterol. Pp. xvi+694. New and revised edition. (London: Eyre and Spottiswoode (Publishers), Ltd., 1953.) £28 the set.

"LET'S see what Heilbron says about it"; some such words and the rather worn appearance of all the volumes are oral and tacit tributes to the esteem in which the first edition of this work is held. When the original three volumes were published a few years before the Second World War it was planned to issue completely revised editions at convenient intervals. Circumstances ordained otherwise; although a new edition of the first volume appeared in 1943, the text of the other two remained unchanged, except for a slim supplement.

Although during the war years the direction of research was changed, it continued unabated, and in the post-war period the heavy task of revision was undertaken; the result of that labour is now represented by this new edition. The division into four volumes instead of three gives books which are less cumbersome to handle, and, by utilizing a somewhat larger area of the paper, more than two thousand five hundred new main entries have been incorporated with the addition of only ninety additional pages; indeed, in inches of shelf space, there is practicall no change. It is claimed that the literature up t the end of 1950 has been covered, and there ar occasional references up to 1953.

The subject of nomenclature is a difficult one, and n particular system has been followed in its entirety indeed, it is stated that that which is employe in the original publication has generally been give preference. The order in which substituents ar listed is different from that formerly used by th Chemical Society, and for convenience it is given i some detail in the introduction to each volume. T have adopted the current alphabetical order woul have incurred extensive revision and considerabl delay in publication, but it is to be hoped that i will be followed in future editions; the few rule are not difficult to learn, and there is then n need to search a list for the relative position o substituents.

The prefixes cyclo- and iso- are treated as integra parts of names. There is much in favour of thi action for the former, because it does not indicat isomerism; but with the latter it means that i comparing properties of, for example, butyl compounds, three are grouped together while the fourt is in another volume. In acyclic acids, the carboxy group is generally regarded as a substituent, so tha 2- and 11-hydroxypentadecanoic acids appear as 1- and 10-hydroxypentadecylic acids respectively; in contrast, 15-hydroxypentanoic acid is listed as 15-hydroxypentadecylic acid. It would seem preferable to adopt the latter numbering throughout so that the same numbers would be used irrespective of whether the name is trivial or systematic. As a minor point, there is lack of uniformity in naming the long-chain olefines—for example, nonene, decylene, tridecene, tetradecylene, octadecene.

For the monoethers of ethylene glycol, one is referred, for example, to 2-hydroxydiethyl ether and 2-hydroxyethyl butyl ether. Such compounds would be more neatly named on the lines of 2-ethoxyethyl alcohol or, even better, 2-ethoxyethanol; the esters of these ethers, for example, the acetates and phthalates, could be named accordingly and are, indeed, of sufficient importance to be listed individually. Such well-established names as carbromal and leptazol are not mentioned at all, the compounds being listed under their foreign names. Mepacrine is referred back to atebrin, and chloramphenicol appears in its own right.

The selection of data which can be quoted with full confidence is very difficult because of the many divergences in the literature. Prof. J. Timmermans, in his recent book on "Physico-chemical Constants", has surveyed some of the ground, and it is of interest to note that an ambitious plan is on foot in the United States to review and assess critically data for chemical compounds generally on the lines of the American Petroleum Institute's Research Project 44, dealing with hydrocarbons.

In this "Dictionary", alternative data which cannot be rejected forthwith are usually placed in brackets. For many hydrocarbons, work by the petroleum interests, both in Britain and in the United States, has reached the stage where some of such values can be discarded. For other types of compounds, there is also some room for improvement. Since 1930, there have been recorded several sets of values for density and refractive index of cyclohexylamine, reasonably concordant among themselves, but very appreciably different from those quoted. Again, There are several records of these two properties for di-*n*-butyl ether and *n*-butyl propionate, for both of which density at 0° C. alone is given, that for the latter compound dating from 1886. The preferred melting point for *m*-hydroxybenzaldehyde is evidently that of Jowett (1900), who later identified his product as *p*-hydroxyacetophenone; there is ample corroboration of the bracketed value.

Generous use of cross-references avoids duplication of entries with corresponding danger of discrepancies. This has, however, occurred with some of the sulpha drugs and their acetyl derivatives; some of these are also listed as the *p*-aminobenzenesulphonyl derivatives of the heterocyclic amines with melting points which differ by up to 8 deg. C.

A particular feature is the inclusion of a large number of organic compounds of natural origin; but asarinin, stevioside (of interest for its sweet taste) and dihydronorguaiaretic acid (NDGA) are three uch products which appear to have escaped the net. Di*tert*-amyl peroxide is listed (under A, contrary o the declared naming of 'double' derivatives) but not the commercially important *tert*-butyl compound.

These various observations must not be taken to mply that the "Dictionary" is bristling with inaccuracies and omissions. They merely show that the editors of books of this kind can never sit back with the comfortable feeling that their work is completely satisfactory; there is always some dusting and polishing to be done. The reviewer will continue to use the "Dictionary", as a first source of information about compounds, except those newly described, with the assurance that, more frequently than not, the search will not be in vain. B. A. ELLIS

LINEAR OPERATORS

Linear Analysis

Measure and Integral, Banach and Hilbert Space, Linear Integral Equations. By Prof. Adriaan Cornelis Zaanen. (Bibliotheca Mathematica: a Series of Monographs on Pure and Applied Mathematics. Volume 2.) Pp. vii+602. (Amsterdam: North-Holland Publishing Company; New York: Interscience Publishers, Inc., 1953.) 38 florins; 76*s*.

Linear Operators

Spectral Theory and Some Other Applications. By Dr. Richard G. Cooke. Pp. xii+454. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1953.) 52*s*. 6*d*. net.

THE general theory of linear operators is mainly a creation of the present century; it originated in the work of Hilbert and Riesz on the theory of integral equations and its extensions, and assumed its modern abstract form in the 1920's in the hands of Banach, von Neumann and Stone. The past twenty-five years have witnessed its growth into the wide-ranging subject known to-day as functional analysis, which may be described as the application of the methods of topological algebra to problems in the theory of functions.

Each of these two books is concerned with certain aspects of this now enormous field. They have a small amount of basic material in common; but their aims are very different. Prof. A. C. Zaanen is mainly interested in topics related to the classical theory of linear integral equations, whereas Dr. R. G. Cooke's principal aim is to acquaint his readers with the spectral theory of self-adjoint linear operators in Hilbert space.

Prof. Zaanen's book begins with an account of the Lebesgue integral on a general measure space, and continues with a detailed discussion, not only of the L_p spaces but also of the less familiar Orlicz spaces. We next find a description of the structure of Banach spaces and Hilbert space, and an outline of the theory of bounded linear operators, including the Banach–Steinhaus theorem and the closed graph theorem. In order to avoid using the axiom of choice, Prof. Zaanen does not prove the Hahn–Banach theorem on the existence of linear functionals in its most general form, but he shows that it can often be dispensed with; for example, the whole Riesz–Schauder theory of compact (or completely continuous) linear operators is obtained without appealing to it. The Dunford spectral theory is outlined; but there is no account of the spectral theory of general self-adjoint operators in Hilbert space. The applications of the Riesz–Schauder theory to integral equations receive very thorough treatment, the Fredholm theory is extended to a wider class of integral operators than usual (those that are completely of finite double norm), and a very detailed discussion is given of various classes of symmetrizable integral operators.

The book is too long and detailed to be suitable as a first introduction to the subject; but it will be an indispensable work of reference for these aspects of functional analysis. Particularly welcome are the numerous illustrative examples, to most of which are attached either hints for solution or references to the original literature.

Dr. Cooke's book is a successor to his "Infinite Matrices and Sequence Spaces", published in 1950. The first five chapters contain an introduction to Hilbert space and its applications in quantum mechanics, and a very full account of the spectral theorem for hypermaximal (or self-adjoint) linear operators, both bounded and unbounded. A number of the known proofs of the theorem are given in detail. The remaining two chapters deal with topics having little direct connexion with the first part of the book. Chapter 6, on projective convergence in matrix spaces and rings, is a pendant to the author's earlier book, and describes some recent investigations on linear operators in sequence spaces. Chapter 7 is on Banach algebras; it contains a useful account of the Gelfand representation of a commutative Banach algebra by functions on the space of maximal ideals, and its applications to the proof of Wiener's theorem on the closure of translations and his Tauberian theorem. Other topics included are the spectacular and powerful Weierstrass–Stone theorem on uniform approximation to continuous functions, the theory of Radon measures, defined as linear functionals on a class of continuous functions, and an application of the theory of Banach algebras with an involution to the proof of Bochner's theorem on positive definite functions.

Much of the material in this book has hitherto been scattered in the periodical literature, some of it being available only in Russian, and the author has performed a useful service in collecting it together. Dr. Cooke writes as an analyst for analysts; the emphasis throughout is on analytic techniques and applications, and the algebraic structures tend to remain in the background. F. SMITHIES

British Journal of Applied Physics

Edited by Dr. H. R. Lang. Vol. 4, 1953, and Supplement No. 2: "Static Electrification"—a Symposium held by the Institute of Physics in London on 25, 26 and 27 March, 1953. Pp. vi+391+(supplement iv+104). (London: Institute of Physics, 1953.) £5 11*s*.

Vol. 4 of the *Journal of Applied Physics*, the monthly journal of the Institute of Physics, is the bound volume for 1953 and contains fifteen special articles and reports, three conference reports and sixty-five original contributions, in addition to a supplement in which are reprinted the proceedings of a conference on static electrification held at Bedford College, London, during March 25–27, 1953. In the three conference reports the proceedings are summarized of the conference on electron microscopy in Bristol during September 1952, the fortieth anniversary celebrations of the discovery of X-ray diffraction in London during October 1952 and the conference on the optical and electron-microscopical properties of textile fibres in Manchester during October 1952. The special articles include the address of Sir John Cockcroft, given at the Bournemouth convention of the Institute on May 29, 1953, dealing with recent advances in nuclear physics; the application of digital computing techniques to physics, by R. A. Brooker; recent developments in magnets and magnetism, by Prof. W. Sucksmith; scientific applications of high-speed rotation, by Prof. P. B. Moon; and scintillation counting and its medical applications, by Prof. W. V. Mayneord.

The supplement on static electrification, after a brief foreword by N. Clarke, the deputy secretary of the Institute and conference secretary, contains the opening address, delivered by Prof. F. A. Vick, in which a brief but clear outline of the theory of contact electrification is given. This is followed by twenty-three papers, with discussions, which are grouped under the four headings of general principles, and useful applications, of generation and dissipation of static electricity, electrostatic machines and harmful static electrification.

The editor and advisory committee must again be congratulated for the excellence of production of Vol. 4 and for the high general standard they maintain in the *Journal*.

A Text-Book of Metallurgy

By A. R. Bailey. Pp. viii+560. (London: Macmillan and Co., Ltd., 1954.) 30*s*. net.

In these days any attempt to write a general text-book on an applied science such as metallurgy is fraught with difficulties arising primarily from the continued rapid expansion of the technology and the further elucidation of the underlying scientific principles. In this case the author has succeeded in producing a very readable survey of most branches of metallurgy without neglecting many recent important developments.

The book falls broadly into three sections—physical metallurgy; ore dressing and metal extraction; fabrication and testing—which are encompassed in just over five hundred pages of text, so it is obvious that most subjects are considered only at an elementary level. Nevertheless, the treatment of the subject-matter is balanced and provides for the first-year degree student a general vista of the subject which is so desirable before he proceeds to more advanced studies. The book's role as a stepping-stone is enhanced by the excellent additional reading lists at the end of each chapter, which are thoroughly u to date. The illustrations are profuse and of goo quality; Fig. 274 is unfortunately upside down, s that the liquid metal apparently defies gravity. Th examination questions set by various examining bodie are a useful ancillary. The book is a commendabl addition to metallurgical literature and deserves to b read by many students. R. W. K. Honeycombe

Cathodic Protection of Pipelines and Storage Tank

By V. A. Pritula. Pp. vi+160. (London: H.M.S.O 1953.) 10*s*. net.

This book is a translation from the Russian, it publication being arranged by the Departmen of Scientific and Industrial Research, which recommends it as a practical manual and a text-book o the subject of cathodic protection of pipelines an storage tanks. It was originally published in 1950 by th Chief Petroleum Marketing Organization of the Russia Ministry of the Petroleum Industry and appeared in series of petroleum and mined-fuel literature.

The purpose of the book is to describe the investigation of the problems of electrical protection o metallic pipelines and storage tanks against underground corrosion. The various types of corrosion ar specified, and the fundamentals of the new method o cathodic protection are outlined. The basic principl is to protect the entire surface of the equipmen cathodically by connecting it to a source of d.c potential and forming an electric circuit the anod of which is a specially earthed electrode which becomes corroded during the process. The anode i usually made of scrap metal.

Full details of the investigation, design and operating conditions for the practical use of cathodic protection, together with explanatory circuits and diagrams and much numerical data, are given in the twelve chapters and two appendixes in the volume. The bibliography refers only to what appear to be Russian periodicals.

Theory of Superconductivity

By M. von Laue. (Translated by Lothar Meyer and William Band.) Pp. x+140. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 4 dollars.

The title of this book is somewhat misleading, since it is not so much a general account of the phenomenon of superconductivity as a comprehensive development of the ideas, originally due to F. and H. London, concerning the nature of the equations governing the supercurrent. In view of the very slender experimental evidence in support of the exact form of the London equations, it may perhaps be questioned whether it is in the best interest of the subject to regard them with such confidence in their correctness as Prof. M. von Laue displays. If they eventually are shown to be correct, he will undoubtedly have performed a valuable service in investigating so fully their mathematical and physical consequences; but there is a genuine danger that his authority, and that of other theoreticians, will serve to stifle the critical experimental investigation which this branch of the subject urgently demands, and cause the London equations to be treated with more respect than any tentative theory deserves. It is, no doubt, an advantage to English-speaking readers to have this book available in translation; but since its main interest lies in the mathematics, it cannot be supposed that the advantage is very great. A. B. Pippard

THE PHYSICS OF THE SOLID STATE

FOLLOWING the meeting of the General Assembly of the International Union of Physics in London in July, a number of scientific meetings were held to take advantage of the presence in Great Britain of the delegates to the Assembly from overseas. Of these, two were about the physics of the solid state; one at Bristol sponsored by the Union and with an attendance of about three hundred and fifty had as its subject "Defects in Crystalline Solids", and one directly afterwards in the Department of Metallurgy of the University of Birmingham was on the "Mechanical Effects of Dislocations in Crystals".

The idea of the Bristol Conference was to include two subjects which at first sight appear widely separated, but which are becoming more closely related. The first of these subjects was dislocations in their more chemical aspects. It was desired, for example, to discuss their relation to vacant lattice sites and to diffusion; their role in crystal growth and in accelerating precipitation and also their influence on semi-conductors. But questions concerned with their movement and with the mechanism of the formation of slip bands were reserved for the Birmingham Conference. The second subject was the use of electron and nuclear spin resonance in the investigation of defects in solids. On this subject an impressive series of papers was given by Kittel, Kip, Bloembergen, Slichter and others from the United States and also by representatives from Great Britain.

In addition to the X-ray camera, the optical and electron microscopes, radioactive tracers and all the other techniques used in this field, microwaves have quite suddenly, in the past two or three years, become a tool of major importance. Thus, for example, the electric quadrupole moment of the nucleus makes it possible in suitable cases to determine the value of the gradient of the electric field (dE/dx) at any lattice point where the nucleus is situated. In a pure crystalline substance of cubic symmetry this is, of course, zero, but not in an alloy. Dr. Bloembergen, of Harvard, outlined how in dilute solutions of zinc in copper it is possible to evaluate the contribution to dE/dx separately from the nearest, the next nearest neighbours and so on. Such measurements promise to be of the greatest importance for understanding the forces between atoms in alloys. It has also been possible to measure the density of dislocations in cold-worked substances by their effect on the breadth of the resonance line.

Another important effect is that described by Slichter; the broadening of the magnetic resonance line due to a nuclear spin is much reduced if the atom changes its position in a time small compared with the period of the radiation used. This is because the broadening is mainly due to the interaction with the spins of neighbouring nuclei; and it is, so to speak, averaged out by the movement of the nucleus from one lattice point to another. By this method it has proved possible to measure coefficients of self-diffusion in solids without the help of radioactive isotopes, and results were quoted for the alkali metals.

With regard to the rest of the Conference, there were many papers on the effect of irradiation by fast neutrons and other fast particles, and their effect in producing defects such as F-centres. Prof. R. Hilsch, from Göttingen, spoke on the occurrence of a high concentration of defects in metallic and non-metallic films evaporated at the temperature of liquid helium, and the surprising amount of recovery which takes place when the temperature is raised to that of liquid hydrogen. There was much discussion of networks of dislocations in solids, which can be made visible by the formation of various types of precipitate along them. In fact, the role of dislocations in accelerating precipitation seems firmly established, though the exact mechanism by which it does so is less clear. They apparently act as centres for the nucleation of precipitates.

But perhaps one of the most important properties of dislocations which has recently been brought to light is the ease with which foreign atoms can move along them. As explained by Prof. R. Smoluchowski (Pittsburgh) and by Turnbull (General Electric Schenectady), the activation energy for diffusion along a dislocation is the same as that for diffusion in a grain boundary at which there is a large change in the orientation of the crystal planes. Boundaries at which the change of orientation is small can, as is well known, be analysed into rows of dislocations, and for these the rate of diffusion of radioactive isotopes or of impurities depends on the direction. Thus for a boundary which consists of a row of edge dislocations, the diffusion is fast in the direction in which they lie, and slow when they have to move from one dislocation to another.

It is clear that the ease with which foreign atoms diffuse along grain boundaries and dislocations, which can at the same time move about, plays a large part in allowing precipitation and age-hardening at temperatures at which normal volume diffusion would not be possible. Dr. J. H. Hollomon suggested that the formation in aluminium–copper alloys of the plates of mono-molecular thickness known as Preston–Guinier zones is due to dislocations moving through the grains and sweeping up the copper, which quickly diffuses along the dislocation to be left behind in one of these plates. Since most energy is released by this process when the plates form on the (100) planes, this is the direction in which the dislocations move.

On the subject of crystal growth, Hollomon showed a film of the growth of cadmium iodide crystals suggesting that in the early stages these crystals might well grow without the help of screw dislocations, but that the dislocations on which the well-known spirals are centred are formed when two crystals the orientations of which do not quite fit join together. Dr. J. W. Mitchell (Bristol), who was responsible for the scientific and social organization of the Conference, showed a series of slides which demonstrated that silver halide grains in emulsions owe their triangular or hexagonal shape with the (111) faces exposed to a particularly stable arrangement of three dislocations meeting in a point and lying parallel to the flat surfaces of the crystal.

The papers given at this Conference will be published by the Physical Society.

Turning now to the Conference at Birmingham, organized by Prof. A. H. Cottrell, this dealt in the main with the mechanism of work-hardening and formation of slip lines, and with the production of vacant lattice sites by moving dislocations. There seems now to be a fair amount of agreement about many features of this process. For example, it is generally assumed that slip has its origin in Frank–Read sources; it is not now believed that the speed of moving dislocations is great enough for important dynamic effects to occur involving the kinetic energy of a dislocation, and Dr. J. D. Eshelby (Birmingham) presented a new paper on this point. Everyone was agreed on the importance of the fine slip lines (about 10 μ long and around 100 A. high) first observed on many metals by Wilsdorf (Pretoria), and that one of the main mechanisms of work-hardening is the elastic interaction between the dislocations which produce this fine slip; this is very much as envisaged in the paper which G. I. Taylor published in 1934. There was much less agreement on the cause of the slip bands which can be seen under the optical microscope and which are much longer. The case of alpha-brass, however, is particularly instructive, and was discussed by Dr. J. C. Fisher (General Electric, Schenectady). Here no fine slip was observed by Wilsdorf, and single crystals of this alloy show very little hardening, at least so long as slip is confined to one set of planes. This shows that the dislocations on neighbouring coarse slip lines are too far away from each other to interact strongly. Fisher's explanation of the absence of fine slip and the conspicuous coarse slip in this alloy is that there is a certain amount of short-range order, which has to be destroyed over a plane when a dislocation moves across it and which therefore hinders its motion. Once a dislocation has moved along a plane, however, others from the same source can follow it under the influence of a much lower stress.

Another mechanism of hardening and also of resistance to flow in annealed metals is the work which must be done to push dislocations past screw dislocations which cut the slip plane. When this occurs, a 'jog' is produced in a dislocation line, and this has a certain energy. This mechanism of resistance to flow is expected, like the resistance due to locking by impurities, to show a strong dependence on temperature; that due to the elastic interaction of dislocations (G. I. Taylor's mechanism) is not. Cottrell showed some curves giving as a function of temperature σ/G for copper work-hardened at the temperature of liquid air; σ is here the flow stress and G is Young's modulus. This quotient except between 200° and 270° K., is quite independent of the temperature. In this narrow range, however, there is a rapid slope, and Cottrell assumes that here only is this cutting mechanism, which he calls the effect of the 'forest', the one that determines the strength. He also determines from the behaviour in this range the energy of a jog; for copper it is about 4 eV.

It was particularly emphasized by Seeger (Stuttgart) that the jog energy in aluminium is much lower, perhaps 0·5 volt. This is because in face-centred cubic lattices the dislocations split into two half dislocations separated by a stacking fault. At a jog the two halves must be brought together again, and the energy required to do this is the greatest part of the energy of a jog. Now it is characteristic of monovalent metals that the energy of a stacking fault, as of a twin boundary, is very low; there is no contribution from interaction between nearest neighbours, and little from the electrons at the surface of the Fermi distribution due to the fault in the reflecting planes. Therefore the separation between the halves of the dislocation is large, and the work required to bring them together is large too. For zinc and aluminium it is much less, thus providing rather convincing evidence that the behaviour of electrons near the boundary of a Brillouin zone does provide a sort of long-range force between atoms that are not nearest neighbours.

According to Seeger, many of the differences between aluminium and copper are to be associated with this large difference in the energy of a jog Mechanical recovery and polygonization are believed to be dependent on the process known as 'climb'. when a dislocation gives off or absorbs vacancies But it can only do this at jogs, and so, if the log energy is low, climb and recovery without recrystallization can take place at low temperatures, as is the case for aluminium.

Dr. P. L. Pratt (Birmingham) and Dr. J. C. Fisher (General Electric Company, U.S.A.) emphasized that the dislocation forest is responsible for one kind of 'river line' marking observed on cleaved crystal faces. New river lines begin at places where the advancing crack crosses a region of localized plastic deformation or a low-angle boundary. A crack must develop a step whenever it cuts through a screw dislocation, and elementary river lines thus produced run together to form large steps. The cleavage stress is increased due to the extra surface exposed on these steps. Dr. Fisher mentioned an interesting consequence of this effect. The surface area associated with the river lines increases as r^3, where r is the radius of a radially expanding crack, and not as r^2. This upsets the Griffith criterion for a critical crack size. Previous treatments have deduced a critical size by balancing an r^3 elastic energy term against an r^2 surface energy term; but in circumstances where the above r^3 surface term predominates over the r^3 one, there will not be a critical crack size, and cracks of all sizes will grow at the same critical stress.

N. F. Mott

INTERNATIONAL UNION OF CRYSTALLOGRAPHY

THIRD CONGRESS

THE Third Congress of the International Union of Crystallography was held in Paris, at the Sorbonne, during July 21–30 and was attended by more than seven hundred members, representing some twenty different countries, including, it is gratifying to report, the U.S.S.R. This large membership raised several problems, particularly concerning the number of papers offered; these numbered about six hundred and were divided into groups of about ten, which were presented in seven parallel sessions. Since this system would normally give opportunity to members to attend only those sessions in which they were particularly interested, several survey papers were offered in addition. In this way, members were able to keep in touch with progress outside their own particular specialities. Aid in the choice of sessions was given by an 84-page booklet containing résumés of all the papers to be read.

It is naturally impossible, in this account, to deal with the whole of the Congress. Even had it been physically possible for a single person to be present at all the sessions, he could not have been expected to cope adequately with all the mathematics, physics, chemistry, mineralogy, metallurgy, biology and crystallography that would have been presented to him. The study of crystals is affecting intimately developments in many subjects; but in this article the writer will attempt only to direct attention to what seem to him to be the main lines of advance in the study of the solid state. A large number of papers were concerned with the details of crystal structures; these obviously will have to be ignored.

Crystal-structure Determination

The theory of methods of crystal-structure determination is at an interesting stage. At one time it was thought that, since the relative phases of the scattered beams could not be determined experimentally, it was impossible to devise a direct method of producing an image of a crystal structure. About six years ago, it was shown by D. Harker and J. S. Kasper, of General Electric, U.S.A., that the absence of negative electron density imposes certain conditions which, in some problems, enables the phases to be determined directly. This approach has led to many new ideas, and there is some possibility, according to J. Karle and H. Hauptmann, of the Naval Research Department, Washington, D.C., that a direct solution of *all* centrosymmetrical problems is possible. This view has been challenged by V. Vand and R. Pepinsky, of the Pennsylvania State University, and by M. M. Woolfson and W. Cochran, of Cambridge. It will be interesting to look back in a few years time to see how the subject has developed.

Meanwhile, although direct methods have produced several new structures, the main advances have been made rather by standard methods—Patterson synthesis, isomorphous replacement and 'heavy' atoms. Mrs. D. Hodgkin, of Oxford, described a partial solution of the structure of vitamin B_{12}; the molecule contains about a hundred atoms, almost three times as many as the most complicated molecule that has yet been dealt with successfully. Similar methods combined with the Fourier-transform concept have also enabled Sir Lawrence Bragg and M. F. Perutz, of Cambridge, to report some success with hæmoglobin, the molecule of which contains about ten thousand atoms. Unfortunately, the Fourier projection obtained, having a resolution of only 4 A., is not particularly clear, and some intense study will be required before any reliable deductions can be made from it.

This work illustrates the difficulty of studying such compounds by X-ray diffraction. There is still much rather subjective argument, and more evidence of the Bragg–Perutz type is needed to decide between the individual opinions concerning the nature of the protein structure.

Fine Detail of Structures

As experimental methods have improved, it has been found possible to distinguish more detail in the images of crystal structures. J. M. Robertson, of Glasgow, first showed that hydrogen atoms in organic crystals could be detected, and the difference synthesis of W. Cochran put this work on a sounder footing. Anisotropy of heat motion can also be measured, and further progress should enable electron distribution in bonds to be detected.

Methods other than X-ray diffraction can be used for detecting hydrogen atoms. Electron diffraction has provided some promising results, particularly in the hands of Z. G. Pinsker, of the U.S.S.R.

Low-temperature Studies

Room temperature is rather an arbitrary level at which to take X-ray photographs, and several different laboratories are working intensively on apparatus for cooling crystals to low temperatures. There are several reasons for this work: first, one can investigate compounds which are liquid at room temperature; secondly, there are many phase transitions below room temperature; thirdly, greater accuracy of co-ordinates can be obtained when heat motion is reduced; and finally, more detail for determining crystal structures can be obtained (although this may be regarded as a mixed blessing !). I. Fankuchen, of Brooklyn, gave a summary of methods that have been devised for taking photographs of crystals at liquid-nitrogen temperature. So far, most work has been concerned with the first two headings, but there is promise that the other two will also be developed.

Methods of Computation

Much of the work so far dealt with requires extensive calculations. Punched-card machines have been greatly used; but the greatest development since the last Congress has been in the use of electronic digital computors. In Britain, the most important machines are at Manchester and Cambridge, and work on these machines was reported by D. W. J. Cruickshank, of Leeds, and A. S. Douglas, of Cambridge. The former was chiefly concerned with the determination of fine structural detail, and the latter with direct methods of structure determination.

Diffractometers

As more complicated crystals are tackled, the mere process of amassing the diffraction data becomes formidable, particularly now that three-dimensional methods are so much used. Photographic methods can barely cope with the problem, and Geiger counters, coupled to recording apparatus, are becoming increasingly popular. Much ingenuity has been applied to this work, and it is to be hoped that soon some standard form of apparatus will be produced; at present there seems to be a gap between the people devising such apparatus and those who are working out complicated structures.

Neutron Diffraction

Despite the smallness of the number of atomic piles, the results of neutron diffraction are increasing rapidly. Having the experience of X-ray diffraction as a background, the workers in this field have made great progress, both in supplementing X-ray work in, for example, the investigation of superlattices and the detection of hydrogen atoms, and in discovering new phenomena such as antiferromagnetic structures, which cannot be found by X-rays. Most work has been done on powders, but a promising start has been made on single crystals; such crystals have still to be rather large, but it seems likely that rapid progress in the use of much smaller crystals will be made in the future. An instructive account of recent work was given by H. A. Levy, of Oak Ridge.

Crystal Growth

Emphasis on the crystalline state has stimulated work on the way in which crystals grow. F. C. Frank, of Bristol, presented an entertaining film showing the development of spiral growths in crystals. Many such examples are known, and in some quarters the process is believed to be a general one; there are, however, still some people who believe that it occurs for a few crystals only.

Crystal Imperfections

The existence of growth spirals implies that crystals containing them are imperfect, and indeed it has been known for a long time that perfect crystals would not diffract X-rays in the ways observed. The study of imperfections by means of X-ray diffraction is, however, difficult; it depends upon secondary effects not easy to interpret. B. E. Warren, of Massachusetts Institute of Technology, gave a general account of the investigation of one type of imperfection—order–disorder changes in alloys. These changes may be regarded as producing an imperfection based upon a perfect lattice and so should be easier to consider than imperfections of the lattice itself; much theoretical and experimental work has been done, but Warren maintained that the physical interpretation of the results is still obscure.

The conference gave a general picture of the consolidation of existing methods and rapid development of new ones. There seems to be a thriving future for the subject of crystallography, applied to many different branches of science. Much ingenious apparatus was shown in the accompanying exhibition.

In some ways, however, regret must be felt for the departure of the days when an individual worker could make an X-ray tube, construct a simple diffractometer, buy a set of Fourier strips, and produce contributions of real value to the subject. Nowadays, he appears to need an electronic computor, or at least a punched-card machine, some complicated diffractometers and a Geiger-counter outfit. The only steps in the opposite direction seem to be those which make use of optical analogies, introduced by G. von Eller in Paris and by the writer in Manchester. Crystallography will take its own course; but it will be a pity if it follows nuclear physics as a subject which can be studied only at centres large enough for complicated and expensive apparatus to be available.

A Congress of these dimensions could not have been easy to organize. It would have been better if there had been fewer papers; but granted the necessity for accepting all the papers offered, the organizers are to be congratulated on a most successful outcome of their efforts.

H. Lipson

OBITUARIES

Sir Lewis Fermor, O.B.E., F.R.S.

The death of Sir Lewis Leigh Fermor on May 24 removes one of the most distinguished geologists who have worked in India during the present century, and his passing at a time when there was still much for him to do is a severe loss to Indian geology.

Fermor was born in London on September 18, 1880. He was educated at Wilson's Grammar School, Camberwell, and was awarded a National Scholarship to the Royal College of Science in 1898. Hoping to secure a post at the Royal Mint, he took his A.R.S.M. in metallurgy. However, at the invitation of Prof. J. W. Judd, he became a student assistant in geology while working for his B.Sc., and it was Judd who persuaded him to apply for one of three vacancies in the Geological Survey of India before he had completed his B.Sc. course. He was duly appointed in 1902, along with G. E. Pilgrim and J. M. Maclaren and thus went to India primarily as a trained metallurgist, a fact that undoubtedly influenced the course of his geological work in India.

Soon after his appointment to the Survey, Fermor was deputed by Sir Thomas Holland to report on the manganese ore deposits of the country. Holland never anticipated that the investigation would be so detailed or so prolonged. But the resulting memoir was not published until 1909, and it extended to 1,294 pages. It was by this monumental work that Fermor became best known outside India. It included not only a detailed account of all the deposits, with a discussion on their mode of origin, but also important observations on the methods of mining, in which the pitch of the folded rocks was shown to be an important controlling factor. The field-work had also brought to light six new manganese minerals: hollandite, blanfordite, winchite, vredenbergite, sitaparite and juddite, while a seventh mineral, fermorite, was afterwards named after him.

On the completion of this work, Fermor was placed in charge of a party deputed to carry out a systematic survey of the Archæan rocks of the Central Provinces, and he himself surveyed a tract of country between Nagpur and Chhindwara, mapping the rocks in a more detailed manner than had ever before been attempted. The work was interrupted by the First World War, when his services were first lent to the Railway Board in connexion with the exploration of the Bokaro–Ramgarh coalfields, and later placed at the disposal of the Indian Munitions Board. In recognition of this work he was made an O.B.E. in 1919. After the War, work in the Central Provinces was resumed, and Fermor's own portion was completed in 1926. Unfortunately, administrative and other duties prevented the publication of this fine piece of work, though a summary of it was given in his later memoir on the correlation of the Archæan rocks of India.

Work of economic importance that Fermor accomplished during the same period included examination of the Singhbhum and Sikkim copper deposits, the iron ores of Ratnagiri and Goa, the Korea coalfield, the chromite deposits of Baluchistan and Singhbhum, and mica in Ajmer and Orissa.

In 1913 he had published a paper on "Garnet as a Geological Barometer". This was the starting point of a theme that was to recur more than once in his writings; for it led him to the conception of an infra-plutonic zone in the earth's crust composed of eclogite, which he considered to be responsible for the explosive nature of deep-focus earthquakes by the exothermic change of garnet to less dense minerals, for isostatic adjustments in the earth's crust, and for the high fluidity of the lavas of fissure eruptions. He also believed that the chondrules of stony meteorites had once been garnets. His views on these matters were elaborated in a series of lectures that he delivered to the Indian Association for the Cultivation of Science as Ripon professor for 1937, entitled "The Role of Garnet in Nature".

Before he retired from India, Fermor began the writing of a memoir that was to be an attempt at correlating the ancient schistose formations of India. After giving a general discussion on the factors to be considered in effecting a correlation, he had planned to give a summarized account of the geology of the eight Archæan provinces into which he divided India and Burma. Of this plan only the general discussion and about a quarter of the account had been published by 1940, and other commitments prevented the completion of further sections before his death. Thus a work that would have been of the greatest value to geologists in India has been left largely uncompleted.

In the Geological Survey of India, Fermor was promoted to the grade of superintending geologist at the early age of thirty. Though he first officiated as director in 1922, it was not until 1932 that he was substantively appointed to the post. It was unfortunate for him that his period of office coincided with a period of financial stringency in India. This compelled him to reduce the staff of his Department, and prevented him from planning the work of the Survey as he would have liked. In other directions, however, he was able to render service to India, in particular by the part he played in helping to bring into existence a national scientific academy for the whole of India at a time when conflicting interests were tending to divide scientific India. This was effected by the formation of the National Institute of Sciences of India, of which he became the first president in 1935. During the same year he was president of the Royal Asiatic Society of Bengal, while earlier he had been president of the Mining and Geological Institute of India in 1922, and general president of the Indian Science Congress in 1933. To each of these institutions he delivered original addresses that indicated the wide scope of his outlook. He was elected a Fellow of the Royal Society in 1934 and the honour of knighthood was conferred on him on the eve of his retirement after thirty-three years service.

Though he retired from official service in India in 1935, he continued to play an active part in scientific matters. Perhaps the most important of these was his visit to Malaya in 1938 to report on the mining industry of that country. This report must have proved of the greatest value when the time came to reconstruct the country after the Second World War.

On retiring to Bristol, Fermor took an active part in local scientific life, and became president of the Bristol Naturalists Society in 1945 and 1946. Finally, he was elected president of the Institution of Mining and Metallurgy for the year 1951–52, the subject of his presidential address being "The Mineral Deposits of Gondwanaland".

From the time that he first went to school until he left for India, Fermor's education cost his father little, for both at school and at college, by hard work and ability, he won scholarships that paid for his school and college fees. No doubt it was due to this that he was able throughout his life to apply himself with great concentration to the task in hand, while it may also have been responsible for the relatively spartan life that he led. In later years he mellowed, and the patience and tact that he displayed at the time of the formation of the National Institute of Sciences of India revealed to many a new aspect of his character, and won him many friends.

W. D. West

Dr. Saul Dushman

By the death of Saul Dushman on July 8, the General Electric Company of Schenectady has lost one of a small group of scientists who became world-famous and who established the scientific traditions of the Company's research laboratories—the group which included W. D. Coolidge, Irving Langmuir and W. R. Whitney.

Dushman was born on July 12, 1883, in Rostoff, Russia, and his family migrated to Canada in 1892. They settled in Toronto, and when Saul Dushman left the high school there in 1900 he had the best scholastic record ever achieved in the province of Ontario. This won him the Prince of Wales Scholarship at the University of Toronto, where he obtained his A.B. degree in 1904 and Ph.D. in 1911. Soon afterwards he joined the Research Laboratory of the General Electric Co. and remained on its staff until his retirement thirty-seven years later. He was assistant director from 1928 until 1948.

His early work was on physico-chemical problems; but at the suggestion of Dr. Langmuir he changed over to experimental and theoretical work on thermionic emission, to which branch of physics he soon made important contributions. In 1923 he applied the theory of the vapour-pressure constant for monatomic gases to the derivation of an expression for the constant A_0 of Richardson's equation, which differs only by a factor of ½ from the expression accepted to-day (electrons were not spinning in 1923!). On the experimental side, with various colleagues he determined the thermionic constants for a number of pure metals and also for metals covered with adsorbed layers.

This work led Dushman to take an interest in vacuum physics, an interest which persisted to the end of his life. He wrote a short book on the subject in 1922, upon which many of us were brought up, and in 1949 there appeared his monumental volume of 882 pages on the same subject. Throughout the book Dr. Dushman's wide personal experience in the field is evident, and his early interest in physical chemistry coloured his choice and treatment of various topics—as indeed it did in his work on thermionic emission. The book will long be a memorial to his encyclopædic knowledge of his subject, his enthusiasm and his desire to serve others.

His colleagues in the laboratory remember him also for his deep interest in human beings, his friendliness and, again, his desire to serve. Physicists all over the world will join with them in paying tribute to his memory.

F. A. Vick

Dr. K. T. Compton

Karl Taylor Compton was born on September 14, 1887, in Wooster, Ohio. He received his bachelor's and master's degrees from the College of Wooster, where his father, a Presbyterian clergyman, was dean and professor of theology. Compton spent the first part of his academic life doing research and teaching physics. He was awarded a doctorate at Princeton in 1912 and, after teaching for two years at Reed College, Oregon, returned to Princeton in 1915, where he remained until 1930, becoming chairman of the Department of Physics in 1929. His numerous papers covered a variety of physical topics, including ionization of gases, soft X-rays, spectroscopy in the extreme ultra-violet, fluorescence and dissociation of gases, electric arcs and other types of gas discharge and photoelectricity. His contributions in spectroscopy and thermionic emission were recognized by the award of the Rumford Medal of the American Academy of Arts and Sciences. In 1927 he became chairman of the Division of Physics of the National Academy of Sciences and was elected president of the American Physical Society.

He was a great teacher with a marked ability to inspire young men. To this skill was added a natural humanity and directness which brought forth the best in all who came within his influence. He brought these great personal qualities to the Massachusetts Institute of Technology, which he served as president during 1930–48 and then as chairman of the Corporation. Building on the sound traditions which he found in the schools of engineering and architecture, he added a school of science, greatly developed the graduate school and brought a humane and liberal spirit to its teaching of science, engineering and management.

Compton gave his time and energy freely in government service in capacities too numerous to mention in any detail. He served in the Signal Corps during the First World War and was chairman of the Science Advisory Board (1933–35) appointed by the President of the United States to advise on the better use of science in commerce and government. As a member of the National Defense Research Committee during the Second World War, he was responsible for American radar development. In the early stages of the War he was a member of the Baruch Rubber Survey Committee and at its end was in the Philippines directing the field service of the Office of Scientific Research and Development. His advice was sought after the War on the evaluation of atom bomb tests and other aspects of atomic energy, and he served as chairman of the Research and Development Board of the National Defense Establishment. He was awarded the Medal for Merit in 1946 for his distinguished war-time services.

He served numerous institutions and companies as director or trustee, including the Ford, Rockefeller, Nutrition and Sloan Foundations and the Research Corporation.

Compton's qualities and experience were recognized in Great Britain. He was Pilgrim Trust Lecturer of the Royal Society in 1943, became an honorary Fellow of the Imperial College of Science and Technology in 1949 and received an honorary degree at Cambridge in 1952. He became an honorary C.B.E. in 1948. A few weeks before his recent death he was advising the Parliamentary and Scientific Committee on Technological Education.

Compton received the enthusiastic support of his colleagues in his great achievements at the Massachusetts Institute of Technology. He was in a large measure responsible for the atmosphere of comradeship, vitality and quiet confidence which permeates its staff and student body. His selflessness, his nobility and his true appreciation for others were an inspiration, and his wisdom and stalwart commonsense were sure guides in the growth and changes which he fostered. He understood and did his best to achieve the conditions in which scientific work and learning could flourish. At the same time, he was deeply conscious of the responsibility of scientists and technologists to the community.

The loss of this sturdy, generous and inspiring personality will be felt keenly not only by his friends and his Institute, but also by a world grappling with the many problems posed by modern technology.

W. R. Hawthorne

NEWS and VIEWS

Broadcasting Arrangements for the British Association Meeting at Oxford

The presidential address by Dr. E. D. Adrian to the British Association in Oxford on September 7 will be broadcast in the Home Service and on television. Conferment of honorary degrees on this occasion will also be televised, as well as two important talks by eminent speakers on September 2 and 3 and the service from Christchurch Cathedral on the 5th. A summary will be presented in the Home Service on the 8th. Viewers will first see on September 1 the Convocation in the Sheldonian Theatre at which honorary degrees of doctor of science will be conferred by the vice-chancellor, Sir Maurice Bowra, on Sir Ben Lockspeiser, secretary to the Committee of the Privy Council for Scientific and Industrial Research, Sir John Lennard-Jones, principal of the University College of North Staffordshire, and Sir Harold Spencer Jones, the Astronomer Royal. The proceedings will be explained by Richard Dimbleby. The producer is David Martin. Following this ceremony will come the speeches of welcome from the Vice-Chancellor and the Mayor, and then the presidential address by Dr. E. D. Adrian. The first part only of the address will be televised; but listeners to the Home Service will hear the whole of it.

On September 2, in a talk on "Physics and the Future", viewers will see Prof. P. M. S. Blackett discussing the growing impact of physics on our present-day life, and the following day Prof. C. D. Darlington talking about "Genetics and Man" and dealing with some recent advances and future work in this field. Both talks will have illustrations and demonstrations; they will be introduced by Peter Parker, who will also report for television on each day's activities during the meeting. The producer is George Noorhof. The service in connexion with the meeting on Sunday morning, September 5, at Christchurch Cathedral, will also be televised. There will be three processions: that of the Vice-Chancellor, proctors and beadles, of the Mayor and Corporation, and of the officers of the British Association. The preacher will be Prof. Leonard Hodgson, regius professor of divinity; the First Lesson will be read by Dr. Adrian, and the Second Lesson by the Dean, the Very Rev. John Lowe, who will conduct the service. At the end of the meeting, in a Home Service programme on September 8 called "Scientists in Session", some of those present will give their views and impressions by recordings made in Oxford the previous week.

New Chief Scientist of Ministry of Fuel and Power: Mr. K. T. Spencer, C.B.E.

Mr. K. T. Spencer has been appointed chief scientist of the Ministry of Fuel and Power in succession to Sir Harold Roxbee Cox. Born in 1898, Mr. Spencer served as an officer in the Royal Engineers in the First World War and afterwards graduated at the University of London. He entered the Scientific Civil Service in 1923 and spent twelve years at the Royal Aircraft Establishment, Farnborough, in the branch dealing with problems of aircraft design and safety. In 1935 he was transferred to the Air Ministry in London, and up to the outbreak of war took part in the organization of the research, development, production, and safety certification of civil aircraft of all kinds. He went to the Ministry of Aircraft Production on its creation in 1940, and throughout the War was concerned with the expansion of research and development activities here and in Commonwealth countries. Mr. Spencer was a member of the first Brabazon Committee, whose recommendations shaped the first post-war generation of civil air-liners. Towards the end of the War he was seconded to the Air Registration Board to help them build up the technical organization needed to discharge civil aircraft certification duties delegated to them by the Secretary of State for Air. In 1946 he served for six months as an international Civil servant with the Provisional International Civil Aviation Organization in Montreal, and set up their Airworthiness Section. Later he went to New Zealand with a United Kingdom Civil Aviation Mission, led by Sir Frederick Tymms, invited by the New Zealand Government to advise them on aviation matters. He joined the Ministry of Fuel and Power in 1950 as deputy chief, under Sir Harold Cox, of the Scientific Division that had been set up in 1948.

Bacteriology at Belfast: Prof. G. W. A. Dick

Dr. George W. A. Dick, of the scientific staff of the National Institute for Medical Research, Mill Hill, has been appointed to the chair of bacteriology in The Queen's University of Belfast. Prof. Dick, who is thirty-nine, graduated from the University of Edinburgh in 1938 and gained his M.D. in 1949, when he was awarded a gold medal for his thesis. He served with the Royal Army Medical Corps during the Second World War, mainly in Africa with a mobile bacteriology laboratory, and was promoted to lieutenant-colonel in 1945. Having acquired an interest in viruses and rickettsiæ, Prof. Dick was appointed in 1946 to the staff of the Virus Research Institute, Entebbe, Uganda, and there he made valuable contributions to knowledge of yellow fever and some of the recently isolated African viruses. During 1948–50 he held a Rockefeller Foundation fellowship, working at the Rockefeller Institute, New York, and later in Baltimore, largely on poliomyelitis. He then returned to Entebbe and acted for a time as deputy director before going to England in 1951 to the National Institute for Medical Research, where for almost three years he has been working in the Department of Bacteriology and Virus Research, chiefly on hepatitis. Prof. Dick has published forty papers, almost all on viruses. He has lately been appointed joint secretary of the Medical Research Council's Poliomyelitis Committee.

Olaus Wormius (1588–1654)

Olaus Wormius (Ole Worm), who died at Copenhagen three centuries ago, on August 31, 1654, is an interesting example of the seventeenth-century polyhistor, whose fame and authority were as great in his own country as they were abroad. Of Dutch descent, he was born on May 13, 1588, at Aarhus in Jutland, where his father was burgomaster. He was educated at the Gymnasium in Luneburg, studied theology at Giessen and Marburg, medicine at Strasbourg and at Basle under Caspar Bauhin, and at Padua under Fabricius and Giulio Casserio; after visiting Montpellier and Paris, he took his doctorate at Basle in 1611. Having practised in London for a time, he was appointed professor of Greek and of philosophy at the University of Copenhagen in 1613, and in 1624 succeeded his brother-in-law, Caspar Bartholin Primus, as professor of anatomy and of medicine. Bauhin had inaugurated the Paduan tradition of anatomy at Basle, and Bartholin and Worm took it to Denmark. An able and enthusiastic teacher, Worm was also five times rector of the University of Copenhagen, and physician to King Christian IV. He made no original discoveries in science, though his name was attached by Bartholin to the Wormian bones in the sutures of the skull, which were familiar to the ancients and were also described by Eustachius. Known as the 'father of Danish archæology', Worm compiled six volumes of runic inscriptions, "Monumenta Danica" (1643), and founded a collection of natural history, ethnographic and archæological objects, which after his death passed into the possession of the Cabinet of Curiosities at Copenhagen. His son Willum, professor of medicine in the University, edited the catalogue of the museum in 1655, and he was succeeded in the chair by his son Ole.

Energy Transfer in Hot Gases

The sixth in the series of twelve conferences which were held at the United States National Bureau of Standards during 1951 to mark the fiftieth anniversary of its establishment consisted of a symposium on energy transfer in hot gases and dealt with the problems of radiation from flames and hot gases and the basic and physical mechanisms governing energy transfer in these media. The proceedings of the symposium have now been issued in book form (Circular 523, March 10, 1954; pp. 126. Washington, D.C.: Govt. Printing Office; 1.50 dollars). The contents consist of sixteen scientific papers covering many different aspects. A. G. Gaydon deals with processes of electronic excitation in relation to flame spectra; G. A. Hornbeck and R. C. Herman indicate the importance of using low-temperature, high-intensity sources for the study of polyatomic flame spectra; S. S. Penner, M. Gilbert and D. Weber summarize recent work on high-resolution spectra of hydrocarbon flames in the infra-red between 1 and 2·6 μ using lead sulphide photoconductive cells; and S. S. Penner gives an outline of basic theoretical relations used for calculating the infra-red emissivity of diatomic gases. The present position of the theory of flames, by B. Lewis, is a more general survey of the subject in which fields that require further basic study are indicated. A paper on some reactions of atomic hydrogen in flames, by J. R. Arthur and D. T. A. Townend, is a summary of methods of detecting the presence of atoms in flames and includes a description of some of the experiments conducted at the British Coal Utilization Research Association, Leatherhead. The concluding article in the volume is a brief account by H. K. Sen of an astrophysicist's concept of temperature.

Strength Properties of Plywood

In Bulletin No. 29 of the Forest Products Research Laboratory, Princes Risborough, the strength properties of plywood are considered in "Comparison of 3-Plywoods of a Standard Thickness, Part 1", by W. T. Curry (pp. iv+10; London: H.M.S.O., 1953; 1*s*. 3*d*. net). The methods described in the bulletin are used to determine the bending, tension, compression, shear and impact strength of plywood. The results obtained from tests on twenty-five different species of 3/16-in. three-plywood are included. A comparison of the strength properties of the various species is shown in block diagram form with the names of the twenty-five plywoods used. The results indicate that Canadian birch plywood possesses the greatest shear strength. Those experimented with were species of the genera *Terminalia*, *Catostemma*, *Berlinia*, *Betula*, *Bursera*, *Octomeles*, *Daniellia*, *Cistanthera*, *Aucoumea*, *Ocotea*, *Khaya*, *Afrormosia*, *Protium*, *Sterculia*, *Mimusops*, *Mora*, *Tarrietia*, *Araucaria*, *Calophyllum*, *Pterygota*, *Gonystylus*, *Shorea*, *Parashorea*, *Sterculia* v. *rhinopetala* and *S. oblonga*. It is stated that Part 2 of the bulletin will cover investigations on the effect of the shape and thickness of the veneers used in the construction of plywood upon its strength and it will be issued separately when results are available. The object of the whole investigation is to obtain strength data which will allow the comparison of plywoods made from various species of timber and the derivation of working stresses.

Radioactive Tracers in Plant Nutrition

R. P. Martin and R. Scott Russell have reported on the effect of radiation from phosphorus-32 on the growth and phosphate utilization of barley seedlings maintained in water culture (*J. Exp. Bot.*, 5, 91; 1954). Concentrations of carrier phosphate ranging from less than 0·01 to 31 p.p.m. phosphorus were employed for varying periods. It was observed that between experiments there were wide variations in the nature and extent of the effects of radiation. An increase in the proportion of the absorbed phosphate translocated to the shoots, and the reduction of root weight, were the most consistent symptoms. While severe injury was characterized by a reduction in both growth and phosphate absorption, intermediate levels of phosphorus-32 on occasion caused increases in dry weight, in nutrient absorption, and in the development of lateral meristems. The reduced metabolic activity of root meristems is considered to be the primary effect in the syndrome of radiation injury. Although injury is due to the accumulation of phosphorus-32 in meristematic regions, no close correlation could be shown between its extent and the level of radiation received by the meristems. The inaccuracy of present methods for estimating the levels of radiation to which tissues are exposed has complicated the investigations of this subject. It appears, however, that the injurious level of radiation may vary from less than 10 to more than 40 rep. per day when the treatment period is 5–7 days. If active accumulation of phosphate occurs, the meristems of plant roots may receive this dosage when treated with more than 5 μc. of phosphorus-32 per litre for periods of six days. The authors discuss the extent to which the effects of radiation may complicate the interpretation of the results of plant physiological investigations.

Forestry in Nigeria: Annual Report for 1951–52

The political and administrative changes which are taking place in some of the Colonies of the British Commonwealth are having their inevitable repercussion on the Forest Departments. Nigeria is now divided into three largely self-governing regions, termed Northern, Eastern and Western, which are united under one Central House of Representatives and a Council of Ministers. Thus, as is indicated in the annual report of the Forest Department for 1951–52 (pp. 38. Lagos: Government Printer; London: Crown Agents for the Colonies; 1953; 9*d*. net), the Department becomes a regional matter and, accordingly, it, though nominally still a unit, has been split into three more or less independent sections under a Chief Conservator. At the centre, as the adviser of the central government, is an Inspector-General whose functions are to see that the Regions are carrying out a central policy, to act as a co-ordinator between the Regions, to advise on distribution of staff, for whose discipline, promotion and so forth he is largely responsible and to be the general representative of Nigeria in forestry matters. The present report, written by the Inspector-General, states: "All powers under existing legislation, save for such central concerns as control of exports or the appointment of staff, have been transferred to the Regions". This removal of function from the centre applies to the policy, too, and where the ultimate decision regarding dereservation of any parts of the forest estates was specifically vested in the Governor, it now lies regionally with the Lieutenant-Governor concerned. On the subject of the size of the forest estate, it is pointed out that the "overall percentage falls far short of what the optimum of a Forest Estate in this or any other country should be". The report deals with the forest administration as a whole—the main features of the regional reports. The Forest Research Branch, as also the Forest School, remains under the Inspector-General; the work of the former is becoming increasingly important.

Bird Preservation

The report for 1953 of the International Committee for Bird Preservation directs attention to the fact that the Committee has now been in existence for thirty-one years and gives many examples of the ready co-operation existing between the various national sections; the success of the international conference on oil pollution of the sea, held in London in October last year, is a striking example. In addition to the urgent question of oil pollution the British section has also been engaged in work in connexion with new legislation for the protection of birds. Early in the year a number of complaints were forwarded to the British section concerning a measure it was proposed to bring into force in Cyprus under which the use of bird-lime for catching birds would be permitted. The British section pointed out to the Secretary of State for the Colonies that the practice had been condemned by almost every country in Europe, and its prohibition was contained in the International Convention for the Protection of Birds, which was signed *ad referendum* in Paris in May 1950 by representatives of twelve different countries. The matter was settled satisfactorily.

During the year the Scottish Ornithologists' Club undertook to make an investigation into the effect of herring gulls on other species, and appointed Dr. J. A. Gibson to take charge of this work. This is part of a scheme which was initiated at a meeting in Sweden in 1950 when it was decided to make a yearly survey of the numbers and details of herring gull colonies in the countries bordering the North Sea, with observations of the effects of these birds on other species, and records of the measures taken to control their numbers and the results obtained. Detailed records are being kept in Denmark, Germany and Holland; but the problem is far more difficult in the British Isles. The report also contains further details of the inquiry into status of the wildfowl of Europe.

Museum Techniques

SEVERAL interesting papers are contained in the April issue of *Conservation* (1, No. 3; 1954), the journal of the International Institute for the Conservation of Museum Objects. Mr. W. G. Constable reviews the whole basis of conservation, especially in relation to problems of responsibility and general administration, and deals with the tasks of a curator as distinct from a conservator. An article on the Coronation Chair in Westminster Abbey proves that there have been two distinct decorative treatments, the first one consisting of paint and being in all probability Walter's original scheme. This was replaced at some undocumented date by a second one, richer and more elaborate, transforming the chair into a gilded throne. The radiographs also show the crude repairs of earlier times carried out with nails or screws. Prof. F. C. Thompson and Dr. A. K. Chatterjee write concerning the age-embrittlement of silver coins, and the issue closes with some useful reviews. Curators who also—and indeed should—deal with conservation will find much of interest and help in this new and worth-while publication.

University of London Appointments Board: Report for 1953

THE forty-third annual report of the Appointments Board of the University of London, which covers the year ended December 31, 1953, notes specially, first a decrease in the number of registrations of men in the age-group 21–25 years (probably due to the increasing number who elect for National Service after taking their degree), and second, the doubling of the number of appointments secured by women graduates. Fewer teaching vacancies were notified to the Board; but there is no evidence to support the thesis that an increase in the number of graduates will alleviate the shortage of good teachers in scientific subjects. Although a number of good biologists on the Register are seeking a career in research or scientific work generally with no great prospects of suitable posts, they are unwilling to consider school teaching, although the vacancies are not unattractive. In previous years the greatest demand was for chemists; but during 1953 the main pressure was for engineers, chiefly those with mechanical and electrical training. There is a shortage of civil engineers for municipal work, and the Civil Service still attracts a substantial proportion of the best scientific workers and engineers. Of 617 men and women placed in full-time posts during the year, only four took science teaching posts in secondary schools, twenty taking university appointments, fourteen technical college appointments and twelve full-time tutorships. The Register at December 31, 1953, included 957 names compared with 1,042 on December 31, 1952; of these, 36 held an engineering degree, 50 general degrees in science, and 128 other degrees in science (biology, 39; chemistry, 31; mathematics, 33; and physics, 19).

United States National Museum: Annual Report for 1952–53

THE annual report of the United States National Museum, under the direction of the Smithsonian Institution (pp. vii+98. Washington, D.C.: Government Printing Office, 1953), always provides stimulating and impressive reading, and that for 1953 is no exception. Starting with the recognized two-fold function of a museum to preserve objects for posterity and to enlarge the scope of human knowledge by a critical study of the collections, it continues with the outline of a scheme to modernize the exhibits. The Museum is really three museums in one: a natural history museum dealing with plants, animals and minerals; a museum of anthropology dealing with ancient and modern man and his works; and a museum of national history and technology. The present policy is to interpret this three-fold aspect in a broad, integrated panorama of life. The report then details some of the exhibition work which has already been accomplished towards this lofty goal. A most impressive part of the report is an account of the investigations and researches carried out by individual members of the staff—a clear indication that they have not allowed the factual minutiæ of day-by-day work to dull their imaginations. A total of more than a hundred and fifty papers were published during the year.

Lundy Field Society

THE seventh annual report of the Lundy Field Society describes the year's working as one of consolidation. Much of the work on the non-avian fauna and the flora of Lundy was made up of contributions towards long-term surveys which are not yet complete enough for report. One paper, however, by M. T. Delany, describes his observations on the habitats of the bristle-tail, *Petrobius maritimus*. Within the limits of Lundy, the distributional range of this insect is wide. Providing rocks are available, whether they be slate or granite, capable of offering the appropriate cover, populations of *Petrobius* will survive. The factors, and their differential effects, responsible for the maintenance of the population balance of *Petrobius* in various localities have still to be determined. The other paper describes the observations of A. L. Galliford on the freshwater localities of Lundy; he now reports on the minute waterfleas and wheel animalcules. The report also includes a short summary on the domesticated and semi-domesticated stock which adorn the island.

British Weed Control Conference at Harrogate

THE British Weed Control Conference will be held this year during November 2–4, at the Majestic Hotel, Harrogate, under the presidency of Sir James A. Scott Watson, chief scientific and agricultural adviser to the Ministry of Agriculture and Fisheries. The Conference is being organized by the British Weed Control Council, which is composed of representatives from the Ministry of Agriculture and Fisheries, the Department of Agriculture for Scotland, the Ministry of Agriculture for Northern Ireland, the Agricultural Research Council, the Colonial Office, the Association of British Insecticide Manufacturers, the British Agricultural Contractors Association, the National Association of Corn and Agricultural Merchants and the National Farmers Union. The formal papers will cover the present position of herbicides in British agriculture; cultivation and weed control; chemical weed control in the United States with special reference to horticulture; rotation of weed killers; spraying machinery; economics of commercial applications; legal aspects of spray damage; weed persistence and dispersal; weed dispersal by machinery; the present position concerning the law; the Ministry approval scheme for herbicides; and woody weeds with particular reference to the British Colonies. In addition, reports will be presented by research workers from many sources on new herbicides, mixed herbicides and herbicides plus nutrient or crop-protection agents, total herbicides, mode of action of herbicides, experimental techniques, weed control in horticultural crops, grasses and legumes, and the winter spraying of cereals. Accommodation at the Majestic Hotel must be booked before October 4. A Conference registration fee of £2 10*s*. will be charged which will include a copy of the proceedings. All communications should be addressed to the Conference Treasurer, Mr. W. A. Williams, Association of British Insecticide Manufacturers, Cecil Chambers, 86 Strand, London, W.C.2.

Fourth World Forestry Congress, Dehra Dun

The Fourth World Forestry Congress will be held in Dehra Dun at the Indian Forestry Institute during December 11–22. The occasion will be of noteworthy interest in that this will be the first time that the Congress will have been held outside Europe, and although some aspects of the utilization of tropical timbers have been considered at previous Congresses, this will be the first one at which special emphasis will be laid on tropical forestry. The discussion on tropical sylviculture will also include the control of desert areas and problems arising from shifting cultivation in various parts of the tropics. In general, the theme of the Congress will be on the land economy and economic development of the country as a whole. Besides visits to forest areas in India, arrangements have also been made for the delegates to make tours in Pakistan. Further information regarding the Congress can be obtained from the Inspector-General of Forests, Ministry of Agriculture, New Delhi.

The Night Sky in September

Full moon occurs on Sept. 12d. 20h. 19m., U.T., and new moon on Sept. 27d. 00h. 50m. The following conjunctions with the moon take place: Sept. 1d. 15h., Venus 3° N.; Sept. 2d. 14h., Saturn 7° N.; Sept. 7d. 10h., Mars 3° S.; Sept. 21d. 16h., Jupiter 1° N.; Sept. 29d. 08h., Mercury 3° N.; Sept. 30d. 02h., Saturn 7° N.; Sept. 30d. 22h., Venus 1° S. In addition to these conjunctions with the moon, Jupiter is in conjunction with Pollux on Sept. 12d. 14h., Jupiter 6·7° S.; Venus is in conjunction with Saturn on Sept. 16d. 03h., Venus 6·1° S.; Mercury is in conjunction with Spica on Sept. 23d. 17h., Mercury 0·6° N. Mercury is too close to the sun throughout September to be seen. Venus is an evening star, setting at 19h. 50m., 19h. 10m. and 18h. 25m. at the beginning, middle and end of the month, respectively. The visible portion of the illuminated disk rapidly decreases from 0·513 to 0·341, but owing to the decrease in the planet's distance from the earth—from 67 to 46 millions of miles—the stellar magnitude increases from $-4\cdot0$ to $-4\cdot2$. Mars, an evening star, sets at 22h. 50m., 22h. 30m. and 22h. 15m. on September 1, 15 and 30, respectively: the planet's fairly large declination south—about 26°—renders it rather unfavourable for observation in the British Isles. Jupiter rises at 0h. 50m., 0h. 10m. and 23h. 25m. at the beginning, middle and end of the month, respectively; its easterly movement in the constellation Gemini is easily seen, and this movement will continue until the middle of November. Saturn sets at 20h. 40m., 19h. 45m. and 18h. 50m. on September 1, 15 and 30, respectively, but in the last case only about an hour after sunset. It is easily recognized in the constellation Virgo and is a little brighter than a first-magnitude star; its easterly movement takes it into the constellation Libra about the middle of the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Sept. 20d. 02h. 59·9m., 36*B* Gemi. (*R*); Sept. 24d. 04h. 29·9m., π Leon. (*R*); *R* refers to reappearance. Autumnal equinox occurs on Sept. 23d. 14h.

Announcements

The first Drummond Fellowship in nutrition has been awarded to Dr. Iain MacIntyre at the Postgraduate Medical School of London. The Drummond Fellowships are endowed from the proceeds of a recent appeal in memory of the late Sir Jack Drummond.

In order to deal with the numerous inquiries that are received for advice on the prevention of corrosion of ferrous metals, the British Iron and Steel Research Association has formed a Corrosion Advice Bureau, which will be at 140 Battersea Park Road, London, S.W.11. Dr. J. C. Hudson has been appointed head of the Bureau, Mr. E. E. White as secretary, and Dr. W. H. J. Vernon as consultant. The services of the Bureau will normally be free to members of the Association, and also available to others on a fee-paying basis.

The jubilee of the application by Sir Ambrose Fleming for the British patent for his thermionic valve will be celebrated by the Institution of Electrical Engineers on November 16, exactly fifty years after the event. The proceedings will be opened by the Lord President of the Council, the Marquess of Salisbury, and three lectures will be delivered, by Sir Edward Appleton, Prof. G. W. O. Howe and Dr. J. Thomson, respectively, dealing with valves from the earliest developments to the present day. There will also be an exhibition of historical apparatus.

The Seventeenth International Congress of Industrial Chemistry will be held in Brussels during September 11–19, this being the fifth time that the Congress has met in Belgium. The Congress will include twenty-nine sections grouped under the following ten main headings: general problems of the chemical industry; fuels; nuclear science; metallurgy; industrial inorganic chemistry; cements, building materials, glassware, ceramics and enamels; industrial organic chemistry; foodstuffs and agricultural industries; Colonial problems; and organization (industrial, commercial and professional). Further information can be obtained either from the Secrétariat du Comité d'Organisation, XXVIIème Congrès International de Chimie Industrielle, 32 Rue Joseph II, Brussels, or from the Commission permanente d'Organisation des Congrès de Chimie Industrielle, 28 Rue Saint Dominique, Paris 7ᵉ.

W. Watson and Sons, Ltd. (313 High Holborn, London, W.C.1), makers of microscopes, optical and scientific instruments, are holding an exhibition on "The Microscope in Industry and Research", in Milton Hall, Deansgate, Manchester, during September 20–25 (10.30 a.m.–7.30 p.m.; except September 25, closing at 2 p.m.). Eighteen firms or other organizations are supplying exhibits illustrating the microscope in connexion with various processes.

DEVELOPMENT AND WELFARE IN THE BRITISH COLONIES

REPORT FOR 1953–54

THE schemes detailed in the latest return made under the Colonial Development and Welfare Acts, covering the period April 1, 1953–March 31, 1954[*], bring the total commitments for development and welfare schemes under the Acts to £110,879,335, of which £14,729,660 was for the year in question, and for research schemes to £12,401,606, of which £716,818 was for the year ended March 31, 1954. Of this last-named sum, £249,596 was for agriculture, £205,312 for medicine, £83,226 for social science, £96,923 for insecticides, £22,100 for tsetse and trypanosomiasis, £32,295 for products research, £7,137 for fisheries and £7,059 for economic research. There were no grants for research fellowships.

Of the actual research schemes, much the largest were £123,743 for the establishment of the West African Council for Medical Research, £110,000 for the continuation of research at the East African Veterinary Research Organization, a supplementary £66,984 for the maintenance of the West Indian Institute of Social and Economic Research and £50,000 for the control of malaria in the hyper-endemic area at Taveta-Pare, East Africa. A supplementary £31,330 was provided for the continuation of sugar technology research at the Imperial College of Tropical Agriculture, Trinidad, while the West Indies also received £23,371 for research into the 'unknown' disease of coconuts and Panama disease of bananas, and £14,300 for banana breeding research (both in Jamaica) and a supplementary £2,444 for research into the control of leaf-scald disease of sugar-cane in British Guiana. East Africa received supplementary grants of £18,750 for the preparation of the "Flora of Tropical East Africa" at the Royal Botanic Gardens, Kew, £16,000 for the establishment of a malarial unit and £8,500 for the establishment of a team in Tanganyika for insecticides research on the control of crop pests.

In West Africa £14,780 was provided for the establishment of a fungicide research unit, £12,250 for the maintenance of the West African Institute for Trypanosomiasis Research, £12,290 for the expansion of the Veterinary Research Laboratory, Vom, Nigeria, and £9,850 for a pilot scheme for tsetse reclamation. £16,022 was provided for an investigation into the control of filariasis in Fiji by insecticidal methods, and £6,975 for the establishment of the Fisheries Research Unit at the University of Hong Kong. In south-east Asia the Federation of Malaya received £14,915 for research on virus and other diseases transmissible from animals to men and £9,334 for the establishment of a Timber Research Station, and North Borneo £9,784 for an investigation of the diseases of the manila hemp plant. A general grant of £13,525 was for the establishment of a pool of Colonial soil surveyors.

Grants of particular scientific interest for development and welfare schemes include the following: £182,101 for the Desert Locust Control campaign in East Africa; £37,000 for the establishment of the agricultural and veterinary training centre at Lilongwe, Nyasaland; £22,300 for the development of medical and health services in Gambia; £474,600 for land planning and soil conservation in the Northern Territories of the Gold Coast; £162,030 for the control of leprosy in Nigeria, for which £181,335 is also provided for a scheme in the Development Plan towards which a supplementary £2,583,551 was granted. Out of that sum, supplementary schemes for agriculture received £273,417, for technical education £347,113, and for medical and health £386,679. £100,000 was provided for tsetse control in the northern region of Nigeria, £68,039 for the geological survey of Sierra Leone, while among other grants the University College of the West Indies and its associated teaching hospital received £120,000 for the main building programme; the Nigerian College of Arts, Science and Technology, Ibadan, £124,410 for the construction of student accommodation; the University College of the Gold Coast, £400,000 for the construction of a hall of residence; University College, Ibadan, £51,600 for the development of the permanent site; and Makerere College, £180,000 for the construction of a men's hall of residence, senior staff housing and science laboratory.

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[*] Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies with the Concurrence of the Treasury, in the Period from 1 April, 1953, to 31 March, 1954. (Colonial No. 181.) Pp. 26. (London: H.M. Stationery Office, 1954.) 1s. 3d. net.

PROFESSIONAL, TECHNICAL AND SCIENTIFIC CIVIL SERVANTS

IN evidence submitted to the Royal Commission on the Civil Service, the Institution of Professional Civil Servants claims that the status and standing of professional, technical and scientific Civil servants in relation to the remainder of the Civil Service should more accurately reflect the relations existing between the administrator and the professional man outside the Civil Service and the importance of the professional man in the life of the country as a whole; they should also be such as to encourage young people to take up professional, scientific and technical careers. At present the heads of the various sections of the professional Civil Service are in an unsatisfactory position with respect to each other and especially to the administrative class; the highest professional officer is always a grade lower than his administrative colleague, and this relation, applying right down to the lowest technical grades, is a factor in diminishing the attractiveness of such careers.

After referring to Lord Cherwell's statement for the Government in 1943, and the representations made in the Barlow Report and by the Parliamentary and Scientific Committee, the Institution urges that the Commission has the opportunity to place science on an equality with administration and that this would constitute a major advance. It suggests that there is complete justification for the claim that the post of deputy chief scientific officer should rank with that of under-secretary in the administrative class; that of senior principal scientific officer should rank with that of assistant secretary, while the senior scientific officer grade should be abolished or combined with that of principal scientific officer to rank with that of principal in the administrative class. The scientific officer grade should rank with that of assistant principal, and a considerable increase in the number of posts in grades above that of principal scientific officer is necessary to make the career open to the scientist sufficiently attractive compared with that open to the administrator.

As regards the works group of professional classes, whose position was reviewed by the Gardiner Committee in 1951, the Institution submits that a wholesale change is necessary to put such professional officers on a basis that reasonably recognizes the degree of responsibility they carry compared with that of the administrative class. It is suggested that the main grade should be equated with the administrative principal, the senior grade with the assistant secretary and the superintending grade with the under-secretary in the administrative class. As regards the experimental officer class, the Institution submits that a broad comparison should be made between the assistant experimental officer and the executive officer, the experimental officer and the higher executive officer, the senior experimental officer and the senior executive officer and between the chief experimental officer and the chief executive officer, with salary scales favouring the experimental officer class in view of the higher standard of qualification, the inferior promotion prospects and the increased responsibilities. For the assistant (scientific) class, the Institution submits that the assistant (scientific) and the senior assistant (scientific) grades should be placed on salary scales sufficiently higher than those of clerical officer and higher clerical officer to be attractive in competition with the careers and salaries available to officers in those grades. It is also submitted that to provide a proper career for technical officers it is imperative to increase the scales of these classes to a basis of parity with the executive class. Other proposals relate to the admission to the appropriate professional scales of those who have obtained professional qualifications after entry to the Civil Service and for the simplification and reduction of the number of salary scales.

BRITISH WELDING RESEARCH ASSOCIATION

THE ninth annual general meeting of the British Welding Research Association was held on July 14 at the Association's Engineering Research Station at Abington, near Cambridge, under the chairmanship of the president, Sir William J. Larke. At the subsequent luncheon, a toast to the Association was proposed by Dr. O. Wansbrough Jones, chief scientist, Ministry of Supply, and acknowledged by Sir Charles S. Lillicrap, chairman of the Council. In his speech, Sir Charles made reference to the annual income, which had reached £113,000 (being an increase of £20,000 over that for the previous year), and also to the new terms of the grant from the Department of Scientific and Industrial Research which had again been agreed for the next two years at the level of £100 for each £100 of membership subscription. Nevertheless, it was pointed out that in order to qualify for this grant after the end of the period, it would be necessary for the annual subscription income to be raised by £10,000 to £50,000. He was sure that this would be possible, if the goodwill of members was secured. Mention was also made of the Association's intention to move the metallurgical researches from London to Abington in the near future. For this purpose a provision of £40,000 has been made for new laboratories, and a housing association has been formed.

During the day an exhibition was staged of metallurgical work in progress, and the engineering laboratories were open to view. The metallurgical work is to be the subject of a separate open day in the autumn, and the examples illustrated were confined to the micro-analysis of hydrogen in metals and weld deposits, and the development of a suitable cracking test for light alloy welds with various parent materials and filler alloys. Associated work has shown the important influence of silicon dilution of the filler alloy by the parent plate, as a cause of cracking in welds made in the heat-treatable aluminium alloy H.10.

In the fatigue laboratory tests were shown in progress on butt welds in heavy sections of steel plate and tube. Various welding methods are being investigated, together with the effect of deliberately introduced faults. An interesting effect of one such fault—lack of penetration—which introduces the equivalent of a sharp notch, is that although the joint fatigue strength is much impaired, the relative scatter of results is reduced to negligible proportions. In another test, conducted co-operatively with the Department of Metallurgy, University of Cambridge, large steel specimens which have been fatigue-tested to destruction have been sub-divided so as to avoid the main fracture faces, for further fatigue tests on a smaller scale. Such specimens have shown no diminution of fatigue life as compared with otherwise identical control specimens taken from the unstressed ends of the larger specimens.

Although the work of Prof. J. F. Baker and others at the Department of Engineering, University of Cambridge, on the plastic design of welded steel frames has reached fruition, in that buildings so designed are giving satisfactory service (including the fatigue laboratory already mentioned), full-scale investigations continue to take place. On an outdoor site a full-scale portal frame was shown which had been loaded to destruction. This particular test convincingly demonstrated that the additional stiffening effect of fully encastered feet could be obtained with simple and economical concrete foundations.

In past years the use of welding has made possible the construction of pressure vessels and pipelines to suit exacting operating conditions in the steam, oil and chemical industries. In such cases the technicalities of welding and design are inseparable, and much attention is paid by the Association to stress analysis, particularly with regard to the reinforcement of openings in pressure vessels, and the behaviour of pipeline components such as bends and branches where expansion movements have to be sustained. Tests on a number of such components were on view. Experiments on the reinforcement of openings were represented by a steam drum for stress analysis containing six nozzle openings, each with a different type of reinforcement; a pulsating pressure test on small vessels of about $0\cdot3$ m.^{3} capacity to determine the efficiency of different types of nozzle weld preparation; and a pressure cell in which a portion of plate 3·0 m. × 2·4 m. containing a manhole opening 60 cm. diameter had been tested under hydrostatic pressure, simulating the loading which would be sustained when present in an oil-storage tank 40 m. in diameter. This test could not be made on a smaller scale since it was necessary to determine the reserve of ductility as well as the stress distribution in the plate containing the manhole.

During the year the resistance welding laboratory has been almost completely re-equipped in order to meet new programmes of work. The main acquisition, through a Mutual Security Aid grant from the United States, has been a Sciaky three-phase spot-welding machine of large capacity for use mainly with light alloys. As a result of previously conducted fundamental work on heat flow, it has been proved possible to calculate optimum and electrical and thermal cycles for spot welds in hardenable steels. Electronic timing equipment has now been installed, so that the work may proceed with examination of complex thermal cycles by means of which individual spot welds may be heat-treated immediately after they are made.

Experience in the welding industry has already shown that the ultrasonic probe is a powerful tool for non-destructive testing, and one which is often more discriminating than radiography. The two methods may best be described as complementary. Nevertheless, the technique for ultrasonic testing is not easily acquired or taught, and the work of the Association is directed towards the choice of the best methods for examining particular designs of welded joints, while using commercially available equipment. Illustrations were on view of the success which has been achieved with quite complex welded joints, including fillets.

In spite of the research effort which has been expended, brittle fracture still takes a certain toll of steel structures fabricated both by welding and riveting. The use of steels with improved notch toughness can undoubtedly reduce the hazard; but the contribution to safety of better methods of fabrication cannot be ignored. In this direction the Association is investigating problems of the mechanics of such fractures. A new galvanometer was shown by means of which it has been possible to measure the surface energy of a propagating fracture by detecting the plastic-flow heat which is evolved. In this string instrument, which is used with thermocouples, extreme sensitivity has been achieved without high electromagnetic damping by using a very small controlling field, and suspending the strings in a deep catenary to secure the minimum tension. The instrument is being used for studying the influence of stored elastic energy from residual welding stresses on the propagation of fractures in notch-brittle steels. For this purpose, since it is impossible to secure complete residual stress systems other than in wide plates, a 600-ton tensile testing rig has recently been constructed and was on view. This rig was designed by Association investigators and donated by a member firm. Calibration of each of the four hydraulic-loading capsules in the rig was carried out in a Baldwin 180-ton universal testing machine which has recently been acquired through Mutual Security Aid funds.

PHYSICAL AND CHEMICAL ASPECTS OF BASIC MECHANISMS IN RADIOBIOLOGY

A VERBATIM report has been prepared on an informal conference of physicists, chemists and biologists held during May 7–9, 1953, at Highland Park, Illinois, to discuss the interaction of radiation and biological systems in its basic aspects[*]. The foreword emphasizes that "There was no attempt to make the discussions comprehensive; but rather topics of current interest were discussed and analysed". There are five main sections. The first two, dealing with the energy transfer from radiation to matter, were introduced by Robert L. Platzman, of Purdue University. The mechanisms of energy degradation and chemical change and effects of secondary electrons were considered in Section 3, which was introduced by John L. Magee, of the University of Notre Dame. Discussion of the effects of electronic excitation in Section 4 was introduced by Henry Linschitz, of Syracuse University. The final section, which is headed as "Summary: Importance of Radiation Chemical Effects in Radiobiology", was introduced by Martin D. Kamen, of Washington University Medical School, and is, in some ways, the most interesting part of the whole proceedings. The list of references to the individual sections are collected at the end of the papers and deal mainly with work published during and since 1950.

The presentation in the form of a verbatim record, which appears to be very well edited, is a useful way of treating a subject in which there is so much that is problematical. The book deals with those problems which everyone working in these various fields discusses repeatedly, usually without definite conclusions. Probably no single reader will be able to understand the whole of the discussion. The uncertainty of knowledge of the basic physico-chemical mechanisms involved and lack of the necessary experimental evidence is emphasized repeatedly, and often interesting suggestions for further experimental work arise in the course of the discussion.

The basic lack of knowledge is emphasized in connexion with the value of W, the mean energy expended per ion pair. It is useful to quote from p. 5: "All this has a strong moral in radiobiology, and it is one which even the physicist has often taken too lightly . . . namely, that one really knows virtually nothing about the value of W to apply for tissue. Even with a wholesome amount of grains of salt, it seems highly doubtful that this quantity has any present significance in radiobiology". It is interesting that recent experimental evidence tends to confirm Fano's approximate theory of W. Mention is made (p. 2) of the work of Lindhard and Scharff on the theory of stopping-power. The uncertainty of the position concerning the experimental evidence for the stopping-power of α-particles by liquid water is mentioned. Attention is directed to the interesting experiments of Ageno (p. 14) and the whole problem of energy transfer. A practical point of interest is made on p. 19 where Fano points out that, if a 1-MV. photon strikes a water surface, the probability of its emerging back out again is of the order of one-third. On p. 68 Platzman refers to his earlier statements at the Oberlin conference and, in particular, that the whole subject of ionization is very vague in liquid water. On p. 67 there is an interesting discussion on stable, long-lived excited states of water, and the problem of the linear HOH molecule in a triplet state with low energy is discussed.

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[*] Physical and Chemical Aspects of Basic Mechanisms in Radiobiology: Proceedings of an Informal Conference held at Highland Park, Illinois, May 7–9, 1953. (Publication 305 of the National Academy of Sciences: Division of Physical Sciences of the National Research Council.) Edited by John L. Magee, Martin D. Kamen and Robert L. Platzman. Pp. vii+145. (Washington, D.C.: National Research Council, 1953.) 1 dollar

At the end of the section on electronic excitation, the important problem of the nature of radiomimetic action is discussed; but no real conclusion is reached as to its mechanism. Attention is directed to the work of A. Kellner (*J. Bacteriol.*, 65, 252; 1953) on the growth, respiration and nucleic acid synthesis in ultra-violet irradiated and in photo-reactivated *E. coli*, the deoxyribonucleic acid synthesis being stopped immediately after irradiation and restarted after reactivation. The problem of triplet states with the possibility of long-lived states in complex molecules is discussed again on p. 115. Of particular interest is the discussion on the effects of radiation on the unfolding of proteins and the mechanism of building of adaptive enzymes. The important problem of oxygen effects is not discussed explicitly, and I would like to suggest that this is a problem which might engage the attention of similar conferences.

The book as a whole is very stimulating and should interest physical chemists and physicists, in the important experimental and theoretical problems arising in connexion with the effects of ionizing radiations on the complex systems in aqueous solution which must be studied as a foundation for the understanding of the biological actions of radiations. A conference such as this is obviously of the greatest value to the participants, and one must be grateful that a report such as this is now available.

J. S. MITCHELL

CURRENT TRENDS OF GENETICAL RESEARCH IN HUNGARY

By ANNE McLAREN and DONALD MICHIE
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WE recently had an opportunity of visiting a number of laboratories in Hungary in which genetical research is in progress.

Our first visit was to Prof. Györffy, who directs the Hungarian Academy of Sciences' Institute of Agrobiology in Budapest. A major activity of the Institute at present is the investigation of possible genetic effects produced in young plants by vegetative contact with partners of contrasting genotype. For example, it has been claimed by Michurin (see Waddington[1]) that interspecific crosses which are normally difficult or impossible to obtain can be facilitated by previous grafting between the intended sexual partners. Working with tobacco species, Györffy has found that this method, which has been termed 'vegetative approximation', is strikingly effective in crosses of *Nicotiana glauca* with *N. tabacum* and *N. rustica*, but without effect in crosses between *N. tabacum* and *N. alata*.

Györffy has also used *N. tabacum* for investigating claims of 'vegetative hybridization' made by French and Russian workers (for example, Daniel[2], Glushchenko[3]). It is suggested that, in the seed generation obtained by selfing a grafted plant, variant forms sometimes appear with characters apparently derived from the stock on to which the parent was grafted. In Györffy's experiment spines appeared on the capsules of tobacco plants which had been grafted on to *Datura*. A weaker expression of the modification appeared in the seed generation, but not in subsequent generations. Györffy intends to publish in due course an account of all the recent tobacco work of this Institute.

A large-scale experimental attempt to obtain 'vegetative hybridization' by intervarietal grafting in tomatoes was also undertaken; but no visible modifications appeared either in the grafted plants or in their descendants. Biochemical analyses are now in progress to determine whether the results are also negative in respect of 'physiological' characters. Györffy has also been encouraged by Felföldy's recent positive results (see below) to embark on a new attempt with starting-varieties, which he is now preparing, differing in as many characters as possible.

In addition, a laboratory for the genetics of micro-organisms has recently been set up in the Institute. Pontecorvo's work on heterokaryosis is being followed up in *Penicillium*; a method for prolonging the haploid phase in yeasts is being used for investigations on directed mutagenesis; and studies on the transfer of heritable properties by killed cells in *Rhizobium* are being made. This work is in part designed to throw light on 'vegetative hybridization', in the belief that heritable effects of the host upon grafted plants may be analogous to the phenomena of 'transduction' (see Stocker, Zinder and Lederberg[4]) or 'transformation' (see Avery, McLeod and McCarty[5]) in bacteria.

In search of further information on tomato-grafting experiments we visited Dr. Felföldy in the recently founded Botanical Department of the Biological Research Institute at Tihany on Lake Balaton.

The results of his experiment, up to and including the seed generation, have been published in English[6]. The present remarks include some additional material.

Of the six possible scion-stock combinations obtainable with the three varieties Pruniforme, Oxheart and

Table 1. CLASSIFICATION FOR MENDELIAN CHARACTERS OF THE SEED GENERATION OBTAINED BY SELFING GRAFTED AND CONTROL PLANTS. The convention *A/a* denotes intra-plant variation in the character

Parental plants	Phenotypes in the seed germination	No. of fully classified plants	Subsequent behaviour in five generations of selfing
Oxheart (control)	*R y o n f*	40	Bred true
Oxheart grafted on Golden Apple	*R y o n f*	18	Bred true
	R y O N f	12	Continued to segregate
	R Y O/o N F/f	1	Continued to segregate
	R Y O N F/f	5	Continued to segregate
	Perished	4	
	Total	40	
Golden Apple (control)	*r Y O N F*	40	Bred true
Golden Apple grafted on Oxheart	*r Y O N F*	32	Bred true
	r Y O N f	2	Reverted to *r Y O N F* in F_2
	R/r Y O N f	6	Bred true
	Total	40	

R = red, *r* = yellow (flesh). *Y* = yellow, *y* = colourless (skin). *O* = short, *o* = long (fruit shape). *N* = normal, *n* = nipple-tipped (fruit-shape). *F* = normal, *f* = fasciated (many-chambered in cross-section)

Golden Apple, only the two reciprocal combinations of Oxheart with Golden Apple showed any striking effects of the treatment. These two varieties differ in five major Mendelian characters; but the modifications were confined in the graft generation to an increase of sugar-content and luxuriance in the grafted plants as compared with self-grafted controls. But when the grafted plants were selfed, variant forms appeared in the first seed generation showing characters apparently derived from the stock. Data are given in Table 1 (notation based on Boswell[7]).

In addition, changes in foliage type and in several physiological characters appeared in the seed generation. Dr. Felföldy has concluded that the phenomenon of 'vegetative hybridization' is conditional upon the particular pair of varieties chosen to act as stock and scion, and that the optimal circumstance is that the two varieties should differ in as many physiological properties as possible. He suggests that this may throw light on the negative results obtained by some other workers (see, for example, Sachs[8]). But Dr. A. J. Bateman informs us that at the John Innes Horticultural Institution he obtained negative results from a similar experiment starting with seed supplied by Dr. Felföldy. Next year Dr. Felföldy himself plans to repeat the experiment and to make a concomitant study of sexual crosses between the same varieties.

In the same Institute we spoke with Dr. Fabian, who is working on mammalian genetics in collaboration with Drs. Csik and Stohl. Studies (in the press) have been made by Fabian on the inheritance of morphological characters in reciprocal crosses between *Mus musculus domesticus* and *Mus musculus spicilegus*. Significant evidence of maternal effects was found for skull dimensions, depth of nasal groove, and the ratio of tail to body-length. Heterotic effects were noted in skull-length, body-length and total weight.

Fabian has also been crossing wild rabbits with the 'Belgian' domesticated variety, and has observed a significant maternal effect on skull size in reciprocal crosses. With the object of seeking parallels between phylogenetic and ontogenetic adaptations, studies are now proceeding on the effects of conditions of rearing upon biochemical characters for which the two parent populations differ.

We were able to examine other work on animal breeding and genetics in the Institute of Small Animal Husbandry at Gödöllő. Here most of the genetical projects are still in a preliminary stage.

Dr. Mészáros, from the Institute of Animal Husbandry in Budapest, is injecting sperm from various poultry breeds, and also duck and turkey sperm, into the albumen of fertile eggs of White Leghorn hens on the second day of incubation. It is believed that specific nucleoproteins carried in by the additional sperm may have detectable and specific effects on the course of embryonic development.

An attempt is being made using Rhode Island Reds and White Leghorns to follow up Bratanov's[9] report that the offspring of White Leghorn hens which had been transfused with blood from turkeys were larger and faster-growing than control chicks, and also that some showed pigmentary changes.

Dr. Mészáros also told us that he is using blood transfusion between sheep and goats as a method of 'vegetative approximation', having visited Bratanov's laboratory in Bulgaria and seen live sheep–goat hybrids said to have been obtained by this procedure (for previous attempts, all unsuccessful, to obtain viable hybrids, see Gray[10]). In the same Department, Mr. Piko is using blood transfusion in studies of duck–goose and hen–turkey hybridization.

Dr. Mészáros is also directing all work conducted on artificial insemination in Hungary, where the number of cows artificially inseminated is expected to rise this year from 30,000 to 50,000, and of mares from 65,000 to more than 70,000. In connexion with this work he has made the observation that the fertilization-rate in cattle is increased some 15 per cent by using a mixture of sperm from two different bulls of the same breed. He has evidence that the effect is due to an increased motility of the sperm when in contact with seminal fluid from a genetically different donor. The same effect has been observed in horses and sheep.

Hungarian genetical workers whom we did not visit include Prof. Horn, of Debrecen University, who is making endocrinological studies of the sterility of the economically valuable Peking × Muscovy duck hybrid, and Academician Sedlmayr, who claims to have transferred the heritable character 'anthocyanin-less' by intervarietal grafting in sugar-beet.

All the genetical workers whom we met shared the sense of regret which is widely felt in Britain at the recent lack of communication and understanding between the split halves of the international genetical fraternity. It is in the hope of contributing something towards the re-establishment of this communication that we have prepared this brief and incomplete survey.

[1] Waddington, C. H., "An Introduction to Modern Genetics", Chap. 14 (George Allen and Unwin Ltd., London, 1939).

[2] Daniel, L., *Rev. Hort., Paris*, 108, 186 (1936).

[3] Glushchenko, I. E., "Vegetativnaya Hibridizatsiya Rastenii" (Moscow, 1948).

[4] Stocker, B. A. D., Zinder, N. D., and Lederberg, J., *J. Gen. Microbiol.*, 9, 410 (1953).

[5] Avery, O. T., McLeod, C. M., and McCarty, M., *J. Exp. Med.*, 79, 137 (1944).

[6] Felföldy, L. J. M., *Acta Biol. Acad. Sci. Hung.*, 2, 3 (1951).

[7] Boswell, V. R., Yearb. U.S. Dep. Agric., pp. 176–206 (1937).

[8] Sachs, L., *Nature*, 167, 282 (1951).

[9] Bratanov, K., *Izv. Akad. Nauk SSSR* (Ser. Biol.), No. 1, 53 (1954).

[10] Gray, A. P., "Mammalian Hybrids" (Commonwealth Agricultural Bureaux, Farnham Royal, 1954).

BRITAIN'S FORESTS

THE Forestry Commission is producing a series of booklets on "Britain's Forests", two of which deal respectively with the forests at Glentress and Drumtochty*.

Glentress Forest, close to the old Border town of Peebles, was one of the first planting projects in Scotland by the Forestry Commission through the acquisition from the Haystoun Estate of what is now the oldest portion of Glentress Forest, in co-operation with the Department of Agriculture, which was then setting up a land settlement scheme for ex-Service men. Work began there in 1920, and Glentress now includes more than two thousand acres of the hill slopes. The old woodlands and upper hill slopes amounting to 873 acres in all were taken over by the Forestry Commission. Most of these lands lie in the Eschiels of Glentress valley at the eastern end of the forest extending down to the banks of the Tweed; but the braes of Ven Law just behind the town of Peebles were also included. At that date about three hundred acres carried woodland, mostly European larch planted during 1903–5, while the rest was either former woodland that had been cleared of trees or hill ground suitable for afforestation.

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* Britain's Forests. Glentress: pp. 18; 1s net. Drumtochty: pp. 20; 1s 3d net. (London: H.M.S.O., 1953.)

In 1932 the forest was extended by the addition of about a thousand acres of ground on the north-west in the Soonhope or Shielgreen Glen. The 1903 larch plantations around Eschiels had to be felled during the Second World War. The Forestry Commission has been planting mainly Scots and Corsican pines, Norway and Sitka spruces, Douglas fir and both European and Japanese larches. Thinnings have been already commenced in the older plantations, necessitating the construction of additional roads, so there is plenty of work demanding labour in the area. A forester's training school was established there in 1945, but was moved in 1953 to Faskally, near Pitlochry. The pamphlet is well illustrated.

Drumtochty Forest is another of the Forestry Commission's forests thus described. The traveller who passes through the Howe o' the Mearns, either by road or rail, comes within a few miles of Drumtochty, and if he looks to the west he will see the new forest clothing the slopes of Strathfinella Hill. Moreover, the Glens o' Drumtochty, in the heart of the forest, is on a well-known beauty spot, visited every summer by thousands of tourists; and, indeed, the whole of Kincardineshire, though small, is rich in contrasts by virtue of the high heather-clad Grampians which come down almost to the sea at Stonehaven. The forest is situated on the south face of the Grampians, extending now to 3,340 acres, with 2,400 acres of thriving woodlands established on land too poor for agriculture. It looks out over the Howe o' the Mearns, a fertile hollow famed for its rich harvests of grain and potatoes and its fat cattle. Beyond the Howe to the east stands a low ridge of sheltering hills bordering the rugged coast of the North Sea with its little fishing villages hidden away below the cliffs.

The main routes from the south, which come up the great valley of Strathmore from Perth, traverse the Howe on the way to Stonehaven and Aberdeen. Most of the planting was done between 1927 and 1937. Larches were planted, of which the Japanese and the hybrid have done best on slopes up to a thousand feet. For the moister ground the Norway spruce and Sitka spruce are used, the former where spring frosts are likely to be severe. At lower levels in the glens *Abies grandis* and *A. nobilis*, Douglas fir, western red cedar and the western hemlock have been used; also the Serbian spruce *Picea omorika*. Planting is now giving place to the harvesting of the thinnings from the older plantations, and a first return is being obtained for the outlay. This pamphlet is also well illustrated.

COCOA FERMENTATION

By R. V. WADSWORTH and G. R. HOWAT

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Proposed Method for fermenting Small Quantities

An attempt has been made to solve the problem of the fermentation of small quantities of cocoa beans. A solution to the problem is particularly urgent at the present time when botanists have made available a large number of new varieties of cocoa. What has been lacking is a satisfactory method of fermenting beans from only one or two pods of each variety, to enable an early and accurate assessment to be made of their quality and acceptability to chocolate manufacturers.

For our experiments, pods of West African Amelonado cocoa were flown from the Gold Coast by commercial airline. Usually they arrived at Bournville about 24–30 hr. after leaving Accra. On arrival the pods were swabbed with a solution of a quaternary ammonium compound to remove surface moulds and other organisms. Tests for viability were made on a few beans by staining technique[1] and by germination tests. It was found that no chocolate flavour could be developed from dead beans, and the time of death was an important factor.

Two methods of fermentation were developed. In the first method an apparatus similar to that described by De Witt[2] was used. The pods were opened under aseptic conditions and the beans were sprayed with a mixed culture of a yeast, *Hansenula anomala*, and an acetic acid producing organism, *Bacillus orleanense*.

Knapp (ref. 3, pp. 17, 30) states that both these organisms are found frequently in commercial fermentations. The inoculum was about 20 million organisms suspended in 10 ml. of Ringer's solution. In accordance with the practice adopted in good commercial fermentations, the beans were well stirred every second day.

Fig. 1 shows the fermentation curve aimed at using this method. It will be noted that during the first 3¼ days the temperature should not exceed 38° C. During the last three days the temperature should be about 50–51° C.

At the end of the fermentation period, the beans were dried in a cabinet maintained at a high humidity to simulate West African conditions. Heat was supplied by a 100-W. electric light bulb. The temperature was not thermostatically controlled and it varied between 45° and 50° C. Under these conditions, drying to a moisture content of about 6 per cent took five or six days.

Beans prepared by this method and using the temperature limits shown in Fig. 1 were generally brown in colour and had cotyledons with an open texture. A few beans showing some purple colour in the cotyledons were found in most of the experiments. It was found that the beans from these fermentations, after roasting and shelling, could be made into chocolate with a good chocolate flavour.

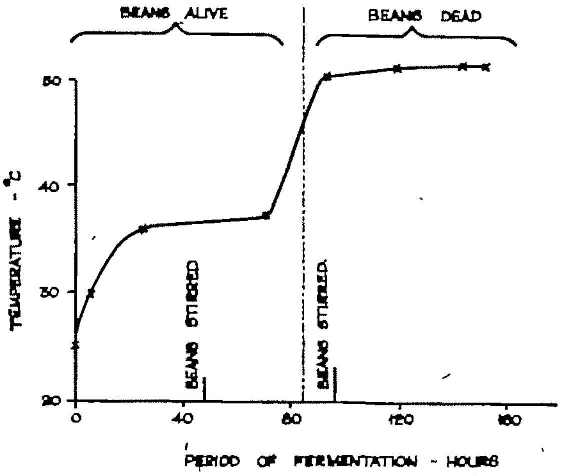

Fig. 1

The second method involved the use of 'aseptic fermentations'. In these, the beans were maintained at any desired temperature in a water-bath or incubator. The pulp was not removed; but the beans were sprayed with a very dilute solution of a quaternary ammonium compound to prevent the growth of organisms in the pulp during 'fermentation'. This method is capable of general application, and it is independent of the chance presence of desirable (or undesirable) micro-organisms in the atmosphere or the use of pure cultures. Suitably modified, we have been able to ferment successfully single beans by this method. In our later experiments the aseptic method was used exclusively, and we consider it less liable to variation than the traditional method.

Details of the aseptic method are as follows. The beans are removed from the pods under aseptic conditions and placed in sterile glass vessels. If the beans from two or three pods are being fermented, tall 600-ml. beakers are suitable. The beans are then sprayed with a solution containing 300 p.p.m. of a quaternary ammonium compound. The beakers are fitted with false bottoms prepared by placing inverted watch glasses on a framework of glass rod. Any liquid produced during 'fermentation' consequently drains away from the beans. The top of each beaker is covered with several thicknesses of aluminium foil and this is kept in place with a tight rubber band.

The beakers are placed in a water-bath or incubator kept at a temperature of 35° C. and allowed to remain there for a period of 84 hr. (3½ days). During this period a considerable volume of carbon dioxide gas is produced and it is essential that this should be removed. It can be done in one of two ways. A quantity of potassium hydroxide solution can be placed under the watch glass at the bottom of the beaker, or the beans can be thoroughly stirred after 24, 48, and 72 hr., and at 84 hr. The first method is probably the better; but it will be remembered that in no circumstances should the potassium hydroxide solution come into contact with the beans.

The beaker containing the beans is then transferred to a water-bath or incubator at 50° C. and kept at this temperature for a period of 72 hr. (3 days). Although production of carbon dioxide at 50° C. is limited to the first few hours (until the death of the bean), it is desirable that even this small quantity of gas be removed. This can be done either by stirring after 24 hr. at 50° C. or by the use of potassium hydroxide solution.

At the end of the period the 'fermented' beans are plump, and when cut exude a small quantity of dark brown liquid. The cotyledons are open and can readily be separated from each other. They are a pale watery purple colour, possibly with a background of brown.

The beans are now transferred to a drying cabinet and dried under the same conditions as those fermented naturally. When dry, the beans will be found to have a loose shell and, on cutting, the cotyledons will be found to be dark brown in colour and to have an open texture. After roasting and shelling they can be made into chocolate which has a good chocolate flavour.

Factors Involved in Fermentation

Recent experiments on the fermentation of small quantities of West African Amelonado cocoa in these laboratories have directed attention to several aspects of the changes involved in fermentation which do not appear to have been noted previously. At least three factors play a part in the development of chocolate flavour.

The first is the germination processes in the bean during the first part of fermentation. This seems to have been accorded no importance in previous work. Indeed, Knapp (ref. 3, p. 134) states that "until the bean is killed no change takes place in the interior, so that it is desirable to raise the temperature rapidly to accomplish this". Our experiments have shown that this view is incorrect. Beans which have been killed by cold—24 hr. in a refrigerator at 1–1·5° C.—and then fermented using pure cultures of organisms, or prepared by the aseptic method, do not produce anything resembling a chocolate flavour. Also, when beans are maintained at a temperature of 50° C. for several days without a prior period at a germinating temperature, no chocolate flavour is developed.

The second factor is that the beans must be maintained at a temperature of about 50° C. for several days after the initial germination period. If this is omitted and the beans maintained at around 35° C. for five days, they give either a mild flavour which is reminiscent of caramels, or have a slight liquorice character when made into chocolate. In addition, the colour of such beans after drying is not brown, it is purple. At higher temperatures the degree of purple remaining in the finished beans is less; but it is our experience that even when a temperature of 45–46° C. is maintained instead of 50° C., some purple background is present and there is bitterness in the chocolate produced. It should be noted that the temperatures used in our aseptic fermentations approximate roughly to those observed in good commercial fermentations. The nature of the changes produced during this period has not been studied by us in detail. They are, however, undoubtedly associated mainly with changes in the polyphenols, as has been noted by Forsyth[4].

The third factor is the removal of carbon dioxide from the air around the fermenting beans. It is well known, of course, that carbon dioxide is produced in fermenting cocoa. There appears, however, to be no published record that large quantities of carbon dioxide are produced by the bean itself—as distinct from fermentation of the pulp—during the early stages of fermentation.

Our experiments have shown that when fermented under aseptic conditions, the carbon dioxide content of the atmosphere around the cocoa beans may rise as high as 90 per cent during the first three days. In fermenting single-bean samples, we have found that a single cocoa bean (dry weight 1·2 gm.) produces up to 10 ml. carbon dioxide at N.T.P. during the early stages of fermentation. There is apparently no liberation of carbon dioxide after the bean dies.

In certain experiments an atmosphere of carbon dioxide was maintained around the beans during the period they were held at 50° C. or during drying. In each case it was found that the chocolate prepared from such beans was unpleasant and had no chocolate flavour.

It is interesting to note that in good commercial fermentations the practice is to turn the cocoa or to mix it every second day. This will have the desired result, if properly done, of removing the carbon dioxide.

Two other points have interested us. One is that during fermentation very little change takes place in the *p*H of the cotyledons. In our fermentations, using pure cultures of organisms, we found that the *p*H of the pulp fell from about 4 to 2·5. There was no similar fall in the *p*H of the cotyledons; here a slight reduction, from 5·5 to 5, was all that was noted.

This point is of particular interest in that it has been frequently suggested that the flavour of fermented beans is affected by the character of the fermentation which it has undergone, and that the esters formed during fermentation may permeate the testa and pass into the cotyledons. In the light of our findings, this seems unlikely.

The other point which interested us was the gap in temperature that exists between the thermal death-point of the organisms which occur in commercial fermentations and the maximum temperature recorded in a fermenting heap. The thermal death-point of most organisms occurring in commercial fermentations is 43–44° C. as observed by Rombouts[5]. The maximum temperature recorded in good fermentation practice is, however, usually 50–51° C. It appears possible that the heat produced by the enzymic processes in germination is sufficient to raise the temperature of the whole fermenting mass sufficiently to bridge the gap between 44° and 51° C.

A fuller account of these experiments is in course of preparation and will be published elsewhere. We are indebted to the Directors of Cadbury Brothers, Ltd., for permission to publish this communication.

[May 26.

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PHOTOSYNTHESIS BY ISOLATED CHLOROPLASTS

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THE many attempts to reconstruct photosynthetic events by systems less organized than whole green cells have met with success in only one area: the photolysis of water by chloroplast preparations resulting in the evolution of oxygen[1] (the Hill reaction). Evidence has now been obtained that whole chloroplasts, unaided by other cellular particles, have the ability to carry out two other photochemical reactions outside the living cell: (*a*) carbon dioxide fixation, and (*b*) photosynthetic phosphorylation, a term which we use for the conversion of light energy into the high-energy phosphate bonds of adenosine triphosphate (ATP), without the participation of respiration.

Although there are valid reasons for believing that the functioning photochemical mechanism in isolated chloroplasts, as measured by the evolution of oxygen, is the same as in the intact cell[2], there is uncertainty as to the manner in which light energy captured by chloroplasts is linked to carbon dioxide reduction. Until now, isolated chloroplasts appeared to differ from intact cells by being unable to link the photochemical evolution of oxygen to carbon dioxide fixation even when the latter was measured by the sensitive tracer carbon technique[3]. The Hill reaction proceeded only in the presence of non-physiological electron or hydrogen acceptors such as ferricyanide or quinone.

A step forward was the finding that, under proper conditions, illuminated, isolated chloroplasts can reduce the well-known physiological electron carriers triphosphopyridine nucleotide (TPN) and diphosphopyridine nucleotide (DPN)[4]. This permitted the linking of the Hill reaction to many enzymatic reactions, including carboxylations, which are dependent on reduced pyridine nucleotides. Indeed, the expectation that any enzyme system which uses reduced tri- or di-phosphopyridine nucleotide can do so whether the reduced coenzymes are produced by respiration or by illuminated chloroplasts was amply documented, particularly by the work of Vishniac and Ochoa[5]. These workers have also shown[6] that photochemically reduced diphosphopyridine nucleotide could be reoxidized by mitochondria from non-photosynthetic tissues and bring about the synthesis of adenosine triphosphate by an oxidative phosphorylation of the type observed by Lehninger[7].

Concepts, based on experiments with model enzyme systems, assigned to chloroplasts *in vivo* the limited functions of photolysis of water and the transfer of electrons and hydrogens to suitable acceptors, which were assumed to be pyridine nucleotides[8]. Carbon dioxide fixation proper and the conversion of light energy into the pyrophosphate bond-energy of adenosine triphosphate would, in this view, be carried out by mitochondria and soluble enzymes situated outside the chloroplasts. This concept was made plausible by the finding that in green leaves the malic enzyme, mediating the reductive carboxylation of pyruvate to malate, was in the cytoplasmic fluid[4,9,10]. Other carboxylases[10] as well as an important enzyme of the glycolytic cycle, glyceraldehyde phosphate dehydrogenase[11], were also found in the cytoplasmic fluid of green leaves rather than in the chloroplasts.

Our present findings, however, speak against this concept. Since washed chloroplasts were found to have the capacity, without the addition of other enzymes, to use light energy for adenosine triphosphate synthesis and carbon dioxide fixation, it follows that these particles contain the enzyme systems and at least most of the co-factors concerned in these reactions. The only added compound which gave consistently large increases in both photosynthetic phosphorylation and carbon dioxide fixation was ascorbic acid. The addition of di- or triphosphopyridine nucleotide, uridine triphosphate, cocarboxylase, thioctic acid or a mixture of thioctic acid and cocarboxylase was without effect on carbon dioxide fixation or photosynthetic phosphorylation. In the light of our present evidence, isolated chloroplasts emerge as remarkably complete cytoplasmic structures, equipped to carry out not only oxygen evolution but also carbon dioxide fixation and the conversion of light into chemical energy.

In setting out to investigate light reactions of isolated chloroplasts with reference to photosynthesis, our basic premise has been that only those chloroplast preparations which possessed the capacity for photolysis of water, as measured by oxygen evolution, were desirable objects of study. Isolated chloroplasts lacking this capacity are, so far as we know, incapable f the primary conversion of light into chemical nergy, and would therefore not be expected to articipate in reactions involving carbon dioxide ixation. The dependence of phosphorylation and arbon dioxide fixation in whole chloroplasts on their apacity for photolysis was demonstrated by the use f *o*-phenanthroline, a powerful inhibitor of photoysis[12,13]. Chloroplasts inhibited in this manner were n our experience unable to synthesize adenosine riphosphate or to fix carbon dioxide. It is therefore ifficult to interpret the relation to photosynthesis of arbon dioxide fixation by those chloroplast preparaions reported by Fager[14], which retained only a egligible capacity for oxygen evolution.

Our first experiments showed (Table 1) that while he capacity for photolysis is a prerequisite, it is not he sole condition for active photosynthetic phoshorylation and carbon dioxide fixation. Whole pinach chloroplasts, prepared in 0·5 *M* glucose or 0·35 *M* sodium chloride, were found capable of carrying out all three reactions. Chloroplast fragments, which in these (Table 1) and previous experiments[13] retained an unimpaired capacity for photolysis, showed only feeble photosynthetic phosphorylation and practically no light-induced carbon dioxide fixation. Whole chloroplasts were therefore used in all subsequent experiments. The ratio of light to dark fixation was used as an index of photosynthetic activity. With good preparations of chloroplasts the ratio averaged about 160 for carbon dioxide fixation and 20 for phosphorylation.

Table 1. PHOTOLYSIS, PHOTOSYNTHETIC PHOSPHORYLATION AND CARBON DIOXIDE FIXATION BY CELL-FREE PREPARATIONS

All three reaction mixtures were in 3 ml. of 0·13 *M* tris (hydroxymethyl) amino methane, *p*H 7 2, and 0·35 *M* sodium chloride. Reaction time, 60 min. Temperature, 15° C. Gas phase, air. Special components were: photolysis–chloroplast material containing 0·5 mgm. chlorophyll and 7·4 μM *p*-benzoquinone; photosynthetic phosphorylation–chloroplast material containing 2 mgm. chlorophyll, 10 μM sodium ascorbate, 10 μM adenylic acid, 20 μM of a mixture of sodium and potassium phosphate, *p*H 7·2, containing 290,000 counts per minute (c.p.m.) of phosphorus-32. Carbon dioxide fixation–chloroplast material containing 2 mgm. chlorophyll, 10 μM sodium ascorbate, 20 μM of a mixture of sodium and potassium phosphate, *p*H 7·2, and 1·5 μM sodium carbonate containing *c.* 1 5 × 10⁶ c.p.m. of carbon-14

Preparation	Photolysis (mm.³O₂/hr./mgm. chlorophyll)	Photosynthetic phosphorylation (c.p m. organic ³²P)		Carbon dioxide fixation (c.p.m. ¹⁴C)	
		Light	Dark	Light	Dark
Leaf homogenate	340	4,900	3,140	60,600	3,140
Intact chloroplasts	480	4,250	950	52,000	288
Chloroplast fragments	400	1,100	300	1,100	1,000

Our results suggest an increasing order of complexity for the three photochemical reactions of isolated chloroplasts. Photolysis could be carried out by preparations incapable of photosynthetic phosphorylation and carbon dioxide fixation. In turn, photosynthetic phosphorylation was found to proceed unimpaired in the presence of potassium hydroxide when the partial pressure of carbon dioxide was extremely low. Carbon dioxide fixation, however, has so far been observed only under conditions which were compatible with active photolysis and phosphorylation.

The three photochemical reactions were separable by differential inhibition and by variations in the technique for the preparation of chloroplasts. Chloroplasts isolated in ethylene glycol retained their capacity for photolysis and photosynthetic phosphorylation, but fixed practically no carbon dioxide. Using chloroplasts prepared in glucose or potassium chloride, we found that 2,4-dinitrophenol (8×10^{-4} *M*) was a strong inhibitor of both carbon dioxide fixation and phosphorylation, but that its effect on photolysis was rather mild. Iodoacetamide (2×10^{-4} *M*) inhibited carbon dioxide fixation about 97 per cent but had practically no effect on photosynthetic phosphorylation. As shown in Fig. 1, *p*-chloromercuribenzoate (CMB) was a strong inhibitor of carbon dioxide fixation, a less effective one of photosynthetic phosphorylation and had practically no effect on photolysis. This inhibition suggested the participation of sulphydryl groups in the chloroplasts. However, attempts to reverse the inhibition by the addition of cystein or glutathione were inconclusive since these compounds were themselves inhibitory.

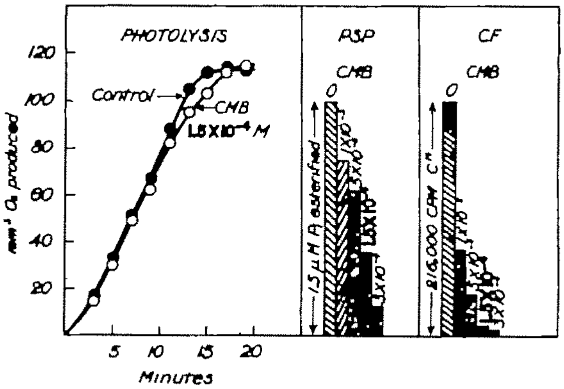


Fig. 1. Effect of *p*-chloromercuribenzoate (CMB) on photolysis, photosynthetic phosphorylation (PSP) and carbon dioxide fixation (CF) by isolated chloroplasts. Experimental conditions as in Table 1, except that gas phase in photolysis and carbon dioxide fixation was nitrogen, and phosphate was omitted in the latter reaction mixture

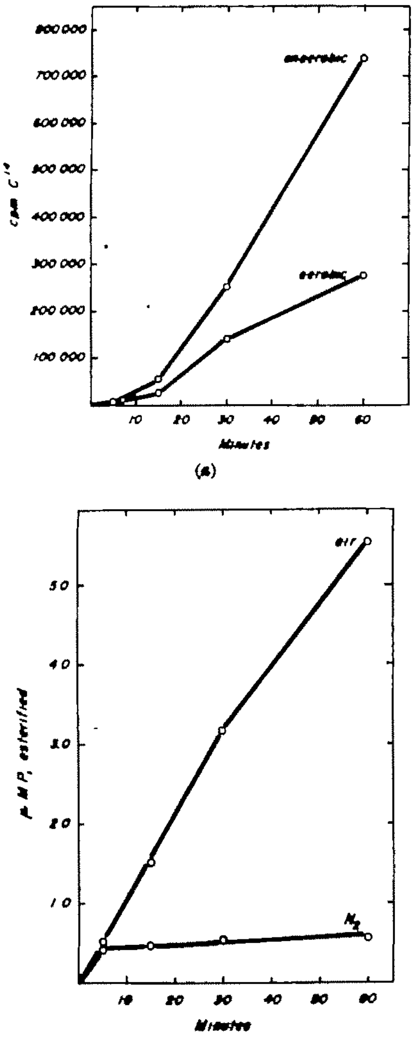
An important difference between photosynthetic phosphorylation and carbon dioxide fixation was their response to anaerobiosis. As shown in Fig. 2, carbon dioxide fixation was increased under conditions of low oxygen tension, whereas photosynthetic phosphorylation was markedly inhibited. Anaerobic conditions were maintained by flushing the reaction vessels with nitrogen gas and having an 'Oxsorbent' solution (chromous chloride) in the side arm. These conditions would, of course, not exclude the very small quantity of oxygen (1 micromole at most) of photosynthetic origin newly liberated *in situ*.

The addition of adenosine triphosphate or of adenylic acid did not increase carbon dioxide fixation by isolated chloroplasts. A wholly unexpected finding was the inhibition of carbon dioxide fixation by the addition of inorganic phosphate (Table 2). These results suggest a competitive relation between photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts. It

Table 2. EFFECT OF ADDED INORGANIC PHOSPHATE ON CARBON DIOXIDE FIXATION

Experimental conditions as in Table 1 except for phosphate

Exp. No.	Carbon-14 dioxide fixed (c p.m.)	
	20 μM *Pi* added	*Pi* omitted
922	54,600	178,300
923	47,400	240,200
924	63,000	310,700
932	106,900	431,900



(a)

(b)

Fig. 2. Effect of anaerobiosis on (a) carbon dioxide fixation and (b) photosynthetic phosphorylation. Experimental conditions as in Table 1, except that phosphate was omitted in carbon dioxide fixation. Anaerobic conditions were provided by nitrogen gas and 0·2 ml. 'Oxsorbent' in the side arm of reaction vessel

seems prudent, however, to defer an interpretation of these data until results are obtained from other experiments now under way. Our chloroplast preparations contained measurable quantities of inorganic and organic phosphate. The identification, now in progress, of the products of carbon dioxide fixation by isolated chloroplasts in the absence of added phosphate should provide pertinent data on the relation between photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts.

Although the dependence upon oxygen of photosynthetic phosphorylation seems well established, the elucidation of the role of oxygen in this reaction must await further experimentation. Photosynthetic phosphorylation is not accompanied by manometrically measurable evolution of oxygen. The accompanying equations represent a tentative scheme of the course of the reaction, in accordance with experimental facts now known.

AMP and P_i represent adenosine-5-phosphate and orthophosphate (labelled with phosphorus-32).

$$(1) \quad H_2O \xrightarrow[\text{chloroplasts}]{\text{light}} 2e + 2H^+ + \{O\}$$

$$(2) \quad AMP + 2P_i + 2e + 2H^+ + \{O\} \rightarrow ATP + H_2O$$

$$\text{Sum}: \quad (3) \quad AMP + 2P_i \xrightarrow[\text{chloroplasts}]{\text{light}} ATP$$

Adenosine diphosphate was found equally effective. The brackets around the oxygen in reactions (1) and (2) are intended to denote that it has not yet been determined whether: (a) oxygen is released in reaction (1) and immediately consumed in reaction (2), or (b) whether the oxygen in reaction (1) represents the formation of some oxidized substance within the chloroplast which is reduced by electrons in accordance with equation (2). In this connexion the recent observation by Lundegårdh[15] of the oxidation of cytochrome *f* in green cells on exposure to light is of special interest.

Adenosine triphosphate was identified as the product of reaction (3) (a) directly, by adsorption on 'Norite' followed by hydrolysis of labile phosphate, and (b) indirectly, using hexokinase and glucose as an adenosine triphosphate acceptor system either during the progress of photosynthetic phosphorylation or following the termination of the reaction and the chemical isolation of adenosine triphosphate. In both cases the product of the hexokinase reaction, glucose-6-phosphate, was identified chromatographically.

The photochemical esterification of inorganic phosphate by chloroplasts, independent of carbon dioxide fixation, provides a mechanism for converting light energy into adenosine triphosphate, without the utilization of energy released by reoxidation of partly or wholly reduced products of carbon dioxide fixation[16]. Both photosynthetic phosphorylation and carbon dioxide fixation by isolated chloroplasts are novel findings which require careful documentation. The conclusions presented here are based on forty-three consecutive experiments with isolated chloroplasts in which photosynthetic phosphorylation and carbon dioxide fixation were observed without a single exception. A full account of these experiments will be presented elsewhere.

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LETTERS TO THE EDITORS

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Trace Analysis by X-Ray Emission Spectrography

We have used X-ray emission spectrography[1] X-ray fluorescence) for rapid and accurate direct analysis of small quantities of material by a technique resembling that of the familiar spot test[2]. Our results on zinc (Fig. 1) show the simplicity and speed of the method.

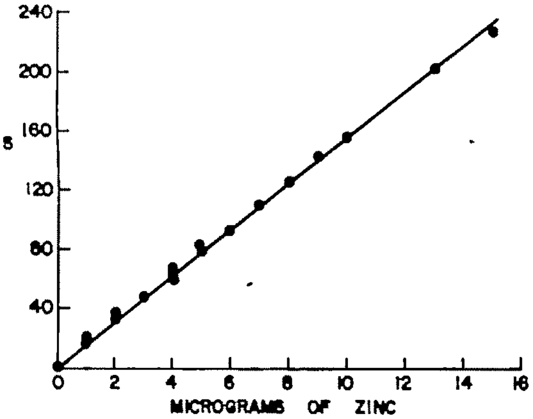

Fig. 1. Counting-rate of zinc $K\alpha$ line for various amounts of zinc on Schleicher and Schuell No. 740*E* ½-inch disks. Samples prepared by placing measured amounts of zinc sulphate solution on the paper and drying to remove the water

The samples containing zinc were dissolved and the solutions dispersed over a well-defined area that could be placed completely in the X-ray beam. As a carrier for the dispersion, Schleicher and Schuell bioassay paper (No. 740*E*) or Whatman's No. 50 filter-paper worked well. The thinness and rigidity of the paper simplified the problem of keeping the sample at the proper place in the X-ray system; other carriers, however, can be used. The intensity of the zinc characteristic $K\alpha$ radiation above the surrounding background gave the direct quantitative measure of the zinc content. Typically, 15·6 counts/sec. of zinc $K\alpha$ radiation per microgram were observed above a background of 49·7 counts/sec. using the bioassay paper. With the filter-paper the background was only 15 counts/sec. The reduced background decreased the time necessary for the detection of 1/30 microgram of zinc from 7 to 2 min. counting time. Different samples of paper gave varying backgrounds, with a standard deviation of 3 counts/sec., which made it possible to determine the larger zinc concentrations without a separate background determination.

Fig. 1 shows the accuracy of the method for numerous samples; the linear range extends to 100 μgm. before absorption effects introduce curvature. The same technique was used for the determination of small amounts of vanadium, copper, iron, silver, bromine, gold, and lead with standard deviations of well under 1 microgram for a determination taking 10 min. or less.

We have increased the sensitivity by counting for longer times. Care is necessary, however, because long-time fluctuation in the X-ray equipment can cause difficulty. Therefore, we have used a commutation method in which the sample and background are counted alternately until the desired number of counts is accumulated.

The samples we used are thin—a microgram of zinc spread over 1 sq. cm. is only 3 atoms or about 10 A. thick; radiation produced in such a thin layer will be essentially unaffected by the presence of other atoms in like quantities. It should therefore be possible to analyse mixtures without concern for the interferences that occur in the X-ray emission spectrographic analysis of bulk materials.

Except for the rather rare overlapping of X-ray lines, the components of mixtures will respond independently, and no previous chemical processing beyond dispersing the sample is required.

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Visibility of X-Ray Quantum Fluctuations on Image Intensifier Radiographs

The gain in brightness with an X-ray image intensifier is accompanied by a more or less disturbing effect, namely, the visibility of a kind of visual 'noise', especially when the X-ray intensity is low, the intensification factor of the intensifier is high (greater than 1,000 times) and the optical magnification of the final image large.

In intensifier radiography, in certain circumstances a coarse mottling is observed on the photographic image of the viewing screen. In Fig. 1, four prints are shown of intensifier radiographs (original size 5 mm. diameter) on Agfa Fluorapid film. An object

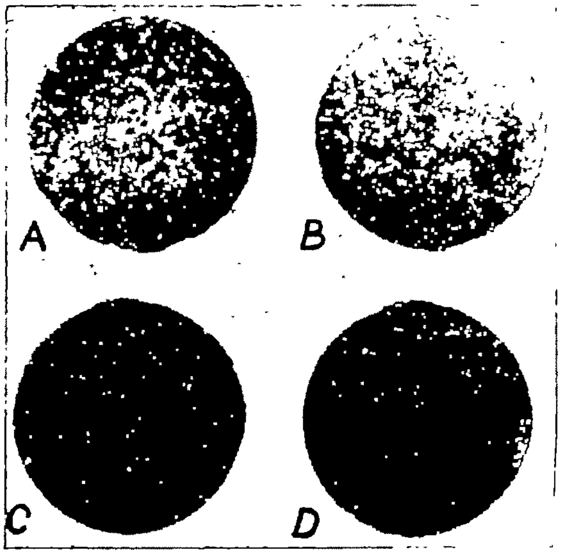

Table 1

Photo	Charge (mA sec.)	Relative exposure time	No. of developed grains per X-ray quantum absorbed
A	0 006	1	32
B	0 030	5	6
C	0·19	32	1
D	0 96	160	0·2

equivalent to 8 cm. of water was placed between the X-ray tube and the image intensifier. The pictures were taken at 67 kV., focal distance 90 cm. The difference between the radiographs is the amount of X-ray energy detected per picture. By varying the speed of the optical system with an aperture, an equal density of 0·75 on the original radiographs was obtained.

In Table 1 are given for each picture the X-ray energy which is proportional to the electrical charge (mA.sec.) through the X-ray tube, the relative exposure times and the approximate number of silver grains per absorbed X-ray quantum. Though the film material and the density were the same, the structure of the pictures is quite different. The mottling of the image decreases with increasing current. The intrinsic film graininess is reached when the number of X-ray quanta necessary for producing one silver grain exceeds 1.

The explanation is as follows: on picture *A*, taken with a small quantity of X-rays, every absorbed X-ray quantum gives rise, due to the intensification, to the development of a cluster of 32 silver grains in the film emulsion. The mottling of the radiograph is determined by a statistical distribution of grain clusters, the dimensions of which are determined by the circle of diffusion of the intensifier X-ray screen. The number of grains in one cluster is given by the last column of Table 1. As the number of clusters per unit area in picture *A* is considerably smaller than the number of separate grains in picture *D*, the grain distribution in picture *A* deviates much more from a homogeneous distribution than that in picture *D*, due to the larger relative statistical fluctuations in the number of clusters.

A similar effect has been observed by Eggert and Schopper[2] when taking full-size radiographs with X-rays of different hardness. The picture with hard X-rays seems to be more grainy than the photo with soft X-rays. This effect, however, is less pronounced than on intensified radiographs, because on an ordinary full-size radiograph only two to three grains are developed for each X-ray quantum of the same energy.

Recently, Cope and Rose[3] published an X-ray noise picture, using a photoconductive pick-up tube.

The visual 'noise' in intensifier fluoroscopy with low X-ray intensity and the coarse mottling in intensifier radiography with small quantities of X-rays, due to the statistical fluctuations in the (relatively small) number of absorbed X-ray quanta, have the consequence that the perceptibility of detail on intensified images and radiographs is limited. This has been predicted by Sturm and Morgan[4] and confirmed experimentally by us[5]. Only by increasing the number of X-ray quanta detected can the perceptibility of detail be improved.

Summarizing, the influence of quantum fluctuations on image-intensified radiographs is such that in certain circumstances (high-speed optics, sensitive film) the picture is much more mottled than corresponds with the normal intrinsic graininess of th photographic emulsion.

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Velocity of Electron Pulses

One of us[1] has noted that the velocity of electron has never been measured under conditions which allow no alternative interpretation. A linear velocity of displacement is a necessary inference only when two successive events, departure and arrival, have been observed which are localized and distinct, both in space and in time. In the known determinations with static or periodic deflecting fields one canno discriminate between *transit times* of localized entities and *vibration periods* of extended systems. It appeared therefore, of interest to determine the transit time across a measured distance, of a brief pulse of electrons of known energy. This was achieved by using two deflector gates, which are opened for very brief intervals only by a single surge travelling in a cable with an accurately measurable and adjustable delay time, corresponding to the length of cable, between the opening of the first gate and of the second.

A sketch of the apparatus is shown in Fig. 1. An electron gun directs a fine beam of 2 kV. electrons into the top deflexion chamber. At the start the beam is deflected by a static potential of 1·1 kV on the cable core, so that the gate is closed. The voltage is reversed by a vacuum switch, which sends two travelling waves to the gates. The top gate opens first, at an instant when the potential of the deflector electrode connected with the cable core passes through zero. By using fine apertures, the opening time can be reduced to about 10^{-10} sec. A group of electrons passes through the small exit aperture, and is focused by a magnetic lens on the entrance aperture of the second gate, so that no electrons are lost in the transit. The opening pulse at the second gate is delayed by a length of polythene cable; the delay can be accurately adjusted by means of a sliding branching-point. If the electrons are monokinetic, and if the delay in the cable is equal to the transit time, practically all electrons which have passed through the first gate will also pass through the second. They are collected by a nine-stage beryllium–copper electron multiplier, which we owe to the courtesy of Dr. Alexander Baxter (Cambridge), with a gain of the order 100,000. Using three valve-amplifier stages, pulses of less than fifty electrons could be easily observed on the screen of a cathode ray tube, and the noise-level was so low that spontaneous pulses of this order occurred only a few times per minute.

The results completely confirmed the orthodox expectations. By moving the branching-point, it could be ascertained that about 90 per cent of the electrons arrived within ± 1 per cent of the mean transit time; and the most probable transit time,

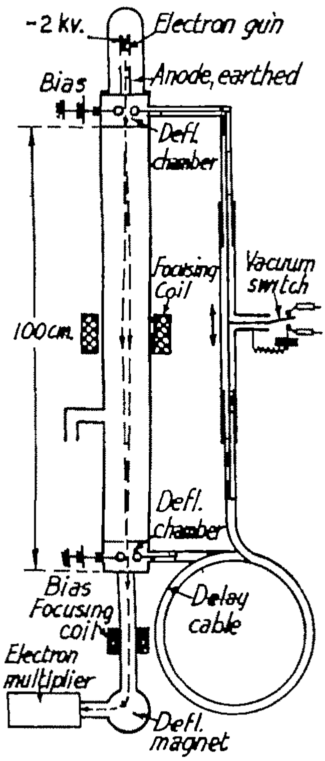

Fig. 1

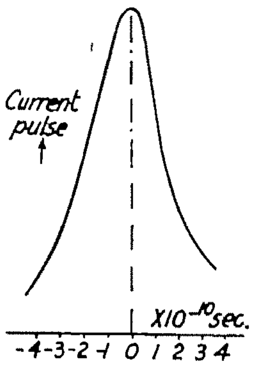

Fig. 2

that is to say, the position of the current peak in Fig. 2, could be ascertained within ± 0·25 per cent. The corresponding delay in the cable agreed with the calculated electron transit time within about 1 per cent, which is inside the error limit due to the calibration of the cable, and of the measurement of the accelerating voltage. The scatter in the electron arrival (Fig. 2) can be accounted for by the fluctuations in the high-voltage source and by the opening characteristic of the gates. The position of the maximum could be ascertained in a range of ± 5 mm. shift of the branching-point, corresponding to a time uncertainty of 3×10^{-11} sec. We estimate that by using a stabilized voltage source, finer apertures and a thirteen-stage multiplier this could be reduced by an order of magnitude. It appears, though, that the experiments, as they stand, constitute a sufficient *a posteriori* justification of velocity measurements using periodic fields.

The apparatus was so devised from the start that, once this confirmation was obtained, it could be used as a velocity spectrograph, and as a chronograph for measuring the time of rise of very steep surges. If in one of the gates the deflecting electrode opposite to the one which is energized by the surge is biased by, say, ± 100 V., the moment of opening will be delayed or advanced by the time which the potential in the wave-front takes to rise by 100 V., and the other gate must be correspondingly delayed or advanced in order to pass the maximum current. It was found that the time of rise for 100 V. in a surge of 2·2 kV. total, initiated by a vacuum switch, was 3×10^{-10} sec., and no significant difference was found between the slope at the top gate and at the bottom gate due to damping by the polythene cable. This figure must be considered as giving a lower limit only for the slope, as no particular care was taken in matching the deflecting chambers to the cable.

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Orientation of Apatite Crystals in Bone

From the earliest experiments on X-ray diffraction by specimens of bone, it has been well known that in long bones, for example, femora, the *c*-axes of the hexagonal apatite crystals are preferentially orientated parallel to the long axis of the bone. In regard to sections of bones cut normal to the long axis, no one has reported any preferential orientation of the crystals. In fact, it has been repeatedly stated in the literature that there is no orientation of the crystals in the plane perpendicular to the long axis[1].

During the past few years we have been studying the crystal structure of bones in relation to growth, and as part of this research we have investigated sections cut perpendicular to the long axes of the femora of rats of all ages. The sections were cut near the middle of the bone by means of a section-cutting machine similar to that described by Atkinson[2]. They were approximately 0·006 in. thick and were mounted in a miniature X-ray camera of the Chesley type[3]. In every specimen examined we have found that the apatite crystals are always preferentially orientated with the *c*-axis approximately tangential to the surface of the bone. A systematic investigation was carried out as follows.

A reference line was marked on the collimator holder which also carried the specimen, and a corresponding line was marked on the film. The collimator with specimen attached was mounted on the stage of a microscope and a beam of light passed through the collimator (diam. 0·01 cm.) so that a bright spot of light was seen at the point on the specimen where the X-ray beam would strike. A photograph was taken with a magnification of 18 times, so that for each X-ray photograph the exact spot where the X-ray beam passed through the specimen was known as well as the orientation of the specimen with respect to a reference line on the film. After each X-ray exposure the specimen was moved and another photomicrograph taken until a series of exposures had been taken at points all round the hollow sections.

The 002 powder ring appears as two strong arcs and the position of these arcs moves around the powder ring as the point irradiated moves around the annulus of bone. (The much weaker 004 ring is similar.)

The angle which the line joining the middle of the arcs makes with the reference line was measured on each photograph. This is the preferred direction of the *c*-axis of the apatite crystals. A tracing of the outline of the bone section was made from one of the photomicrographs and the successive points irradiated were marked on it. From each of these points a line was drawn perpendicular to the tangent to that part of the bone surface nearest to the point considered. For each photograph the preferred *c*-axis direction was drawn on the tracing and the angle it makes to the 'radial' lines measured. If the direction of

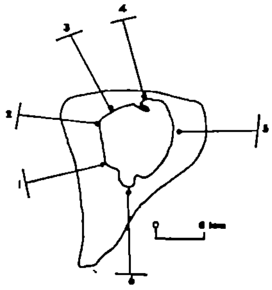

Fig. 1

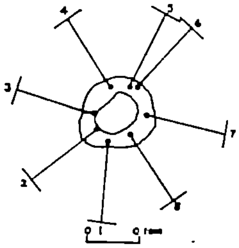

Fig. 2

Fig. 1. Outline of cross-section of rat femur (age 4 months) showing positions where X-ray diffraction photographs were taken and corresponding directions of preferred orientation of c-axes of apatite crystals

Fig. 2. As for Fig. 1 (age 10 days)

preferred orientation is tangential, these angles should be 90°.

Two examples are illustrated. Fig. 1 is a section of a femur of an adult rat (four months) and the angles are respectively as follow:

(1) 90°, (2) 79°, (3) 87°, (4) 83°, (5) 85°, (6) 87°.

Fig. 2 is a section of the femur of a young rat (ten days) and the angles in this case are:

(1) 87°, (2) 88°, (3) 89°, (4) 88°, (5) 90°, (6) 86°, (7) 87°, (8) 89°.

In view of the difficulty of drawing accurate tangents to the non-regular surfaces, it seems well established that the apatite crystals in the cross-section of the rat femora are preferentially orientated with the c-axis tangential to the surface of the bone.

When photographs of a longitudinal section are compared with those of a cross-section, it is clear that the intensity of the 002 arcs in the latter is much less than in the former. It seems, therefore, that in the bone shaft as a whole the majority of crystals are arranged with their c-axes approximately parallel to the long axis of the bone; but of those crystals which are lying with their c-axes in the cross-sectional plane, most are arranged with the c-axes tangential to the surface. Fig. 3 shows X-ray diffraction photographs of (a) a longitudinal section with X-ray beam perpendicular to the long axis, (b) a cross-section of the same specimen with X-ray beam parallel to the long axis of the bone (position No. 3 of Fig. 1); copper $K\alpha$ radiation, specimen-to-film distance 1 cm. The 002 reflexion which shows pronounced arcs in both photographs is inside the strong continuous ring.

We are indebted to Prof. A. Haddow, of the Chester Beatty Research Institute, London, for a supply of pure-line Wistar rats and to Prof. G. H. Bell an Miss M. H. Thomas for providing us with most o the specimens.

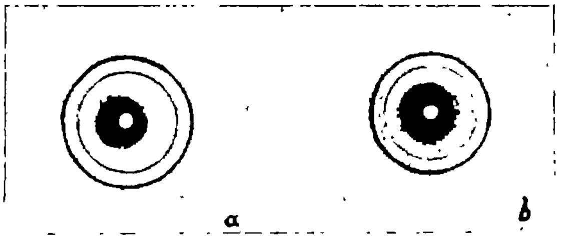

Fig. 3. X-ray diagrams of (a) longitudinal section of rat femur, (b) cross-section of same femur

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Fluorometric Detection and Estimation of Germanium

Fluorometry has become a very important too in the hands of the analytical chemist in recent years not only for the detection but also for the quantitative estimation of several substances, especially those occurring in traces. Nevertheless, very few metals are detected and estimated by fluorometric methods.

No fluorometric test has so far been reported fo germanium. This element has in recent years attained strategic importance on account of its use in the manufacture of transistors and on account of it scarcity. We have now found that traces of germanium give an intense greenish-yellow fluorescence with a solution of resacetophenone in concentrated sulphuric acid or syrupy phosphoric acid under filtered ultra-violet light. No other metal interferes.

Borate gives a blue fluorescence with this reagent, as already reported by Neelakantam and Row[1]. Nitrite, nitrate, fluoride and chromate quench the fluorescence given by germanium in both the sulphuric and phosphoric acid media. Bromide, iodide and chlorate quench the fluorescence in the sulphuric acid medium but not in the phosphoric acid medium. When sulphuric acid is employed, the solution acquires a brownish colour, which deepens on standing.

We recommend the following method for the fluorescence test for germanium. The resacetophenone reagent is prepared by dissolving 0·5–1·0 gm. of the pure substance in 100 ml. of acetic acid. To 3 ml. of this reagent in a quartz test-tube is added 6 ml. of syrupy phosphoric acid. 0·1–1·0 ml. of the germanium solution is now run in and mixed, adding some more syrupy phosphoric acid, if necessary, to make up the total volume to 10 ml. Then the test-tube is kept exposed to ultra-violet light from which all visible light has been filtered out; for this purpose we have used the 'Cenco Black Light' source operating on 220-V. a.c. mains. The intensity of the greenish-yellow fluorescence has been found to vary with the concentration of the germanium ions. The limit of sensitivity is 1 : 10,000 and the limit of identification 100 γ.

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Synthesis of (±) Methyl Fluoromalate

The observations of Peters *et al.*[1] that the administration of fluorocitrate resulted in the inhibition of the tricarboxylic acid cycle suggested the synthesis of other fluorinated acids of biochemical interest. In this preliminary communication, we wish to report the synthesis of (±) methyl fluoromalate and fluoromalamide.

Ethyl ethoxalylfluoroacetate, prepared according to Rivett's method[2], was reduced with potassium borohydride (two equivalents) in absolute methanol with vigorous stirring. The temperature of the reaction mixture rose to 50° during the reaction, which was complete after 90 min. Excess dry methanolic hydrogen chloride was added and the filtered solution distilled with repeated addition of methanol to remove methyl borate. The remaining solution was neutralized with lead carbonate, filtered and dried (sodium sulphate). Removal of the solvent furnished (±) methyl fluoromalate (transesterification having taken place during the reactions) as a colourless viscous liquid. The ester gave negative tests for carbonyl groups, a positive test for hydroxy groups and had the following microanalytical composition: C, 40·0; H, 5·8 per cent. $C_6H_9O_5F$ requires C, 40·1; H, 5·1 per cent.

The reduction of ethyl ethoxalylfluoroacetate with lithium aluminium hydride and aluminium *iso*propoxide was also attempted; but preliminary experiments gave much poorer yields of the ethyl fluoromalate.

(±) Methyl fluoromalate was identified by converting it into the diamide with saturated methanolic ammonia for 48 hr. The fluoromalamide was recrystallized from *iso*propyl alcohol (m.p. 160° uncorr.). A mixed melting point with malamide[3] (m.p. 162° uncorr.) gave a depression (m.p. 130° uncorr.). Fluoromalamide exhibited an absorption band at 1,050 cm.$^{-1}$ which was attributed to the C–F bond and gave the following micro-analytical results: found: C, 32·1; H, 4·4; N, 18·8 per cent. $C_4H_7O_3N_2F$ requires C, 32·0; H, 4·65; N, 18·7 per cent.

The results of biochemical assay[4] and details of this work will be published elsewhere. We thank Dr. E. M. Gal for his advice and interest in these experiments.

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Reversal and Mechanism of Oxidative Phosphorylation

The importance of reactions in which electron transport from reduced pyridine nucleotides to oxygen is coupled with the formation of adenosine triphosphate from adenosine diphosphate and inorganic phosphate is well recognized by biochemists. Although much pertinent information has been accumulated, no clear picture of the sites and mechanism of uptake of inorganic phosphate coupled with electron transport has yet been obtained. This communication gives some results of exchange reactions of inorganic phosphate labelled with phosphorus-32 and oxygen-18 which may give some additional insight concerning oxidative phosphorylation, together with a brief presentation of a hypothesis for the mechanism of coupling of electron transport with inorganic phosphate uptake.

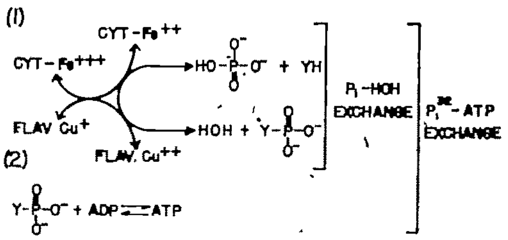
EXCHANGE REACTIONS CATALYSED BY LIVER MITOCHONDRIA IN THE ABSENCE OF ADDED SUBSTRATE

Oxygen uptake	<0·05	µM
Inorganic phosphate (phosphorus-32) – ATP exchange		
Total phosphorus-32 added	3,670	c.p.m.
Total phosphorus-32 found in ATP	820	c.p.m.
Amount of reaction, $^{32}P_i \rightleftharpoons$ ATP	14	µmoles
Inorganic phosphate – oxygen-18 exchange		
Initial atom % excess oxygen-18 in inorganic phosphate	0·278	
Final atom % excess oxygen-18 in inorganic phosphate	0·063	
Amount of reaction, $P_i - {}^{18}O \rightleftharpoons$ HOH	280	µ atoms

Each Warburg flask contained 21 µM K⁺ – ATP, 21 µM $MgSO_4$, 150 µM KCl, 150 µM sucrose, 45 µM inorganic phosphate (phosphorus-32 or oxygen-18) and washed liver mitochondria from fasted rats from 0·5 gm. fresh liver. Flasks were incubated 5 min. at 23° before addition of the inorganic phosphate-32 and measurement of oxygen uptake. Reaction time, 15 min.

Various considerations suggested that oxidative phosphorylation under suitable conditions might be a demonstrably reversible process. Prominent among these was the unexplained observation of Cohn[1] that in the presence of tissue preparations carrying out oxidative phosphorylation the oxygen of phosphate was rapidly exchanged with that of water. Subsequent experiments reported briefly herein have shown that liver mitochondria preparations in the absence of added substrate and net oxygen uptake will catalyse a rapid exchange of inorganic phosphate–^{32}P with adenosine triphosphate accompanied by a very extensive exchange of the oxygen atoms of inorganic phosphate as measured with oxygen-18. Results of a typical experiment are shown in the accompanying table. Although there was little net change in the concentrations of adenosine triphosphate and inorganic phosphate, extensive exchange had occurred and the two substances appeared to be in equilibrium. The total micromoles of inorganic phosphate which was incorporated into and released from adenosine triphosphate was calculated on the basis of the expected exponential approach to isotopic equilibrium, with the assumption that two phosphate groups of the adenosine triphosphate were available for equilibration with inorganic phosphate.

The exchange of approximately twenty atoms of phosphate oxygen for each atom of inorganic phosphate incorporated into adenosine triphosphate shows clearly that reversal of the overall reaction P_i + ADP $\rightleftharpoons$ ATP + H_2O could account for only one-twentieth of the oxygen exchange observed. The demonstration of the reversibility of the overall reaction does suggest, however, a satisfactory explanation for the observed oxygen exchange. If, as depicted in the accompanying scheme, the initial reaction or reactions of oxidative phosphorylation accompanying electron transport involve loss of an oxygen from inorganic phosphate, reversal of these



An explanation of $^{32}P_i$—ATP and P_i—HOH exchange. Overall: ADP + $^{32}P_i \rightleftharpoons$ ATP + HOH reaction(s) would lead to exchange of the inorganic phosphate oxygens with water. Inorganic phosphate under equilibrium conditions would be expected to pass through the initial reaction(s) at a rate equal to or greater than through the subsequent reaction(s). Thus exchange of inorganic phosphate oxygen could be much more extensive than exchange of inorganic phosphate with the phosphate of adenosine triphosphate.

Evidence that the phosphate oxygen exchange probably does not result from transfer of the phosphate moiety after its initial uptake comes from observations that no phosphate oxygen exchange accompanies the phosphate transfer reactions of the adenylic system which have been measured[2], and from further experiments with liver mitochondria using oxygen-18. The latter experiments have shown that when phosphate is cleaved from adenosine triphosphate by liver mitochondria in the presence of 2,4-dinitrophenol, only the expected incorporation of approximately one oxygen from water into the inorganic phosphate formed was found. When inorganic phosphate – ^{18}O was transferred to adenylic acid to give adenosine triphosphate by mitochondria oxidizing alpha-ketoglutarate, the phosphate derived from the adenosine triphosphate formed had exchanged only 1·6 atoms of oxygen per phosphate; this exchange may have resulted from some reversal of the initial step(s) of the phosphate uptake at the site of phosphorylation in the mitochondria. This is in marked contrast to the extensive oxygen exchange under apparent equilibrium conditions as shown in the table.

The exchange reactions measured with phosphorus-32 and oxygen-18 were almost completely abolished by the presence of 3×10^{-4} *M* 2,4-dinitrophenol, which gives evidence in support of the suggestion that the exchange results from a reversal of phosphorylation coupled with electron transport. The unlikely possibility that the exchange of inorganic phosphate – ^{32}P was a result of reversal of hydrolytic cleavage of adenosine triphosphate was eliminated by the finding that 'adenosine triphosphatase' prepared from mitochondria according to Kielley and Kielley[3] did not catalyse the incorporation of inorganic phosphate – ^{32}P into adenosine triphosphate under conditions similar to those used for experiments reported in the table. Thus for the exchange of inorganic phosphate and adenosine triphosphate to occur, energy derived from the cleavage of the phosphate moiety from the latter must be preserved either by reduction of a component of the respiratory chain or in the form of a 'high-energy' intermediate.

If the explanation for the marked oxygen exchange is valid, and since 2,4-dinitrophenol abolishes this exchange, it follows that 2,4-dinitrophenol either dissociates electron transport from the initial inorganic phosphate uptake or causes breakdown of a 'high-energy' intermediate before the reaction leading to uptake of inorganic phosphate. The activation of adenosine triphosphate hydrolysis by 2,4-dinitrophenol[4] would be an expected result. In the reversal of the reactions by which inorganic phosphate is incorporated into adenosine triphosphate in oxidative phosphorylation, the energy derived from the splitting of the latter would be lost in the presence of dinitrophenol and thus the formation of inorganic phosphate would be essentially irreversible.

Explanations based on experimental evidence as to how transport of electrons through the cytochrome system might be coupled with phosphate uptake have been singularly lacking. Recent fundamental studies of Taube and associates[5] may give information pertinent to biological oxidations; for example, they have found that in the oxidation of chromous ion by ferric iron catalysed by chloride ion, the activated complex contains a chloride ion as a 'bridge' between the two metallic ions. The initial oxidation product is chromic chloride, which is thermodynamically unstable and reacts with water with liberation of the chloride ion. By analogy, the hypothesis is advanced that transport of electrons from metalloflavoproteins (for example, butyryl coenzyme A dehydrogenase[6]) to a cytochrome involves participation of a 'bridge' atom between the metal of the flavoprotein and the cytochrome iron, or, similarly, between an intermediate and the iron of cytochrome oxidase. The bridge atom might be a sulphur, an oxygen of phosphate or dinitrophenol, or a group on a cytochrome. The compound formed after electron transfer would be a 'high-energy' phosphate or be cleaved by inorganic phosphate to give a 'high-energy' phosphate. Phosphate-bond energy might thus be used to reverse the direction of electron transport. The hypothesis leads to a satisfactory, but by no means the only possible, explanation of the findings reported here.

Details of these and related experiments will be given elsewhere. This work was supported by grants from the National Science Foundation and U.S. Public Health Service.

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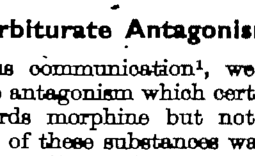
Barbiturate Antagonism

In a previous communication[1], we reported the discovery of the antagonism which certain substances exhibited towards morphine but not towards barbiturates. One of these substances was 2-4 diamino 5 phenyl thiazole. We wish to report now the discovery of a compound which is a barbiturate antagonist, and at the same time to link this antagonism with that of morphine by means of 2-4 diamino 5 phenyl thiazole (which has now been shown to be slightly antagonistic to barbiturates).

The barbiturate antagonist is ββ methyl ethyl glutarimide (designated *NP*13).



Rats and Mice. Two groups of twelve animals were taken and pentobarbitone (60 mgm./kgm.) injected intraperitoneally. To one group *NP*13 (100 mgm./

kgm.) was given by the same route. The average sleeping time of the test group was reduced to about half (a t test gave $P < 0{\cdot}1$). A similar antagonism to barbitone and phenobarbitone was demonstrated. *NP*13 (15 mgm./kgm.) itself caused convulsions which at 30 mgm./kgm. were fatal. Treatment of the animal with pentobarbitone before or after injection of *NP*13 prevented these convulsions.

Cats. These animals were aroused to a state of reflex activity and semiconsciousness from the narcosis of pentobarbital (60 mgm./kgm.). In the case of mice, rats, dogs and rabbits, *NP*13 brought about a return to consciousness from deep anæsthesia. This, however, could not be achieved with cats, and only a marked decrease in depth of anæsthesia resulted. In this respect cats behaved in the same manner as human beings (see below).

*NP*13 was effective orally, as well as by intravenous or intraperitoneal routes. It was also observed to have marked stimulating action on the barbiturate-depressed respiration, the rate being as much as doubled for a period of 5–10 min. after injection.

Rabbits. Each member of a group of six rabbits was given sufficient thiopentone (0·5 per cent) intravenously to induce a desired degree of anæsthesia. The mean duration of anæsthesia for the group was obtained. On a subsequent day the experiment was repeated, except that at the end of the thiopentone injection 3-ml. portions of a 0·6 per cent solution of *NP*13 were injected until the animal regained consciousness. The mean duration was again noted. A t test revealed a marked shortening of anæsthesia ($P < 0{\cdot}1$). Again the ability of *NP*13 to increase the barbiturate-depressed respiration was noted.

The individual dose of thiopentone to depress the respiration to 12 per minute was determined from six animals. This dose was then increased by one-third. At the end of administration of the augmented dose of thiopentone, *NP*13 was given until the animals recovered. Several days later the augmented dose alone was given; all six animals died.

*NP*13 injected alone produced convulsions which could be controlled by thiopentone.

Dogs. Six tantalum electrodes were inserted through the skull in a series of eight dogs, insulated with polyethylene and kept in position with stainless steel wire. Later, electroencephalogram records were taken. By this means it was possible to obtain a control electroencephalogram of the normal dog followed by the change in pattern as the pentobarbital took effect. Then the return towards normal produced by the intravenous injection of *NP*13 could be observed—likewise the effect of overdosage of this substance. Several experiments were carried out on each animal.

*NP*13 reversed the pentobarbital narcosis, restoring the animal to consciousness. Overdosage resulted in fasciculation, convulsions and the appearance of spikes in the electroencephalogram. The safety margin was, however, large. In none of our experiments (about twenty), despite deliberate overdosage, were there any fatalities.

We have also shown that 2-4 diamino 5 phenyl thiazole reverses the narcotic effects of pentobarbital, its action in this respect being much inferior to that of *NP*13. This substance, however, synergizes with *NP*13, the mixture giving especially greater respiratory stimulation than *NP*13 alone. Further, the convulsive effects of *NP*13 are counteracted by the thiazole.

Man. We have been fortunate in terminating the coma of some twenty cases of barbiturate poisoning with a mixture of *NP*13 and thiazole. The details of these cases will be reported fully in a clinical journal[2].

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Metabolism and the Occurrence of *d*(−)Glutamic Acid in Tumour Proteins

SEVERAL investigators[1], using isotope techniques, have failed to reproduce Kögl's results on the *d*(−)glutamic acid content of tumour proteins. All such experiments were based on the hydrolysis of tumour proteins with concentrated hydrochloric acid. Kögl tried to explain the discrepancies as due to differing methods of hydrolysis[2]; but strangely enough, Kögl's feeding experiments have never been repeated. In 1940, Kögl was able to isolate, after hydrolysis, *d*(−)glutamic acid from the fæces of a dog which had been fed with Brown–Pearce tumour tissue; in 1948, he obtained in a similar way pure *d*-pyrrolidonic acid after feeding tumour protein[3] using the method of Ratner, that is, extraction of the urine with ethyl acetate at pH 2 and precipitation with barium[4]. No objections can be raised to these methods.

We have now repeated these feeding experiments employing Ratner's procedure. After feeding 1,500 gm. of human liver metastases isolated by hand to rats, 190 mgm. of pure *d*-pyrrolidonic acid was obtained in crystal form from their urine. The ethyl acetate residue, after removal of pyrrolidonic acid, yielded a dipeptide containing *d*(−)glutamic acid. Its presence and composition were shown, after coupling with dinitrofluorbenzene, by paper chromatography and infra-red spectroscopy (we are indebted to Dr. Schiedt, Max Planck Institut fur Biochemie, for measuring the infra-red spectrogram), and after hydrolysis and paper chromatography by the microbiological method of Ayengar and Roberts[5] (incubation of the material with acetone-dry powder of *E. coli* E26 (Iowa State College) test for *d*(−)glutamic acid in the presence of γ-aminobutyric acid from decarboxylated *l*(+)glutamic acid). Other feeding experiments with two human liver metastases did not yield any crystallized *d*-pyrrolidonic acid; but the micro-method mentioned above indicated clearly the presence of *d*(−)glutamic acid. After feeding rats with human liver, beef, bread or grain equal in amount to the tumour tissue used in experiments described here, we were never able to isolate pyrrolidonic acid or to detect *d*(−)glutamic acid after ethyl acetate extraction and barium precipitation following careful hydrolysis with hydrochloric acid. However, after direct careful hydrolysis of the ethyl acetate residue with 20 per cent hydrochloric acid (1 hr. on steambath) and separation over 'Amberlite

IR-4B', we were able to show by paper chromatography the presence of small amounts of $d(-)$glutamic acid which were not due to racemization.

In order to investigate whether this $d(-)$glutamic acid arose from ordinary food proteins, the urine of starved rats was analysed. $d(-)$Glutamic acid could readily be shown to be present, employing the procedures described above. The same result was obtained with human urine. We are now trying to determine differences in the $d(-)$glutamic acid content of urine from patients with different diseases.

Since we have found $d(-)$glutamic acid in the urine of starving humans and rats, it may well be that account must be taken of the presence of 'unphysiological' d-amino-acids in ordinary metabolism; this would seem to us to explain the so far ambiguous role of d-amino-acid oxidases.

Details of this work will be published in the *Zeitschrift fur Naturforschung*.

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Influence of Carbon Dioxide on the Toxicity of Ammonia

RIVERS polluted with sewage effluent may contain low concentrations of dissolved oxygen at places where the concentrations of ammonia and carbon dioxide are relatively high. It is known that both ammonia and carbon dioxide are toxic to fish in high enough concentration, and that they are rendered more toxic by lowering the concentration of dissolved oxygen[1,2]. A study of the toxicity to fish of water containing both these substances when the concentration of dissolved oxygen was low, but not lethal, was thought desirable.

Sufficient ammonium chloride to give concentrations equivalent to 0, 15 and 30 parts of nitrogen per million was added to tap water at Garston, Watford. A mixture of oxygen, nitrogen and carbon dioxide was blown through the solutions to maintain the concentration of dissolved oxygen as close as possible to 4·41 p.p.m. and to give six concentrations of carbon dioxide, in the range 0–240 p.p.m. in each concentration of ammonium chloride; the temperature was maintained at 17·5° C. Ten yearling rainbow trout were placed in each of the eighteen solutions; and their periods of survival were observed. Each test was ended after 12 hr. even if some fish were still alive.

In the absence of ammonia, carbon dioxide was not toxic to the fish within 12 hr. at concentrations up to 30 p.p.m.; 60 p.p.m. carbon dioxide was toxic, however, and the periods of survival decreased as the concentration was increased above this level (Fig. 1). The solution containing ammonium chloride equivalent to 30 p.p.m. nitrogen was markedly toxic when no carbon dioxide was added; but as the concentration of carbon dioxide was increased to 30 p.p.m. the periods of survival lengthened. At concentrations of carbon dioxide between 60 and 240 p.p.m. all solutions were toxic, and there was little difference between the concentration – survival-time curve for carbon dioxide with ammonia and the curve for carbon dioxide alone. Very similar results were obtained with ammonia solutions containing 15 p.p.m. nitrogen.

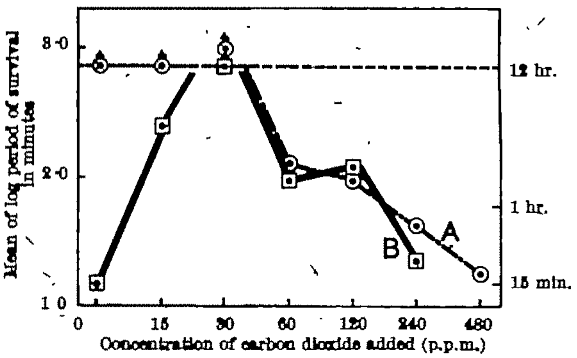

Fig. 1. Toxicity of carbon dioxide and ammonia to rainbow trout. *A*, solutions containing no ammonia. *B*, solutions containing ammonium chloride equivalent to 30 p.p.m. nitrogen

The results show that the presence of carbon dioxide up to a concentration within the range 15–60 p.p.m. reduces the toxicity of ammonia solutions; higher carbon dioxide concentrations are themselves toxic. It has been shown[1,3] that the toxicity of ammonia solutions to fish is influenced by the pH value of the water, because less of the highly toxic un-ionized ammonia and more of the much less toxic ammonium ion is present at a low pH value. The pH values determined during the experiments with ammonia solutions fell with increasing concentrations of carbon dioxide from about 7·91 when none was added to 7·4 with 30 p.p.m. carbon dioxide and to about 6·9 with 120 p.p.m. carbon dioxide. The calculated amounts of un-ionized ammonia in these solutions were 1·08, 0·26 and 0·10 p.p.m. nitrogen respectively. It is virtually certain, therefore, that the lowering of the pH value is a principal, if not the only, cause of the reduction of the toxicity of the ammonia solutions by the addition of carbon dioxide.

This communication is published by permission of the Ministry of Agriculture and Fisheries and the Department of Scientific and Industrial Research.

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Ergothioneine in the Equine Ampullar Secretion

A STRIKING feature of semen and of the reproductive organs in mammals is the diversity in chemical composition and secretory function encountered among different species[1]. Recent studies on the occurrence of ergothioneine provide a good example of this behaviour. This sulphur-containing nitrogenous base, which has been isolated in a crystalline state from the boar vesicular secretion[2] and which has been shown to be capable of protecting spermatozoa against the spermicidal action of sulphydryl-binding substances[2], is present in large quantities in the semen of the boar but not in the semen of man, bull, ram or rabbit.

It has been assumed that the rather specific occurrence of ergothioneine in boar semen is linked with the protective (reducing) property of ergothioneine, which may be of particular value to boar spermatozoa in view of the following factors which distinguish the semen of boar from that of most other species: (i) an exceptionally large volume of ejaculate (up to 500 ml.), (ii) low sperm density (less than 100,000 sperm/µl.), (iii) a protracted period of ejaculation (lasting several minutes or even longer), and (iv) a very low level of seminal fructose (a few mgm. per cent). In so far as these four characteristics are concerned, there is some similarity between the boar and another domestic animal, namely, the stallion. Whereas, however, in the boar the bulk of the seminal plasma is produced by the seminal vesicles and bulbo-urethral glands, in the stallion, and also in the jackass, an important contribution is made by the very large ampullæ of the vasa deferentia, which form two well-developed organs, about 20 cm. long and 2 cm. wide. These organs, which have been studied largely by anatomists and histologists[4], have now been found to secrete large quantities of ergothioneine.

In the secretory fluid collected from the ampullæ of stallions, ergothioneine was found to occur in quantities ranging from 14·5 to 115 mgm. per cent, as against 6 mgm. per cent in the vesicular secretion. An even higher content, 63–167 mgm. per cent, has been observed in the ampullar secretion of the jackass, again in contrast to much smaller quantities in the vesicular secretion. These values have been obtained by the use of Hunter's quantitative method, based on the diazo reaction[5]. Additional evidence for the identity of ergothioneine was obtained through chromatographic analysis[3] as well as by the determination of the bromine-labile sulphur[6].

Apart from establishing yet another source of ergothioneine in Nature, the results described here provide fresh evidence that in two different animal species a given chemical constituent of semen need not necessarily arise from the same reproductive gland; thus, in the pig, ergothioneine is found exclusively in the seminal vesicles; but in the horse and ass, much more ergothioneine is produced by the ampullæ than by the seminal vesicles. Once more, it is shown by biochemical methods that anatomically analogous reproductive organs may differ substantially in their specific secretory function.

I am indebted to Dr. T. Mann for his continued help and advice.

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Detoxification of Diphtheria Toxin with Formaldehyde mixed with an Amino-Acid

In the preparation of diphtheria vaccine, the commonly used method involves treatment of the crude toxin with formaldehyde followed by purification of the toxoid by usually rather laborious methods, for example, precipitation at the isoelectric point with methanol in the cold.

Purification of the toxin before treatment with formaldehyde can be achieved by a relatively simple process. Thus, fractionated salting out with ammonium sulphate yields products of high purity (about 2,000 Lf./mgm. nitrogen). However, the detoxification of the purified toxin raises new difficulties, as the appropriate amount of formaldehyde has to be accurately determined in pilot experiments in order that excessive denaturation and loss of antigenicity may be avoided.

These difficulties can be overcome in the following way. Formaldehyde combines with some amino-acids in a reversible reaction, the equilibrium for some acids being highly in favour of the complex[1]. A mixture of formaldehyde and such an amino-acid will consequently have a low and almost constant concentration of free formaldehyde. Provided that diphtheria toxin reacts only with free formaldehyde but not with the amino-acid – formaldehyde complex, it should be possible to use a relatively large excess of formaldehyde, most of which will be reversibly bound to the amino-acid, and yet to keep the rate of detoxification at such a low level that complete destruction of toxicity may be secured even at 35° C. without appreciable loss of activity (that is, Lf./ml.). Furthermore, in a controlled system of this type reproducible results with different batches of toxin might be more easily obtained. An amino-acid combining with formaldehyde in an irreversible reaction cannot be used. In this investigation glycine (amino acetic acid) has been employed throughout.

Purification of the toxin. Crude diphtheria toxin, obtained by cultivation of the *PW*8 Toronto strain of *Corynebacterium diphtheriae* in Mueller and Miller's medium, was concentrated to one-tenth of the original volume by ultrafiltration. Ammonium sulphate (720 gm. per litre toxin) was added and the *p*H adjusted to 7 with sodium hydroxide. After 15 hr. at room temperature, the precipitate was separated by filtration and dissolved in water. (The filtrate was discarded.) A neutral saturated solution of ammonium sulphate was added to one-third saturation, and the precipitate formed separated by centrifugation. It was then dissolved in water, and again precipitated at one-third saturation of ammonium sulphate. After 15 hr. at room temperature, the precipitate was removed by centrifugation and discarded. The supernatants were pooled and neutral saturated solution of ammonium sulphate was added to 55 per cent saturation. After 15 hr. at room temperature the supernatant was decanted and the precipitate separated by centrifugation. The precipitate was dissolved in water and dialysed against tap water.

The degree of purity of the toxins obtained by this method was 1,800–2,000 Lf./mgm. nitrogen, the yield being 60–80 per cent of the original activity.

Detoxification. 200 ml. 0·5 *M* glycine, 3·5 ml. 40 per cent formaldehyde and 640 ml. water were mixed and the *p*H adjusted to 7 with sodium hydroxide. 156 ml. diphtheria toxin, containing 3,210 Lf./ml.

and having a purity of 2,050 Lf./mgm. nitrogen, were added and the *p*H adjusted to 7·2–7·4. The final concentrations of formaldehyde and glycine were thus 0·05 *M* and 0·1 *M* respectively, the concentration of toxin being 500 Lf./ml. The mixture was kept at room temperature for four days and then at 35° C. for twenty-five days. The *p*H was checked daily during the first week and adjusted when necessary. After twenty-five days at 35° C. the preparation was non-toxic, the activity being 480 Lf./ml. (that is, 4 per cent loss). The flocculation time was twice that of the purified toxin.

For control a mixture of the same composition but without glycine was kept at room temperature for four days and then at 35° C. After four days at 35° C., the activity was completely destroyed.

The toxoid was precipitated with sodium trichloroacetate at *p*H 4·2 [2], dissolved in water, dialysed, sterilized by filtration and adsorbed on aluminium phosphate.

Antigenicity. Half a human dose (that is, 25 Lf.) was injected subcutaneously into guinea pigs of 500 gm. weight. The animals were bled after four weeks. A pool of sera from seven animals contained 2·8 A.U./ml.

This experiment indicates that diphtheria toxin reacts only with free formaldehyde but not with the amino-acid – formaldehyde complex. The antigenic activity of the toxoid obtained was in excess of standard requirements.

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Bacterial Antagonism by *Serratia marcescens*

Arising out of class-work associated with the separation of mixed cultures of *Serratia marcescens* and *Staphylococcus aureus* (*M. pyogenes* v. *aureus*), an inhibitory effect of the *Serratia marcescens* on the *Staph. aureus* has been observed.

The antibiotic responsible differs from that described by Fuller and Horton[1] in several respects. For example, its presence has not been demonstrated in shallow broth cultures of either the usual peptone–'Lemco'–broth or the medium used by Fuller and Horton. Again, using a streak-plate method o peptone–'Lemco'–agar, we have been able to shov that the inhibiting zone is a maximum after tw days incubation at 30° or five days incubation a 22° (Fig. 1).

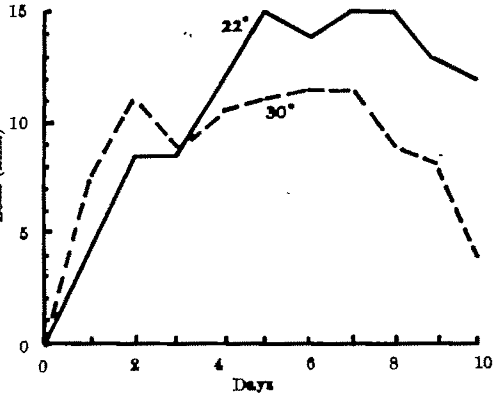

Fig 1 Inhibition of *Staphylococcus aureus* by *Serratia marcescens*

Organisms sensitive to this antibiotic include *Bacillus megatherium*, *B. subtilis*, *B. mycoides* *Corynebacterium hoagii*, *Mycobacterium phlei*, *Micrococcus flavus*, *M. roseus*, *M. viscosus*, *Staph. aureus* *Staph. albus*, *Sarcina lutea*, *Streptococcus lactis* an *Str. faecalis*.

Organisms insensitive to the antibiotic actio included *Alcaligenes faecalis*, *A. viscosus*, *Aerobacte aerogenes*, *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas fluorescens*, *Micrococcus tetragenus* and *Streptococcus cremoris*.

Owing to the lack of suitable facilities, it is not proposed to carry the work any further in these laboratories. The strain of *Serratia marcescens* is, however, available to anyone interested in following up the work.

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Progesterone in Human Blood and Tissues

The problem as to whether progesterone is present in human peripheral blood, and in what concentrations, has not yet been solved satisfactorily.

Investigations on the content of progesterone in human blood, made with bioassay methods, have yielded contradictory results. Findings obtained by different methods showed enormous differences of concentration. Hoffmann and von Lám[1] found a maximum of 0·004 γ per c.c. of blood in the luteal phase and a maximum of 0·009 γ per c.c. of blood in pregnancy. Forbes[2] found much higher levels, up to 5·2 γ per c.c. of plasma in the luteal phase and up to 2 γ per c.c. of plasma in pregnancy. On the other hand, hitherto no progesterone has been isolated from peripheral animal[3] or human[4] blood by chemical methods. This led to the conclusion that biological tests are probably lacking in specificity, so that they react upon other substances as well as progesterone.

Considering the great importance of progesterone in the therapy of endocrine disturbances, the solution of this problem seemed indispensable. The development of very sensitive micro-methods permitted an approach to the problem of chemical measurement of progesterone from the experimental side[5,6].

Our method consists of the following steps[6]: extraction of the progesterone and partition in different solvents, isolation by paper chromatography and quantitative determination by ultra-violet spectrophotometric means; definitive identification of these final products with colour-tests, ultra-violet spectra with sulphuric acid and infra-red absorption spectrum. By this method we estimate a maximal loss of 20 per cent. The smallest amount of progesterone which can be detected is 0·05 γ per c.c. blood.

The elimination of the pregnanediol complex has been considered as an indirect criterion of the amount of progesterone produced in the organism. For this reason we considered that the best time for finding progesterone in the blood would be at the time of highest pregnanediol complex elimination. Therefore, we examined the blood of healthy women from the sixth month of pregnancy onwards. Blood samples of less than 50 c.c. were taken from the cubital vein.

The quantities of progesterone found in these blood samples corresponded approximately to the minima detectable by our method of evaluation. Therefore, the yields from several samples were collected and purified once more by paper chromatography. The ultra-violet absorption spectra in a methanol solution and in sulphuric acid showed the characteristic maxima.

The definitive identification of 61 γ of final products obtained by forty-six single extractions and purified by repeated chromatographies was made by the infra-red absorption spectrum after the method of Schiedt and Restle[7]. The infra-red spectrum showed all the characteristic bands of authentic progesterone. This proves that progesterone is contained in the peripheral blood during the second half of pregnancy.

At this time the average concentration of progesterone in plasma is 0·142 γ per c.c.; converting this value to the corresponding quantity of blood, 0·078 γ per c.c. blood is obtained.

In nine collected extracts made up of four to ten single portions each, a minimum of 0·039 γ per c.c. plasma and a maximum of 0·268 γ per c.c. plasma were found. In the corresponding quantities of blood this represents 0·020–0·151 γ per c.c. blood.

No significant variations of the progesterone concentration in blood were found during the second half of pregnancy.

In order to ascertain the speed of elimination of progesterone from human blood, the variations of progesterone concentration after an intravenous injection of 200 mgm. of progesterone dissolved in a solvent consisting of 40 per cent ethyl-urethane and 40 per cent ethyl-urea were investigated. In menopausal or ovariectomized women, we found 2·540 γ per c.c. plasma at 3–5 min. after injection. This corresponds to 1·443 γ per c.c. blood. Two hours after the injection, progesterone, in a concentration of 0·197 γ per c.c. plasma (0·116 γ per c.c. blood), could still be found. Twenty-four hours after injection, progesterone could no longer be found by our method.

In further studies the organs in which progesterone is produced were examined in order to find out how much free progesterone was present in them. Placentas, corpora lutea, corpus luteum cysts and follicle cysts were studied. All organs were examined *in toto*. The results are summed up in Table 1.

A high concentration of progesterone was detected in a mature Graafian follicle immediately before ovulation. We found 49·4 γ progesterone in 6 gm. follicle fluid with a part of the follicle wall of a twenty-eight year old woman, 14 days after menstruation.

Table 1

Materials examined *in toto*	Contents of progesterone (in γ)
Placenta, pregnancy mens. II–III	61·9
Placenta, pregnancy mens. II–III	51·6
Corpus luteum, pregnancy mens. II	56·1
Corpus luteum, pregnancy mens. II–III	33·5
Corpus luteum, pregnancy mens. II–III	26·3
Corpus luteum cyst (containing 16 c.c. of cystic fluid), pregnancy mens. II–III	21·1
Corpus luteum cyst, pregnancy mens. II–III	17·4
Corpus luteum cyst (containing 7 c.c. of cystic fluid), pregnancy mens. II	17·0
Cystic fluid contained in three follicle cysts from cystic ovary (7·6 c.c.)	7·42
Cystic fluid contained in ovarian cysts from eight women (containing 3·5–265 c.c.)	—

These investigations are being continued, in the hope of determining exactly the amount of progesterone contained in the organs where it is produced, as well as in the blood vessels leading to these organs or issuing from them. The aim is to gain a definite knowledge of the amount of progesterone present during the menstrual cycle and in pregnancy.

I am grateful to Dr. U. Schiedt, Max Planck Institut für Biochemie, Tübingen, for the infra-red absorption spectra, and to Ciba A.G. for the generous supply of progesterone for intravenous injection. This work was supported by a grant from the Deutsche Forschungsgemeinschaft.

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Determination of the Origin of Opium by means of the Composition of the Ash

METHODS of determining the source of opium samples are urgently required as an aid in tightening control measures and suppressing illegal production in those areas of the world where the illicit traffic in opium originates. The Economic and Social Council of the United Nations in 1948–49 authorized research into devising chemical methods of identifying opium, and invited member Governments to participate in such a programme.

Under this programme, work was undertaken in Canada in 1949 on the composition of opium ash. A preliminary spectrographic survey of minor constituents of fifty-seven samples by Lucas and Burgener with statistical evaluation by Dunnet (unpublished results) gave promising results. It was found that, even though opium is produced from one species *Papaver somniferum*, the composition of the ash varies significantly, depending on the geographical origin of the samples.

To extend this work, and to develop the criteria for the identification of unknown samples, the ash of more than a hundred opiums from Yugoslavia, Turkey (two regions), Iran, India, Indo-China, Korea and China has now been analysed for both major and minor constituents. The elements determined were potassium, calcium, phosphorus, sodium, magnesium, silicon, iron, aluminium, titanium, boron, manganese, molybdenum, lead, tin and copper by spectrographic, colorimetric and flame photometric procedures. As an example of the type of composition variation encountered, the distribution of the potassium percentage in the ash plotted against the calcium percentage is shown in Fig. 1.

The results show that, in general, Indian samples have a high potassium and low calcium content in the ash; the druggist type of Turkish opium has a high calcium and a low potassium content, with most other samples being intermediate. The Far Eastern samples have a high phosphorus content relative to the sum of the cations. Within the Far Eastern group the northern sources (China and Korea) produce opiums with a low calcium content and often a low potassium content, while the South-East Asian samples contain more calcium. All Iranian opium ashes studied contain a relatively large amount of tin and copper which, presumably, are introduced during the handling of the raw opium. This feature is very characteristic of Iranian opium. The ash of Turkish soft opium may closely resemble the ash of Yugoslavian and Indian opiums, but can usually be distinguished by the very low silicon and iron content. Yugoslavian opium ash may contain about the same amount of potassium and calcium as some Indian samples; but the percentage of phosphorus is lower. The amounts of the trace metals, boron, manganese and molybdenum, found in opium also vary and may add corroborative evidence to aid in establishing the origin. The criteria for identification have not yet been extended to other opium-producing areas of the world, since insufficient samples of known origin have been available from these areas for developmental work.

Twenty 'unknown' samples of opium were supplied by the United Nations Secretariat for an experiment designed to test the accuracy of the criteria for discrimination of origin based on the ash composition. The origins of these samples were known to the Secretariat but not to us. In the case of several of these samples positive identification could not be made, and two possible origins were quoted in a report to the Secretariat. However, in every case where a single choice was given the origin identified was correct, and in cases where two possibilities were given, one of these two was correct.

The variation in ash composition of opium probably depends on the varieties within the species *Papaver somniferum*, and on such local features as soil, climatic conditions and agricultural techniques. In the case of Iran, the processing of the raw opium has probably contributed to the variation.

The application of the inherent variations in opium ash to the determination of the origin of the raw opium illustrates the usefulness of this techniqu and its possible application in similar problems o identification.

A full report on this work will be publishe elsewhere.

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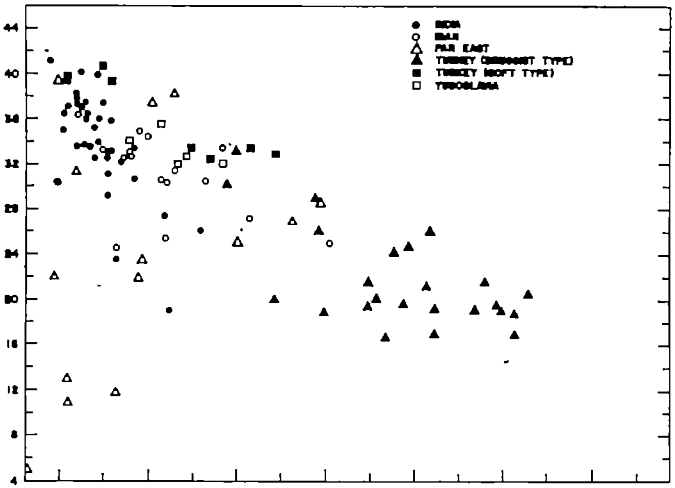

Fig. 1. Scatter diagram showing relationship between per cent calcium and potassium in opium ashes

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Test for the Pseudomycorrhizal Group of Soil Fungi

A CONVENIENT method has been employed fo differentiating between mycelia belonging to the so-called pseudomycorrhizal group, that is, forms o *Rhizoctonia* and *Mycelium radicis atrovirens*, and mycelia regarded as 'trivial' soil fungi which, so far have not been observed to infect the roots of forest trees.

Cones of filter-paper, cotton-wool and similar cellulosic materials are placed in Erlenmeyer flasks in such a way that they are constantly moistened by capillary rise from the nutrient solution contained in the flasks in which they stand. *Rhizoctonia* and *M. r. atrovirens*, the most common causes of pseudomycorrhizal infection in Great Britain, grow well on these cones, gradually covering them with a dense layer of mycelium. After three to four weeks growth, the cellulose material shows invasion by the mycelium at points where lesions occur in the fibres. Some of the hyphæ penetrating into the lumen of the fibres form large black sclerotia within the central canal, the zones of infection being easily recognized under the low power of the microscope as black, swollen areas. A number of hyphæ, however, traversing through the lumen do not produce sclerotia. After frequent cell divisions, they can be observed to form numerous irregular fusions giving rise to a well-defined structure (Fig. 1) very similar to that of an intercellular net present in pseudomycorrhizal associations of living root tissues. In contrast to the areas affected by sclerotia, the zones exhibiting net structure are of the same diameter as the uninfected parts of the fibres. It would appear that, in these cultural sets, the lumen of the fibres serves as a substitute for the intercellular spaces of the cortical tissues of the tree root.

We have in progress analyses of the factors inducing net formation under these artificial conditions. They indicate that the 'net' infection is mainly dependent on the constitution of the nutrients supplied and the rate of absorption of liquid by the cellulosic material. Beer wort proved to be a most suitable nutrient medium while, for example, potato-dextrose was not successful. Among the cellulosic

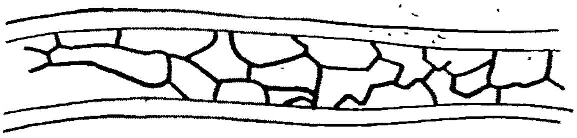

Fig. 1. *Mycelium radicis atrovirens* hyphae forming a 'net' structure in the lumen of a cotton fibre; drawing by Abbé camera (× 600)

materials employed, cotton fibres were observed to be a good substrate; acetylated cotton cellulose, however, did not encourage net formation.

None of the large number of 'trivial' soil fungi ested, for example, *Alternaria*, *Stemphylium*, *Pullularia*, *Chaetomium*, etc., although growing vigorously on the surface of the cones, has been observed o produce a net structure within the fibres. Neither was net formation recorded for true mycorrhiza-formers grown under the cultural conditions described.

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Use of Ultra-violet Fluorescent Substances for Observations on Dispersal of *Phytophthora palmivora* Sporangia

Observations have been continued on the take-off of *Phytophthora palmivora* sporangia from cacao (*Theobroma cacao*) pods affected by this fungus. The technique of using 'Vaselmed' disks of 'Cellophane' (3 mm. diameter) mounted on pins above the surface of an infected pod has already been described and the take-off of sporangia thereby demonstrated[1].

No information was available as to the number of stray sporangia in the air around a pod. Therefore, the need arose for a method of distinguishing between the sporangia from a particular pod and those which might be merely constituents of what Gregory has referred to[2] as the air 'spora'.

The marking of sporangia was discussed with Dr. A. B. Hadaway, Colonial Insecticide Research Unit, who suggested the possibility of applying a substance such as salicyl aldazine, which fluoresces in ultra-violet light, as a means of recognizing sporangia from a particular source. Tests were started in which a saturated solution of salicyl aldazine in water was sprayed on to the sporangia-bearing surface of an affected pod in the field. Disks were then placed above the pod as already described. The disks were afterwards examined under the microscope with an illumination source rich in ultra-violet light. Preliminary attempts were unproductive, apparently because salicyl aldazine is insufficiently soluble to give an adequate deposit on the sporangia *in situ*. It seemed desirable to use a more soluble substance in order to obtain a greater concentration on the sporangia. However, before the use of salicyl aldazine was abandoned, this substance was applied to sporangia in the dry form, using a small hand bellows. Later, when the disks were examined, a few sporangia were found with particles of salicyl aldazine adhering. This procedure suffered from the disadvantage of introducing an extremely artificial condition, in that the take-off and dispersal of a sporangium would be affected in an unknown way by the accompanying particle. In seeking a suitable soluble substance for use in these studies, I am greatly indebted to Mr. J. A. Radley, Industrial Research and Development Laboratories, Reading, who suggested and supplied samples of three substances (primuline *A*.150 (I.C.I.) (C.I. No. 812); rhodamine 6 *GDN* 500 (I.C.I.); stilbene derivative) for trial in Nigeria. In the course of preliminary but not exhaustive tests, it was decided that primuline *A*.150 would be the most suitable of the three substances supplied. It was used exclusively in further experiments and is later referred to here as primuline, for the sake of brevity. This substance is soluble in water (5 per cent by weight at 30° C.) and gives a greenish-yellow fluorescence. When a saturated solution was sprayed on to sporangia *in situ*, they were readily stained by the primuline and became very conspicuous in ultra-violet light. Incidental observations indicated that primuline did not exert any toxic effect.

Sporangia showing the characteristic primuline fluorescence have been observed on disks exposed in rainless periods when take-off apparently occurred in 'dry' air. The number of sporangia per disk has averaged 0·3 per 12-hr. period. Larger numbers of sporangia (average 1·4 per disk per 12-hr. period) were observed on disks exposed during periods when rain fell, suggesting that rain-splash take-off had occurred. It has already been suggested that sporangia are commonly dispersed in splash-droplets[1]. Non-fluorescent sporangia were observed on some of the disks examined; these sporangia may have come from the air 'spora'; but it is also possible that they may have been sporangia from the primuline-treated pod which had escaped treatment.

The procedure used for these observations on dispersal of *Phytophthora palmivora* by marking sporangia with primuline has served satisfactorily to confirm the phenomenon of take-off in 'dry' air. It is possible that this technique can be usefully applied to similar studies with other fungi. Detailed results will be published elsewhere.

This communication is published with the permission of the Inspector-General of Agriculture, Nigeria. I am indebted to Imperial Chemical Industries, Dyestuffs Division, for information on the solubility and fluorescence of primuline *A*.150.

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Somatic Selection in Fungi

In a recent communication, Calpouzos[1] reported that prolonged selection of sporulating material from recent single or mass spore isolates of the fungus *Cercospora musae* gradually increased the intensity and uniformity of sporulation in later cultures even though the spores selected were always of asexual origin. He suggested that if the original isolates had been heterokaryotic this observation was in agreement with the gradual sorting out, by selection, of a nuclear type having a greater spore-producing potential. Although this is a possibility in the case reported by Calpouzos, a similar situation has been encountered in my own experiments under conditions where heterokaryosis is ruled out as a possible explanation.

A normal culture of *Aspergillus nidulans* has both asexual conidia (which are always uninucleate) and sexual ascospores. Transfers may be made by conidia, ascospores or hyphal tips. In the course of routine maintenance it was noted that after a few transfers by single conidia the formation of perithecia became progressively delayed and infrequent; until after the fourteenth transfer no perithecia were produced. Since this fourteenth transfer the line has remained asexual for more than a year. After the fifth and ninth conidial transfers, however, single ascospores were used for starting new cultures. In these sub-lines germination of ascospores was initially poor; but after several generations of transfer by ascospores, germination and perithecial formation improved until the lost characteristics of the normal culture had been regained.

A series of transfers by single ascospores for the ascosporal line, made in parallel with the conidial transfers, led to a marked decrease of asexual spores. From the third and ninth generations of this line, sub-cultures were repeatedly transferred by single conidia, and the sub-lines also regained the normal balance of sexual and asexual spores. Thus a change occurred in these two lines in the direction of the method of propagation (sexual or asexual) used, and it was reversible by reversal of the method of propagation. In the asexual line the gradual change reached its extreme in an irreversible change to an *imperfect* form.

An observation probably related to that in *Aspergillus* was made on homokaryons derived from recently isolated heterokaryons of *Penicillium cyclopium*[1], which is known only in the asexual form. In this case colonies arising from single uninucleate conidia varied in their sporulation, the more fertile arising disproportionately often from spores formed early in the life of the parent mycelium. Transfer by hyphal tips or sterile aerial mycelium appeared to lead to a delay in sporulation if not to a real decrease in the number of spores. On the other hand, parallel cultures obtained by continuous transfer through single conidia resulted in a gradual increase in the intensity of sporulation. The changes were found to be reversible whenever tested.

In a preliminary investigation into the inheritance of the difference in *A. nidulans* an autonomous yellow spore mutation was introduced into the ascospore selected line with sparse conidia, and a heterokaryotic association formed between this marked line and the conidial-selected line[2]. The newly formed heterokaryons sporulated freely, giving both green and yellow conidia. They also gave a normal number of perithecia, some of which originated from the mating of two nuclei from the sexual type parent (being recognized by their giving progeny all with yellow conidia), some from the fusion between nuclei from the sexual and from the asexual type parent (which gave mixed progenies with yellow and green conidia), but some also from the fusion of two nuclei from the asexual type parent (which gave only progeny with green conidia). All spores, whether green or yellow, sexual or asexual, gave mycelia with a normal ratio of conidia and perithecia. Thus, not only are the nuclei of the asexual type parent capable of giving the full range of development in the cytoplasm of the heterokaryon but they are still capable of doing so following their extraction from the heterokaryon by means of asexual conidia. We can only conclude therefore, that the difference between the two selection lines is extranuclear in origin.

Since in fungi all cells, capable of reproducing at all, can form complete organisms and in doing so generally give identical results, the differentiation between ascogenous hyphæ, conidiophores and vegetative mycelia must be due not to the nucleus but to the condition of the cytoplasm in the differentiating region. The normal nucleus is capable of determining and responding to the full range of differentiating cytoplasm so that a full range of organs is produced; but mutated nuclei are known which fail to give this full range, as, for example, where non-sporulating forms are produced (Pontecorvo and Gemmell[4], Sansome[5], Hansen and Snyder[6]). That the differences in *A. nidulans* considered above are not of this nuclear kind is shown by the ability of a nucleus originally of a non-sexual type to give the full range of development when present in the cytoplasm of the heterokaryon. The failure of differentiation must reside in the cytoplasm. Now cytoplasmic differences can arise from chance irregularity in distribution of self-reproducing bodies, or from environmental changes or from nuclear action. In higher organisms, nuclear genes play the predominant part in differentiation by their orderly control of cytoplasmic change. In the present case to relate the progressive and reversible changes in spore frequencies to nuclear differences would be to imply a progressive and reversible rate of mutation of a very unlikely kind. It is much more likely that in both species the changes were due to changes in the cytoplasm that perhaps spring from non-random distribution of its components. This could arise by differential multiplication under environmental stimulus (relatable perhaps to staling of the medium) or as a normal outcome of differentiation. Irrespective of the origin of these cytoplasmic differences, as a result of the selection practised here, they have been progressively built up until larger, more permanent differences such as distinguish tissues in higher organisms have been attained. It would seem that one difference between fungi and most higher organisms lies in the less effective co-ordination of cytoplasmic changes, that is, the less rigid control of the cytoplasm by the nucleus in the fungus. Even so it would appear that cytoplasmic differences can be built up and broken down by somatic selection in rotifers[7] and *Lemna*[8]; so that the control of the fungus is related to changes in higher organisms. The information to be gained from the fungus would thus appear to be of potential value to our understanding of the process of differentiation in general.

I am indebted to Prof. K. Mather and Mr. L. G. Wigan for helpful discussion in the preparation of this report.

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Prolonged Stimulation of Wool Growth following Injections of Ox Growth Hormone

DURING an investigation of the pituitary regulation of wool growth, various ox anterior pituitary preparations were injected into normal sheep. The sheep were individually fed a constant weighed ration, and wool growth was measured by clipping an area of 20 cm. × 20 cm. defined by tattoo lines on the midside of the body at weekly or fortnightly intervals. The wool samples were extracted to remove ether-soluble and water-soluble grease, and the oven-dry weight taken as a measure of wool growth over the period between two successive clippings.

In the first experiment, four ewes (two Romney Marsh and two Suffolk) were each injected with 4 ml., daily for fourteen days, of an alkaline saline extract of ox anterior pituitary glands (*F.G.S.* 289) prepared as described by Young[1] and Reid[2]. Four ewes (two of each breed) were maintained as controls. Wool growth was measured over two preliminary periods of fourteen days each prior to commencing injections. Wool growth thereafter was expressed as a percentage of the corresponding mean value for the preliminary period. During the first week of injections, wool growth in the treated group was significantly ($P < 0{\cdot}01$) increased by 17 per cent above that of the controls. A reverse effect was seen during the second week of injections, the wool growth of the treated group being 14 per cent below that of the controls. This effect was not significant, one of the control sheep being sick during the week and showing a depression of wool growth. The value for this sheep was omitted from the comparison. After the cessation of injections, wool growth of the treated sheep significantly ($P < 0{\cdot}05$) increased relative to the controls, the difference reaching nearly 30 per cent fourteen weeks after the cessation of injections, and gradually disappearing over the next ten weeks. There was no significant difference between the two breeds in their responses to treatment. The pituitary extract used was rich in growth hormone but also contained prolactin, thyrotrophic hormone and luteinizing hormone in good amounts.

In another experiment with ewes of the same breeds, four ewes were injected daily with 5 mgm. of ox growth hormone (24 *GH*) for five weeks. The effect on wool growth is shown in Fig. 1. Wool growth in treated ewes of both breeds increased relative to the controls throughout the period of injections ($P < 0{\cdot}01$) and continued above the control-level for twenty-nine weeks after the cessation of injections ($P < 0{\cdot}01$) when the experiment was terminated. The stimulation of wool growth was greater in the Suffolk than in the Romney Marsh ewes both during and after the injection period.

When similar experiments were carried out with Lincoln ewes, a stimulation of wool growth was observed during the period of injections of both anterior pituitary extract and growth hormone; but the response disappeared soon after the cessation of injections except in three ewes (two out of twelve ewes injected with anterior pituitary extract, and one out of eight injected with ox growth hormone). One cannot be sure, of course, that their individual responses were, in fact, due to the treatment.

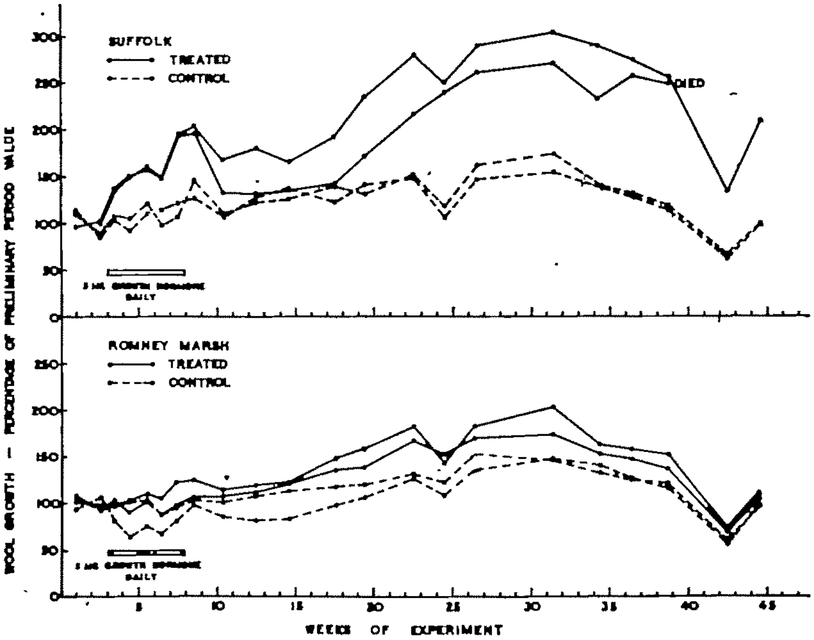

Fig. 1

It was postulated that the prolonged responses of wool growth recorded with the Romney Marsh and Suffolk ewes were due to an immune-type reaction resulting in an increase in the secretion of growth hormone by the sheep's own pituitary or a decrease in its rate of destruction. The sera of the injected sheep were accordingly tested for antibodies to ox growth hormone by the tannic acid hæmagglutination reaction[3]. The results of these tests have been described elsewhere[4]. Antibodies to ox growth hormone were detected in the sera of sheep showing prolonged responses of wool growth. The titre was not correlated with the size of the wool response, but too few observations were available to estimate the correlation with accuracy. More work is in progress to test the hypothesis further.

I am indebted to Dr. E. Reid for his collaboration in the preparation of the pituitary extracts used in the above experiments.

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FORTHCOMING EVENTS

Wednesday, September 1st—Wednesday, September 8th

British Association for the Advancement of Science (at Oxford).—Annual Meeting.

Wednesday, September 1

At 8.30 p.m.—Dr. E. D. Adrian, O.M., F.R.S.: "Science and Human Nature" (Presidential Address).

Thursday, September 2

At 10 a.m.—Sir John Cockcroft, F.R.S.: "Recent Developments in Nuclear Physics" (Presidential Address, Section A).

At 10 a.m.—Sir John Lennard-Jones, F.R.S.: "New Ideas in Chemistry" (Presidential Address, Section B).

At 10 a.m.—Sir Gavin R. de Beer, F.R.S.: "Archaeopteryx and Evolution" (Presidential Address, Section D).

At 10 a.m.—Prof. W. H. Pearsall, F.R.S.: "Growth and Production" (Presidential Address, Section K).

At 11.45 a.m.—Prof. L. S. Hearnshaw: "Recent Studies in the Psychology of Thinking" (Presidential Address, Section J).

At 2.30 p.m.—Dr. C. B. Williams, F.R.S.: "Phenology—The Study of the Seasons" (Presidential Address, Section X).

Friday, September 3

At 10 a.m.—Prof. E. A. G. Robinson: "The Changing Structure of the British Economy" (Presidential Address, Section F).

At 10 a.m.—Dr. Willis Jackson, F.R.S.: "The Effect of New Materials on Engineering Progress" (Presidential Address, Section G).

At 10 a.m.—Sir Mortimer Wheeler: "Colonial Archaeology" (Presidential Address, Section H).

At 10 a.m.—Mr. Ronald Gould: "The Teacher in the Twentieth Century" (Presidential Address, Section L).

At 10 a.m.—Dr. R. E. Slade: "Agriculture—The Industry and the Science" (Presidential Address, Section M).

At 11.30 a.m.—Prof. J. A. Steers: "The Coast and the Geographer" (Presidential Address, Section E).

At 8 p.m.—Prof. W. E. Le Gros Clark, F.R.S.: "Reason and Fallacy in the Study of Fossil Man".

Sunday, September 5

At 8 p.m.—Prof. C. A. Coulson, F.R.S.: "Science and Religion".

Monday, September 6

At 10 a.m.—Dr. C. J. Stubblefield, F.R.S.: "The Relationship of Palaeontology to Stratigraphy" (Presidential Address, Section C).

At 10 a.m.—Prof. A. D. Macdonald: "The Relief of Pain" (Presidential Address, Section I).

At 8 p.m.—Dr. F. P. Bowden, F.R.S.: "Friction".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Advisory Officer (with an honours degree in agriculture or pure science, and a special interest in grassland work) in Agricultural Botany—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (September 4).

Assistant, Grade A (with graduate or equivalent qualifications), at Sheffield College of Commerce and Technology, to teach physics in National Certificate Courses in Chemistry and Metallurgy, in advanced level classes for the general certificate of education, and in various City and Guilds courses—The Director of Education, P.O Box 67, Leopold Street, Sheffield (September 4)

Assistant Lecturer in Metallurgy—The Registrar, The University, Manchester 13 (September 11).

Chemists (with a first- or second-class honours degree or equivalent in chemistry, and with research experience, preferably in physical chemistry), with the Ministry of Supply at various research stations mainly in the south of England—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.546/54A (September 11).

Research Demonstrator in Geography—The Registrar, The University, Sheffield (September 11).

Research Officer (with an honours degree in engineering or science or equivalent qualifications) in the Division of Building Research, Commonwealth Scientific and Industrial Research Organization, Highett, Victoria, to participate in a programme of theoretical and experimental research on the properties and uses of lightweight concrete and gypsum plaster as structural materials—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 390/209 (September 18).

Senior Research Officer or Research Officer (with a university degree in veterinary science, with postgraduate research experience in the control of animal diseases or equivalent qualifications) at the Animal Health Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, to undertake the general responsibilities of a veterinary pathologist and bacteriologist in laboratory and field investigations, and to develop an individual interest in one of the research projects—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 201/81 (September 18).

Lecturer in the Department of Organic Chemistry—The Registrar, The University, Liverpool (September 20).

Lecturer (graduate, with qualifications and/or experience in measurements and/or heavy electrical engineering) in Electrical Engineering—The Registrar, The University, Manchester 13 (September 22).

Lecturer in Dressing of Minerals and Coal Preparation—The Registrar, The University, Leeds 2 (September 27).

Lecturer or Assistant Lecturer (with an honours degree in physical oceanography, mathematics or physics, and prepared to spend several weeks each year at sea) in the Department of Oceanography—The Registrar, The University, Liverpool (September 30).

Chemist or Metallurgist (with a first- or second-class honour degree or equivalent in chemistry or metallurgy, and with post graduate research experience, particularly concerning the study of corrosion), with the Ministry of Supply, Port Harcourt, Nigeria, to study the effects of tropical conditions on Service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F564/54A.

Physicist (with a first- or second-class honours degree in physics and considerable experience of instrumentation research and development) in the Rocket Propulsion Department, Ministry of Supply Westcott, Bucks, to lead a small section on rocket instrumentation research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting 285/54A

Research Assistant in the field of Physical Chemistry (reaction kinetics)—The Secretary, University College, Exeter.

Scientific Assistant (with a degree in agriculture or natural science, a knowledge of languages, and ability to write clear concise abstracts in English), for duties which will mainly consist of examining and abstracting world scientific literature on grassland and field-crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks.

Scientific Officer (with a first- or second-class honours degree in chemistry or equivalent qualifications, and a sound theoretical knowledge of inorganic and physical chemistry, and experience of modern methods of inorganic analysis), at the Capenhurst Works of the United Kingdom Atomic Energy Authority, near Chester, to carry out research and development work on analytical methods—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 650

Scientific Officer (with a first- or second-class honours degree in physics with subsidiary mathematics, and preferably with some knowledge of electronics), at Fort Halstead, Kent, for experimental small-scale work on fundamental problems in connexion with the study of phenomena associated with explosions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 209/WGH/2.

Scientific Officers (with a first- or second-class honours degree in engineering, physics or mathematics or equivalent qualifications) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, for research in several branches of mechanical engineering, for example, fluid mechanics, heat transfer, lubrication and improvement of mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C 551/54A.

Senior Technician in the Department of Botany—The Secretary, Bedford College (University of London), Regent's Park, London, N.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology, for the year 1953, with Report of the Geological Survey Board and Report of the Director. Pp. iv+90. (London: H.M. Stationery Office, 1954.) 3s. net. [17

Forestry Commission. The Queen Elizabeth Forest Park: Ben Lomond, Loch Ard and the Trossachs. Edited by Dr. John Walton. Pp. vii+80+1 map. (London: H.M. Stationery Office, 1954.) 3s. 6d. net. [17

Forestry Commission. Traps for Grey Squirrels. Pp. 9. Forest Record No. 26: Drought Crack of Conifers. By W. R. Day. Pp. 40 (10 plates). 2s. 6d. net. Forest Record No. 27: Use of Home-Grown Timber in Wood Turning and Related Trades in Scotland in 1953. By J. R. Aaron. Pp. 10+4 plates. 1s. 3d. Forest Record No. 28: Volume Table for Small Hardwood Trees. By J. N. R. Jeffers. Pp. 10. 9d. net. (London: H.M. Stationery Office, 1954.) [17

Other Countries

World Health Organization. Technical Report Series No. 83. Methodology of Planning an Integrated Health Programme for Rural Areas. Second Report of the Expert Committee on Public Health Administration. Pp. 46. 1s. 9d.; 0.25 dollars; 1 Swiss franc. Technical Report Series No. 85: First International Conference of National Committees on Vital and Health Statistics. Report. Pp. 22. 1s. 9d.; 0.25 dollars; 1 Swiss franc. Technical Report Series No. 86: Expert Committee on Biological Standardization. Seventh Report. Pp. 22. 1s. 9d.; 0.25 dollars; 1 Swiss franc. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) [57

Smithsonian Miscellaneous Collections. Vol. 120 (Whole Volume): Smithsonian Physical Tables. Ninth revised edition. Prepared by William Elmer Forsythe. (Publication 4169.) Pp. vi+827. (Washington, D.C.: Smithsonian Institution, 1954.) 9 dollars, paper; 10 dollars, cloth. [57

United States Department of Agriculture. Farmers' Bulletin No. 1829: Insects and Diseases of the Pecan and their Control. Pp. 56. (Washington, D.C.: Government Printing Office, 1954.) 25 cents. [57

United States Naval Observatory. Circular No. 51: Positions, Areas and Counts of Sunspots, March–April, 1954. By Dr. Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U.S. Naval Observatory, 1954.) [57

SOCIAL RESPONSIBILITY IN THE MODERN WORLD

RECENT presidential addresses to the British Association have frequently considered the impact of science on society—generally an aspect of hat impact which the president could discuss with pecial authority—and have sought to indicate to he layman some implications of the advance in knowledge and technique for the world to-day. That esponsibility is frankly accepted by this year's president. Dr. E. D. Adrian, whose address is printed on p. 433, believes that the Association should show he layman where the scientific age is leading him and that the success of the Association's meetings is o be judged by its impact on public opinion.

The theme of Dr. Adrian's address, however, is not so much the impact of science on society, as its impact on man himself. To appreciate the difference it is unnecessary to look back so far as Dr. Adrian himself did, to the famous meeting of 1860 which, as he pointed out, emphasized both that man himself is part of the physical world and also man's determination to go on searching for truth—a determination which has been sternly challenged even in the West during the past twenty years. We need look no further than the meeting at Oxford just sixty years ago. At that meeting, at which, in his presidential address, the Marquis of Salisbury referred particularly to our ignorance of the nature of atomic structure, of the ether, and of the causes and origins of life, Sir Oliver Lodge gave the first public demonstration of wireless signalling by means of electromagnetic waves, and Lord Rayleigh and Prof. William Ramsay gave a preliminary account of a new gaseous constituent of the atmosphere. The isolation of argon and helium and the other rare gases still lay in the future, with Becquerel's discovery of radioactivity. Even when next the Association met at Oxford in 1926, although Rutherford had indicated the possibility of atomic fission at a price, the discovery of the neutron lay half a dozen years ahead. Atomic physics and radiochemistry were still to develop, and even broadcasting was a relative novelty which had yet to exert its full power over the mind and habits of society.

On any comparison of the impact of scientific discovery and its applications on society between the meetings of the Association at Oxford in 1894 and 1926, and between that of 1926 and the present, the changes in habit, in opportunities for good and for ill have been far more profound in the second period. As Dr. Adrian pointed out, in atomic physics we face discoveries which could be used to devastate half the world, and if so applied would at least make life in the other half extremely precarious. Moreover, the direct effects of atomic explosions, though of chief concern to the strategist, are not the only dangers: repeated atomic explosions might lead to a degree of general radioactivity which no one can tolerate or escape. The dangers of contamination associated with the supply of atomic energy for industrial use can be avoided by suitable precautions; but in a major war such precautions would soon be set aside, if indeed they could be organized effectively. Dr. Adrian is almost certainly right in suggesting that a long war between powers well armed with atomic bombs would involve an order of radioactive contamination which neither victors nor vanquished could escape.

This additional risk of catastrophe does not, he argued, make our predicament much worse than that of earlier generations. Our predicament is the inevitable result of our curiosity and of the physical nature of the world in which we live; but if we can make our behaviour worthy of our increased knowledge, we can live safely. In other words, scientific advance has imposed on man the need for standards of conduct and forms of social organization which are appropriate for the new powers which are put into man's hands and the changed conditions under which he has to live. If man is to use wisely and safely the immense powers now at his command, he must accept the discipline that such use demands and adapt himself and his institutions accordingly.

Advances in atomic physics are not the only advances in science which make such demands on man. Advances in medical science can be misapplied, and drugs can be used for subduing men's minds as well as for the relief of pain and the cure of disease. Prof. A. V. Hill two years ago pointed to some of the implications of the eradication of disease in the way of social discipline for the backward areas of the world; and, as Dr. Adrian reminds his audience this year, a drug or a system of education which would make us all do as we are told, a method of producing radical conversion to a new system of belief or a knowledge of new ways of rousing patriotic ardour, could all be used with consequences as grim as the genetical deterioration in a radioactive world. The psychiatrist who discovers a cure for paranoia may find he has also revealed a convenient way of producing it.

How precarious is the division between the beneficial and harmful effects of any particular discovery has been emphasized by Mr. Charles Morgan and other modern novelists; and it cannot be too firmly insisted that if we continue to tolerate war, there is no kind of scientific investigation which might not be used for making war more destructive, no discovery in the field of human conduct which could be guaranteed harmless. The alternative to social discipline is, in fact, the renunciation of the whole process of discovery and investigation. To rely on increased knowledge for defence as well as attack is more likely to postpone than avert catastrophe, and the core of Dr. Adrian's address lies in his plea for the individual and social readjustment which these grave possibilities demand as a condition of the continuance of civilization.

The scientist, said Dr. Adrian, has a dual responsibility. He must apply his science to learn as much as possible about the mental and physical causes of our behaviour, and he must study human nature to prevent its failures. He cannot, however, wait; for the discoveries might make us act more wisely. He must take men and women as they are, and make it his task at meetings like those of the British Association to point out that the human race cannot survive more than a few thousand large atomic explosions whether they hit or miss their targets.

If the British Association could make this known universally, Dr. Adrian believes it would have justified its existence, and to do so may just come within its declared purposes: "to give a stronger and more systematic direction of inquiry" or "to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress". He is less confident that a fuller understanding of the physiology of the brain or use of the means at our disposal to ensure clear heads or even tempers after a period of strain or fatigue would assist materially our efforts to live peacefully. Such means may diminish friction and misunderstanding, but we must find out what human behaviour is like before we try to explain how it is produced; and Dr. Adrian's address is an impressive plea for the many branches of social science to provide a dispassionate study of what actually happens in our society. In our pattern of human behaviour the units are men and women, rather than cells or molecules, on one hand, or on the other hand the large groups, with which it is often far easier to deal. When all allowance is made for the differences between the units, the general principles which determine their behaviour should stand out the more clearly because we are dealing with millions and not only individuals. With the increased knowledge psychologists now possess of the irrational factors which can sway the smaller groups as well as the family and the individual, Dr. Adrian believes the stage is set for what might well be the most important scientific development of this century.

Scientists and laymen alike may be growing more aware of the value of social investigation and of the degree of certainty it could bring; but they are scarcely as yet convinced that the kind of observation that the social scientist can make is really objective and precise. Few are ready, as Dr. Adrian remarks, to believe that the social scientists are more open-minded than themselves, and that they are capable of the open-mindedness and an almost superhuman power of selection which the nature of their material demands—of seeing the wood as well as the trees in it. Recognition of the difficulty of controlled experiments encourages reluctance to act on the findings of social scientists even when we can see that there are facts to be ascertained about our relations to one another, our usefulness in society and about the risks we take, and that the search for these facts could be conducted on reasonably scientific lines.

While therefore the social scientist deserves more generous support and a fitting place in the full stream of academic life, we should not expect too much. We may well find out a great deal about the tensions which lead to war without seeing how to eliminate war. Nevertheless, biological studies warrant the suggestion that human beings are not to be thought of as incapable of improvement. Alone in the animal kingdom, we possess a nervous system which enables us to order our ideas in words, and a way of thought which allows us to compare a new problem with an old; and our increasing background of experience makes Dr. Adrian confident that we are constantly acquiring new habits and new ways of thought. Our brains must have been so modified by what we have learnt that they are physically and chemically different, and better adapted for the complex social life of our time. We have more knowledge at our disposal, and if all goes well with our training, our brains should be more civilized than those of our fathers, and those of the next generation more civilized than ours.

It may well be that the scientific investigation of mankind can help the process of civilization by determining the weak points in our equipment and suggesting remedies; though such scientific activities may play only a limited part in the development of human society in this scientific age. The power we have acquired over the forces of Nature may indeed permit us to increase our mental training as well as our standard of comfort; but it does not follow that in many parts of the world the university, as we know it, will play the part in civilizing the most intelligent citizens that Dr. Adrian predicts. The university could not, admittedly, have opened its doors and extended its influence without the very inventions that have been blamed for our troubles—cheap printing and improved means of communication and transport. Whether the university is to be a fully effective civilizing influence depends on two factors: the threat to intellectual freedom, and our sense of social responsibility and self-discipline.

The control over Nature which science has given us has enabled us to improve our natures by more education in the arts of civilized living, and we may be able to do so more rapidly if we extend our insight into human behaviour and if we know where we are going. But we can no longer take it for granted that the British Association and other bodies will be able to foster this and every type of inquiry. Although it is human nature to inquire, to learn by experience, and to profit by what it finds out, that instinct, that right of inquiry, is threatened to an extent unknown since the Association was founded. Not only in Germany, in Italy, in Japan, in the U.S.S.R., in China, but even in the United States, man's right to knowledge and freedom of investigation have been challenged to an extent which made, for example, Columbia University centre its bicentennial celebrations around the theme "Man's Right of Knowledge and the Free Use thereof".

That threat cannot safely be disregarded while we seek to foster investigations which may indicate more precisely exactly how such anti-scientific forces arise and just how it is the values and ethics of science and of scholarship generally come to be repudiated. By and large, mankind knows why those values and that ethic are sometimes repudiated. It is not fresh knowledge that will enable mankind to restore generally the conditions in which creative work flourishes, and solutions for the problems of mankind are sought with uninhibited, vigorous and imaginative minds: it is moral courage to act with wisdom and responsibility on what we already know.

No survey of the horizons which man's mind has yet to explore, and no plea for freedom of investigation and for clear unhampered communication of ideas, is adequate which takes no account of this need for wisdom and responsibility. "We have," said Sir Charles Sherrington, in his Gifford Lectures on 'Man on His Nature" (p. 404; Cambridge University Press, 1940), "because human, an inalienable prerogative of responsibility which we cannot devolve, no, not as once was thought, even upon the stars. We can share it only with each other." Dr. Adrian mentions such social responsibility; but he does not drive home the real sharpness of the threat in anti-scientific and cultural trends to-day, or the challenge to individual as well as to social responsibility.

Every generation of mankind has to re-make its culture and its values and to re-adapt its institutions to the demands of changing circumstances and in the light of new knowledge; the tempo of change in our generation is such that our intellectual, social and political processes increasingly fail to keep abreast of contemporary needs. Hence there are strains and difficulties not only for institutions and the body politic, but also for the individual. It is in part, of course, a problem of communication, of assisting the individuals who make up the mass of society to understand what is happening under the impact of science, of integrating scientific thought and tradition into the rest of the general culture of our time. Only by so doing can we prepare men and women for the discipline demanded in an age of atomic power, broadcasting, television, aviation and the new powers of controlling disease, and leave them no longer bewildered by natural forces they do not comprehend, victims of ignorance, superstition and fear.

We can accordingly only draw comfort from the belief that new techniques and the growth of higher education will make successive generations more civilized if scientists address themselves seriously both to the task of exposition and interpretation, and to that of studying the limitations of our existing intellectual tools and frames of thought and their adequacy for the relations and conditions of to-day. As Dr. P. W. Bridgman has pointed out, we have to examine such social concepts as human rights, duties and responsibilities in the light of the environment with which technological change has surrounded them, and to revise if need be the conceptual foundation of our social and political system in the light of such an examination. In particular, we must have regard to the imperfection with which social organization functions in large communities, where the individual is liable to lose the sense of community and responsibility, and where what were virtues in a small community may even be inverted.

Dr. Bridgman may well be right to suggest that any such appraisal will result in a society in which relations between the individual and society rest on virtues comparatively unfamiliar. What is even more important, however, is that the process of human improvement which he and Dr. Adrian visualize does not rest solely on the furtherance of scientific inquiry into problems of human or civil biology, the physiology of the brain, human behaviour and social, industrial or economic relations. It rests equally on the co-operation and understanding of the ordinary citizen—on the sharing with him of the responsibility of which Sherrington spoke—and working out with him the changes and adaptations required to avert the grave dangers to which mankind is exposed and strengthen the control which at present we exert. Whether the future is regarded with pessimism or with optimism, however, depends less on the ability of men and women to adapt themselves to new circumstances or on the number of those trained to cope scientifically with their environment, than on the capacity of men and women to exercise the self-discipline demanded. It also depends on the wisdom and imagination which informs their political and social decisions, and on the emergence of standards of conduct, ideals, traditions and values and a view of life no less noble than those that inspired our forefathers and enabled them to hand on to us so rich a cultural and spiritual heritage, in which science itself is one of the great human endeavours and experiences.

THOMAS JEFFERSON, UNITED STATES PRESIDENT AND FARMER

Thomas Jefferson's Farm Book, with Commentary and Relevant Extracts from Other Writings

Edited by Edwin Morris Betts. (Memoirs of the American Philosophical Society, Volume 35.) Pp. xxiii + 178 + 552 + 8 plates. (Published for the American Philosophical Society.) (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1953.) 15 dollars; 120s. net.

It is a remarkable fact that two of the great founders of the United States were not only busy statesmen but also large farmers deeply interested in improving their land and in raising the standards of their own and their neighbours' agriculture. It is gratifying to us in these islands to recall that it was to Britain that they looked for the models on which to work, and which they were able to modify successfully to suit their local conditions. British students of agricultural history are familiar with the volume of letters written by George Washington to Arthur Young giving an account of his husbandry at Mount Vernon, Virginia, as well as more general information about the rural economy of other parts of the country: this was published in 1801, two years after his death. The American Philosophical Society has now given us a facsimile of the "Farm Book" of Thomas Jefferson, who lived at Monticello, near Charlottesville, Virginia, about 125 miles south-west from Washington, D.C., and who, like other Virginians of the time, increased his estates until finally they extended to some ten thousand acres. Much of his property was woodland; but several hundred acres were cleared and farmed:

the operations covered a wide range, for the estate had to be nearly self-supporting, providing not only most of the food but also clothes and shoes for the work-people and their families, nails for the carpenters, and other necessities.

Thomas Jefferson was born in 1743, was educated at the College of William and Mary, Williamsburg, and began life as a lawyer; at the age of twenty-six he entered public life, continuing therein for some forty years. His father died while he was still a boy, leaving him five thousand acres; another five thousand came to him later from his wife's father, but he had to leave them in the hands of managers who were not particularly competent. On his return from France "a ten years abandonment of them to the ravages of overseers", he wrote in 1789, "has brought on them a degree of degradation far beyond what I expected". Only in intervals of his active public life—the longest was from 1793 to 1796—and after his retirement from the second term of his Presidency in 1809, did he have time for close supervision on his own land.

The "Farm Book" covers the period 1774–1826. It is more of a note-book than a systematic diary; but the editor, Mr. E. M. Betts, of the University of Virginia, has included a number of Jefferson's letters which throw a flood of light on the problems of estate management of those days.

The work was done by Negro slaves, of whom he had about two hundred; as they increased by birth any superfluous ones were sold: the sale of a man for £100, the purchase of a woman and two sons for £210 and the transfer of eleven for £550 are among the entries. They seem to have been well fed and well looked after; in principle, Jefferson favoured abolition; in practice, he recognized its impossibility. For their food they were provided with maize meal, wheat flour (which they preferred), pork (600 lb. a year for a man and his wife), molasses, fish and peas. The molasses had to be purchased, but keen watchfulness was necessary as considerable quantities of water were liable to be added in transit.

The cash crops were tobacco and wheat; for home consumption large quantities of maize were needed. In the early days, Jefferson's farm manager had concentrated on maize and tobacco, growing them in a two-year rotation. Little manure was used, and inevitably the productiveness of the soil suffered heavily. Following Washington, he recognized the need for a rotation of crops, including clover, on the Norfolk lines, and among others he tried a five-course: peas, wheat, maize, wheat, clover. He used farmyard manure and also gypsum, about which he became enthusiastic. Much of his animal manure was lost, however, because of forest grazing; to obviate this he designed "a moveable air cowshed, to be set up in the middle of the field which is to be dunged, and soil our cattle in that"—an anticipation of the modern milking bail. However, he recognized that manuring might be uneconomical: "we can buy an acre of new land cheaper than we can manure an old one", he wrote.

He began his public life in the firm belief that the country should be predominantly agricultural. Farmers were for him "the chosen people of God": persons "whose breasts he has made his peculiar deposit for substantial and genuine virtue"; indeed, the establishment and survival of democracy in his view depended on peopling the land with farmers. The workshops that supplied manufactured goods, and "the corrupt cities they bred", should remain in Europe, exporting their goods to America in exchang for tobacco. After the war with Britain, however he favoured more self-sufficiency.

He had a flair for mechanical invention, an perhaps his best contribution to agriculture was hi discovery of an exact formula for the constructio of the mould board of a plough that would cause th minimum of friction in its passage through the soil He experimented with sheep; he had many pigs—he kept a breeding sow for every two labourers—and he gives details of the amount of maize require to fatten a pig: one bushel, he said, will produc 10 lb. increase in weight: assuming the bushe weighed the usual 60 lb., the result is within abou 10 per cent of the figure given by the much late Danish experiments.

Jefferson was not only a statesman and an advanced agriculturist, he was also a man of wide education; this, however, did not save him from the fat that has at times befallen other agricultural improvers he kept open house for his visitors and was often i debt; he might have died a bankrupt but a publi subscription was raised to make his position secure

The book is sumptuously produced and is wel worthy of its distinguished subject: it is a rich stor of material for students of the agricultural history of that important period. The American Philosophical Society is to be congratulated on its enterprise in arranging for production of the book, an Mr. Betts for the prodigious labour and carefu scholarship he has devoted to its preparation.

E. John Russell

MODERN CYTOLOGY

International Review of Cytology

Edited by G. H. Bourne and J. F. Danielli. Vol. 2. Pp. xii+545. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 11 dollars.

SYMPOSIA and volumes of reviews must at one time have been intended to spare scientists the burden of reading the original literature in fields of research lying a little to one side of their own; but they have long since become a literary incubus in their own right. This stricture applies far more to those reviews which are in reality mere bibliographic inventories than to articles of the style presented here. The present volume contains more than a dozen lengthy and carefully prepared reviews by recognized workers in the fields of cytology, cytochemistry and microbiology. It is admirably got up—as indeed it should be, at the price.

First among the articles of non-sectarian interest is Hämmerling's admirably translated review of his work on *Acetabularia*—work which no biologist should admit to being ignorant of. At the other extreme, Conway's concentrated theoretical discussion of the redox pump will presumably have the smallest following, for most biologists admit, with uncalled-for complacency, to a total ignorance of thermodynamics. Between these extremes are a number of reviews of orthodox pattern: cytochemical findings are described, their validity inquired into, and their significance pondered upon. Gaillard's summary of a wide variety of researches into the behaviour of cells *in vitro* stands rather apart from this classification, and so does the article shared between Mudd and Sutcliffe on the cytology of bacterial cells. Both contain evidence that is not so compendiously presented elsewhere.

In limited space, only one of the several articles that deserves it can be called specially to the attention of specialists in other fields: that in which H. R. Mahler writes on those complex many-stage enzymic reactions which remain functionally in gear in cell-free extracts containing mitochondria and smaller particles. The *kind* of system that gives functional coherence to the metabolic activities of the cytoplasm is slowly beginning to appear, and it seems to be particulate rather than, in the ordinary sense, 'skeletal'. Indeed, the cytoskeleton seems to have a rather ether-like status: one feels that something of the kind should be there, but more than one observation (for example, on ultracentrifugation) that could rank as an *experimentum crucis* can be reconciled to its non-existence. Now that complex reaction sequences appear to have an anatomical as well as a functional unity, it might be argued that the whole concept of 'separate' enzymes has no place inside the cell, however well it has done duty by the perhaps highly specialized and unrepresentative enzymes that are secreted by cells and work outside them. The argument is tempting, but it will not do. 'Separateness' does not stand or fall by separability, and the enzymes of complex many-stage reactions could be identified by specific inhibitors and substrate competences (or, in micro-organisms, by the skilful use of gene mutations) even if not one of them had been isolated. As it happens, many have been; but what is important about these complex reactions is not their divisibility but their actual indivision, and the biologist will be satisfied to learn of the existence of a level of integration that is so much larger than the molecule and so much smaller than the cell.

P. B. MEDAWAR

SENSORY GATEWAY TO THE MIND

The Human Senses

By Prof. Frank A. Geldard. (Wiley Publication in Psychology.) Pp. x+365. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 40*s.* net.

THE study of the human senses has long been and still remains among the most rewarding fields of psychological inquiry. More than a third of Stevens's "Handbook of Experimental Psychology" is devoted to it. A book exclusively occupied with the subject is therefore to be welcomed. The present effort covers partly the same ground as Piéron's "The Sensations", the English version of which appeared in 1952, though in mastery of the subject it scarcely bears comparison with its distinguished predecessor.

The usefulness of Prof. Geldard's book lies chiefly in its careful review of the recent literature on those aspects of the subject in which he is primarily interested, and those aspects are at least as much physiological as psychological. His own publications include papers on visual phenomena, retinal fatigue and brightness contrast, and on somesthesis. He has also made an exhaustive study of the so-called vibratory sense, arriving at the conclusion that it is not a separate sense but simply 'pressure in movement'. But he is equally at home in the chapters on hearing, temperature and labyrinthine sensitivity, kinæsthesis, smell and taste, though he makes little attempt at synthesis or critical evaluation of rival theories.

Prof. Geldard has not confined himself to American sources. The omission of any reference to the researches of Piéron, doyen of sensory psychophysiology, is all the more noticeable. Nor does the chapter on "The Skin and its Simuli" leave the reader with any glimmering of the haptic qualities of the hand as studied by Révész or Katz.

At one brief stage, in the chapter on colour vision, the author decides to drop the psychophysiological approach and assume a phenomenal viewpoint. It is a pity he did not sustain this second viewpoint throughout. He might then have found it unnecessary "to sidestep the vexing problem of form perception". He might also have found it possible to give more adequate consideration to the problem of pain; no part of the book reveals the limitations of a purely psychophysiological approach more sharply than the discussion of pain. Conceivably he might also have been led to see the importance of intermodal phenomena in sense perception.

Prof. Geldard's initial manifesto raises our expectations. "The highroad to the understanding of human nature," he declares, "is by way of an appreciation of man's senses and of the fundamental role they play in the attainment of knowledge and the regulation of behaviour." This may be the case; but we shall never convince anyone that it is unless we extend our interests to the personal and social aspects of sense perception. Prof. Geldard's inclinations do not seem to reach so far. He does not seem to share the view that the psychologist's task is not to concern himself with eyes, ears and skin as such but with a person seeing, hearing, touching. His restriction of interest is scarcely calculated to lead the reader on the "highroad to the understanding of human behaviour".

JOHN COHEN

THE PRACTICE OF FORESTRY

Forestry

By Prof. H. G. Champion. (The Home University Library of Modern Knowledge, No. 226.) Pp. vi+230. (London: Oxford University Press, 1954.) 6*s.* net.

THERE has been a long-standing need for a simple survey of what is meant by forestry. It is, of course, difficult to write an outline of any large subject, and the method of approach depends partly on the background of the author. Prof. Champion spent a considerable part of his professional life in India, and he has travelled widely in other parts of the world, both tropical and temperate. He has accordingly drawn his illustrations from a wide field. This is the distinctive quality of the book, and it adds greatly to its interest.

The book is comprehensive and the reader may rest assured that he has got at least a glimpse of every facet of the subject. The first chapter deals with "Forests and Trees", and brings together varied information from all over the world: the oldest trees, the tallest trees, the greatest girths, as well as short discussions on all aspects of the life-history of trees from light requirements and pollination to mycorrhiza. This is one of the most interesting chapters in the book. The second chapter, entitled "Structure of Forests", presents the forest as a plant community, discussing not only its structure in an ecological sense, but also the effect of competition, certain aspects of succession, the classification of forests on climate, and the ecological influences of man on the forest. Again, the illustrations are drawn from a world background. Chapter 3 discusses briefly the varied products from the forest, not only timber as such and as a source of cellulose, but also bamboos, fibres, gums, resins, medicines, fodder, etc. Then follows a brief but interesting discussion of the history of forest clearance to provide agricultural land, for timber products, and for hygienic purposes, such as an anti-malarial measure and for tsetse control.

Under the title of "Forest Influences" the author outlines the effect of forests on rainfall, water regime including erosion, wind and temperature, as well as a brief reference to the forest as a habitat of animal and plant life. The chapter on "Forest Conservation and Protection" discusses fire protection, control of grazing and protection against animals, insects and fungi, as well as natural agencies such as wind. The next chapter outlines methods of surveying forest resources, methods of extraction of timber, and the preparation of products from sawn timber and pulpwood to wood distillation and resin derivatives. The next three chapters deal with sylvicultural techniques used in the natural and artificial regeneration of woods and their subsequent tending; generalities are spiced with sufficient detail to make them interesting. Under the title of "Growth of Crops", the techniques of the measurement and management of forests are discussed, while the chapter on "Reclamation and Afforestation" draws its examples from the Culbin Sands in Scotland to the papyrus swamps of Uganda. There is a short chapter on forest policy, law, research and education, while the last gives a brief picture of forestry in the United Kingdom.

In the concluding paragraph, the author considers that it is inevitable that there will be a further reduction in the area at present under forest in certain parts of the world, particularly the less developed, but that this loss will be made good, at least in part, by afforestation of land mistakenly cleared of forest and also land not previously woodland, but which can now be made to carry trees by improved techniques, as in Great Britain, and also by improved production per acre. He has no doubt as to the future of wood as a major world raw material.

This book worthily upholds the reputation of the series for serious but non-technical exposition of a subject. It is remarkable for the amount and variety of the information that the author has presented so skilfully, concisely and lucidly. H. M. STEVEN

MONKEYS AS PETS

The Monkey Book

By Ernest P. Walker. Pp. xii+154. (New York: The Macmillan Company, 1954.) 6.50 dollars.

THIS book, by the assistant director of the National Zoological Park at the Smithsonian Institution, Washington, tells the owner or would-be owner of a pet monkey all that he should know. Mr. Walker has not only successfully supervised the keeping of monkeys in captivity for many years, but also has been answering questions on the subject for as long—now he has set forth his experience and knowledge in an attractive volume. The book will be of great value not only to private keepers of pets but also to those concerned with the care of monkeys in zoos and research laboratories.

The work is divided into two parts; the first part deals with general questions of animal management as applied to the primates, and is full of valuable information ranging from feeding, cages, exercise and health to psychology, and what to do when a pet escapes. This is excellent, and the chapter entitled "Psychology", pointing out that the psychological problem of keeping pets happy is of even more importance than the problem of supplying them with food, should be studied by everyone who keeps wild animals in captivity. A sub-section of the first part giving instructions for the maintenance of cultures of mealworms, wax moths and crickets as food for captive animals is particularly helpful.

The second part of the book deals systematically with all the more-or-less valid groups of species of living primates other than man, and a page is devoted to each of the genera recognized by the author, from lemurs and lorises to anthropoid apes. An introduction gives a short explanation of classification and then a brief description is given of representative species of each genus, with notes on distribution, habits and food, and advice on management in captivity, the probability of obtaining specimens from dealers, and the range of market prices. A special feature of the book is the excellent series of illustrations, mostly from photographs but some from drawings, that gives a splendid pictorial guide to the variety of forms throughout the primates.

The author believes that no pet, if properly treated, will give more satisfaction and companionship than a monkey. The instructions for the care of pet monkeys given in this book will enable owners to derive the maximum of enjoyment from their favourites and will prevent the premature loss of many animals.

The book concludes with a well-chosen select bibliography and a full index. It is a pity that its very high price, for a book of its type and size, will put it beyond the reach of many of those pet enthusiasts outside the United States who would benefit most from possessing it.

L. HARRISON MATTHEWS

COALFIELDS OF GREAT BRITAIN

The Coalfields of Great Britain

Edited by Sir Arthur Trueman. Pp. xi+396+7 plates. (London: Edward Arnold (Publishers), Ltd., 1954.) 63s. net.

THIS book is a welcome successor, well suited to present-day requirements, of Walcott Gibson's "Coal in Great Britain", the second edition of which appeared in 1927. During the intervening period, many striking advances have been made in the study of the Carboniferous coals and associated strata with which the present book is almost exclusively concerned. More especially, mention should be made of the palaeontological results achieved by Sir Arthur Trueman and other well-known workers, and the detailed re-mapping of the coalfields by the geologists of the Geological Survey. Greater precision has been achieved in most branches of the subject, and many of its aspects have been revolutionized by discoveries of recent years, including, it may be added, those of the authors themselves. All this material, old and new, has been dealt with by Sir Arthur Trueman and his expert collaborators with commendable clarity, and also adequately. Indeed, an outstanding feature of the work is its well-balanced presentation of a subject so charged with detail as is coalfield geology. The two needs which the book aims to meet, those of the ologist and the worker in coalfield industries, have een clearly kept in view, and both interests have een served without sacrifice of scientific method or the requirements of the practical point of view. erhaps a chapter dealing with the fossils of the oal Measures and associated strata and their use as ratigraphical indicators may be fittingly singled ut for mention. For it serves as an example of eatment of a highly technical subject in a manner which the results can be appreciated and applied ike by the geologist and the mining engineer.

The chapter dealing with fossils forms one of a ries of opening chapters written by Sir Arthur rueman which comprise nearly a quarter of the olume. In these chapters, the essential points in gard to the geology of coal and the Coal Measures re described in an admirably simple and yet comrehensive way. The subject of coal as a rock is llowed by a description of the rocks of the Coal Measures. Next, geological structures are dealt with; en fossils of the Coal Measures and their use; and stly, the origin of the British coalfields.

Individual coalfields are next described in a series f eleven chapters. The main plan in each case is to pply a general introduction followed by accounts f the succession and structure, details of the stratiraphy and, finally, notes on coal reserves, references eing appended to each account. Where required by dividual writers of these chapters, additional atures are included, such as the anthracites of outh Wales, and the character of the coals in other ases; the history of development of the local ining industry; proved or possible extensions of a orked coalfield; and the occurrence of igneous ocks, especially in Scotland. Not only coal, but lso other materials of economic importance such as edded iron-ores and fireclays, are reviewed. In eneral, a variety of interests are served *pari passu* ith more important objects.

A brief statement of the authors concerned and ontents of these detailed chapters may be given. rof. L. R. Moore deals with the South Wales coaleld, and with the coalfields of the Forest of Dean, omerset and Glamorgan. The Kent coalfield and ther possible concealed coalfields south of the English Midlands are treated by Dr. C. J. Stubbleeld. The Yorkshire–Nottingham, Lancashire and orth Staffordshire coalfields are described respectvely by Mr. Wilfrid Edwards, Dr. F. M. Trotter and rof. F. Wolverson Cope; those of North Wales by rof. Alan Wood and of the South Midlands by Dr. . H. Mitchell. Accounts of the Northumberland nd Durham fields are given by Dr. W. Hopkins, nd of Cumberland (mainly Whitehaven coalfield) y Dr. Trotter. Finally, the coalfields of Scotland re described by Dr. Murray Macgregor.

The book is adequately illustrated with a number f well-drawn maps, horizontal sections and comarative vertical sections of the local successions of oal-seams, together with drawings of representative nd zonal fossils and photographs of plants. An ndex is supplied at the end of the volume. This ne work will undoubtedly be widely read and be losely scrutinized by the many workers concerned n the subject. It is one of great economic as well as cientific interest, and Sir Arthur Trueman and his o-authors are to be warmly congratulated on their chievement. In its pages a critic can find little for omment except to praise, and a reader, whether xpert or student, will gain both pleasure and nlightenment.

J. E. Richey

ORGANIC CHEMISTRY IN THE ARTS AND MANUFACTURES

Industrial and Manufacturing Chemistry

By Geoffrey Martin. Part 1: Organic. Seventh edition, revised by Edward I. Cooke. Pp. xxi+752. (Kingston Hill: Technical Press, Ltd., 1952.) 90*s*. net.

BETWEEN the first and seventh editions of this book lies a period of forty years; indeed, a thirty-year interval separates the sixth edition and the present revised seventh, and during this period many branches of industrial chemistry have been completely revolutionized, while others, unknown forty years ago, have arisen, undergone development and reached an important place in the present-day industrial field. New chemical techniques and new methods of manufacturing old-established products have followed expansion in chemical knowledge, chemical engineering advances and metallurgical developments of the past forty years. But much of this finds no record in the present book.

The present editor, Mr. E. I. Cooke, faced with the stupendous task of dealing with the twenty-four sections into which this book is divided, has succeeded with his collaborators in completely re-writing some sections, dealing respectively with petroleum refining, manufacture of condensed milk and milk powders, the fatty acids industry, fuel gas industries and coal tar. Much has been done to improve the sections dealing with sugar, rubber and synthetic drugs: a former section on explosives has been omitted and replaced by one on the plastics industry, which unfortunately had to be curtailed due to considerations of space.

But a very large part of the book bears the stamp of the original edition; in most of the sections there are no references to original literature later than 1912 and, almost throughout, the statistical information given relates to the years around 1910–12 and is thus completely valueless. Also, this defect is not remedied by the very sketchy statistical information in Appendix 3. Much of the book, in fact, can be considered as little more than a historical review of the subject-matter to the stage it had reached some forty years ago; but from this point of view there is much to recommend the volume. Yet, if it is to continue to serve a useful purpose every section of it needs drastic treatment to bring it up to date—a task likely to involve its subdivision into two if not three volumes.

Extensive developments have taken place during the past few years in methods of extracting and refining fatty oils, in continuous hydrogenation and in the manufacture of margarine, now an important article of dietary throughout the Western world, though only four pages are here allotted to its consideration. The treatment of essential oils, perfumery materials and synthetics is quite inadequate. The term 'artificial silk' went out of use many years ago, being replaced by the word 'rayon', which finds no use, however, in the present volume, though the relevant section on the cellulose industry is generally well written. Similar remarks apply to the manufacture of alcohol and industrial solvents, where considerable development has occurred during the past thirty years so that we no longer strive to get methyl alcohol and acetone in commercial quantity by wood distillation.

The major technological change in the detergent industry, no longer based exclusively on soap, has brought new products and created new difficulties. The continuous soap-making process and continuous soap drying are revolutionizing the industry, causing thereby an immense saving in labour and steam. Changes such as these should have found mention in the relevant section.

Appendixes 1 and 2 and the two indexes appear to have been well done. The book is well produced and generally free from typographical errors.

H. M. Langton

A NEW PERIODIC TABLE

A New Periodic Table of the Elements Based on the Structure of the Atom

By Dr. S. I. Tomkeieff. Pp. 30+2 charts. (London: Chapman and Hall, Ltd., 1954.) 10*s*. net.

To demonstrate the periodicity in the properties of the chemical elements, Lothar Meyer chose the most direct representation: he plotted the elements in the order of their atomic weights on the abscissa, and the values of the property in question on the ordinate. At the same time, Mendeléef published the Periodic Law in the form of tables; he had to decide whether the short or the long period were to be chosen for the length of the rows; but this was the only arbitrariness.

During the following decades innumerable attempts were made to improve on Meyer and Mendeléef. All sorts of representations, trees with branches, concentric circles, spirals, figure-eights, and various three-dimensioned curves—mostly drawn on the surface of cylinders and cones—were tried; behind all this was the hope to get nearer to the mystery of the periodic system if a more perfect arrangement could be found. But the scientific result of all these attempts was nil; an understanding of the periodic system could only be achieved on the basis of quantum mechanics.

It is somewhat astonishing to see that quite recently "A New Periodic Table of the Elements" has been published which is a revival of the old discarded attempts. The curves, for example, which represent the specific gravity of the elements, are based on one of the well-tried spirals and can, naturally, not avoid the old drawbacks: such elaborate curves are tedious to draw, provide no help to the memory, and do not contain any information which could not be included in simpler representations. How much more clearly does the periodicity of the specific gravity show up if plotted according to Lothar Meyer's straightforward method! The author recommends even a cone-shaped periodic chart, another repetition of previous suggestions; whoever takes the trouble to follow the advice to cut the drawing out and to gum it together as a cone, will scarcely get any insight into the sequence of chemical elements which the usual tables do not give.

It is not very obvious why the author calls his table "based on the Structure of the Atom". It is true that the introductory pages contain an elementary description of the shell structure of the atoms, but this text has no connexion with the graphic part of the publication. It is also doubtful if the "Table of Elements"—extending over fourteen lavishly printed pages—will be of great help to the readers. One of the columns describes the colour o the elements, necessarily with the frequent monotonous repetition of the descriptions "silvery white or "iron-grey"; this column should make it clea that the main value of the periodic system is no based on the properties of the elements as 'simpl bodies', but on the periodicity which they show i their compounds. It is also questionable if th information provided in the column "normal stat of the element" is very instructive without givin more details; we are, for example, told that normally iodine is a metal.

Being a geologist, the author may have reason t suppose that some of his colleagues will find such periodic table useful; but it is not certain tha chemists or physicists or, for that matter, geologist who have sufficient knowledge of chemical an physical publications on the periodic system, wi obtain much help from his book.

F. A. Paneth

THE STABILITY OF THE SUN

Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican

By Galileo Galilei. Translated by Stillman Drake foreword by Albert Einstein. Pp. xxvii+496 (Berkeley and Los Angeles: University of Californi Press; London: Cambridge University Press, 1953. 75*s*. net.

Thomas Salusbury, in the address to th reader which prefaced his translation of th book now in question, wrote in 1661, ". . . tha singular and unimitable Piece of Reason and Demonstration the Systeme of Galileo. The subject of it i a new and Noble part of Astronomy, to wit th Doctrine and Hypothesis of the Mobility of the Eart and the Stability of the Sun". This is a very jus epitome of the famous *Dialogue*, in which th Ptolemaic system is held up to ridicule and th Copernican system abundantly justified. It is perhaps, strange that nothing should be said of th Tychonic system, which had been elaborated by th greatest astronomical observer of the time, but ther it is. Galileo was concerned with the Copernica system alone and did not even mention th fundamental discovery of the elliptic form of th planetary orbits, familiar as he was with Kepler' work and highly as he thought of it in general Strange!

The dialogue is between three characters, Salviat and Sagredo, friends of Galileo distinguished by nobl birth and keen intellect, and a third character denote by the name Simplicio. Both Salviati and Sagred were dead at the time when the book was written into Salviati's mouth are put the words of Galile himself, while Sagredo represents a witty and astut man versed in the general learning of his time. T him are given the most biting comments on th arguments of Simplicio, the peripatetic philosopher while Salviati-Galileo, with his tongue in his cheek remarks, for instance, "Sagredo, you are too causti and sarcastic. Let us put all joking aside, for we ar dealing with serious matters". It has been surmised that Simplicio was meant to represent Pope Urban VIII, but this is unlikely on several grounds. The Pope, Maffeo Barberini before his elevation, had bee a friend and patron of Galileo and was certainly n extreme Aristotelian, and Galileo, although n courtier, would scarcely have invited certain retribution by putting, as has been suggested, arguments supplied by the Pope into the mouth of a figure held up to ridicule. Galileo says that he has given "the good Peripatetic" the name because of his excessive affection towards the *Commentaries* which the neoplatonist Simplicius wrote on Aristotle. While it is not well to take everything that Galileo said in this book at its face value, there seems no reason why this should not be correct.

The *Dialogue*, while not equal to the *Discourses* as a record of original advance in the fundamentals of science, is of the greatest importance both for the immense effect that it had in winning support for the new scientific outlook and for its bearing on Galileo's personal history. The effectiveness of the arguments and ridicule brought to bear against the Ptolemaic system is widely acknowledged beyond the circle of those who have had recourse to the book. The way in which it shows the hold that certain of the older notions still had upon Galileo is less generally recognized—less still, probably, the actual errors which it reveals, particularly in the matters of the cause of the tides and the nature of comets, where Galileo was less correct than certain of his contemporaries. For all those interested in the great man's mind and in the conflicting currents of his period the book is of supreme significance, but hitherto the only English version has been the extremely rare one by Salusbury to which reference has been made.

This new translation, by Mr. Stillman Drake, is evidently a labour of love. In his excellent and modest preface the translator excuses his occasional departure from strict literalness by very properly saying that easy reading is the great requirement. He cites Galileo's dislike of pedantry: he might have quoted his predecessor Salusbury, who wrote "The Book being for Subject and Design intended chiefly for Gentlemen, I have bin as careless of using a studied Pedantry in my Style; as careful in contriving a pleasant and beautiful Impression". To-day the style of Salusbury's conscientious work, even if it were generally available, would offer difficulties to most readers. The present translation achieves an admirable balance, avoiding on the one hand colloquialisms that would be inappropriate in a classic of this kind and on the other hand a rigid verbal adherence to the text that would be troublesome. It is couched in a simple and straightforward English that has, nevertheless, well preserved the character of the original and is furnished with excellent notes which give the reader just what help he is likely to require, without holding him up by too frequent interruption. In spite of, or perhaps because of, their brevity these notes demonstrate how well qualified the translator is for his task.

The book further boasts a preface by Einstein which will be read with the attention that anything from his pen deserves. This is printed in German on the left-hand pages, with an English translation opposite. This translation is dictionary-literal, with occasionally a droll effect, as when we are told that "Apart from its revolutionary factual content the *Dialogue* represents a downright roguish attempt . . .". The roguish Galileo, at sixty-six years old, is an appealing picture. But such things are trifles. The book, which is beautifully produced, is to be warmly welcomed as offering scholarly and substantial evidence of the growing interest in the classics which lie at the foundations of modern science.

E. N. DA C. ANDRADE

AUTOMATIC CONTROL FOR ECONOMIC SYSTEMS

The Mechanism of Economic Systems

An Approach to the Problem of Economic Stabilisation from the Point of View of Control-System Engineering. By Prof. Arnold Tustin. Pp. xi+161. (London: William Heinemann, Ltd., 1954.) 25*s.* net.

UPON the conventionally trained economist this book will have some of the effects of the sculpture of Reg Butler or Barbara Hepworth on those who admire the statues in our streets: "I can't get to grips with it"; "I don't see the point of this extraordinary technique"; "It's all wrong".

It is, I think, easy to see how this exceedingly unusual book came to be written. Prof. Tustin is a very eminent designer of the means whereby electrical mechanisms acquire 'self-control' of essentially the same sort as that given to a steam-engine by its centrifugal governor. Struck by the misery and danger which arise from the booms and slumps of orthodox economic systems, he plans to stabilize these systems by building into their essential structure some features inspired by control-system engineering and working by exactly the same formal principles. But this is not all. The discomfort caused to mathematicians by the work of Oliver Heaviside (whose name appears in the text but is omitted from the index) has in the past dozen or fifteen years very largely been removed by the translation of his methods and results into the language of the Laplace transform, by which the description of the behaviour of any variable as a function of time can be replaced by its description as the sum of a set of exponentially growing or diminishing sinusoids (and thus in effect as a function of frequency), and calculations concerning it thus brought within reach of the compact elegance of vector algebra. It is, I think, the beauty and power of these mathematical methods, almost as much as the urgency of the economic problem and the hope of solution inspired by the wonderful success, in its own sphere, of control-system engineering, which has driven Prof. Tustin to attempt the conversion of economists to his gospel.

To effect this conversion he has first to teach them his language, for few economists are expert in harmonic analysis or even in vector algebra. This education he attempts in a sympathetic, ingenious and optimistic chapter of some sixty-six pages and thirty diagrams, which the non-mathematical reader is urged to "read, at first, straight through, in a light-hearted and optimistic spirit, so as to get the broad idea". I do not deny that such a man, if his lack of mathematics is accidental and not inborn, will have his imagination caught by many a stray gleam from this rich river of ideas and may even feel himself carried along by its urgent enthusiasm of exposition. But to expect the average student of economics to wrestle with this chapter, let alone to master it and add it to his effective equipment of mental tools, is wildly over-sanguine. It is still true that mathematical aptitude does much more for a man in physics or engineering, where it is indispensable, than it does in economics, where formal mathematical procedures are rather like a pair of skis, contributing tremendously to one's speed in special favourable conditions but elsewhere useless. In consequence, economics departments have comparatively few mathematically capable students, attracting instead people of equal mental calibre but with a bent towards philosophy or history. For that small group of professional economists who are mathematicians by nature but not by training, Prof. Tustin's Chapter 3 will be invaluable. This chapter could, I think, in spite of the imaginative efforts which have been made to meet the uninstructed reader half-way, be considerably improved in detail. We read, for example, from p. 55 onwards, the expression "modes of free motion"; but this phrase is not defined until several pages later. Such points may seem insignificant; but they can be fatal to a reader's effort to follow an argument.

The great unproved assumption, on which Prof. Tustin's whole thesis and programme rest, is that an economic system can be treated as a machine which cannot hide in the heart of its nature and being any autonomous capacity for responding differently, to-morrow, to a given situation from its response at a similar situation to-day. It is not, that is to say, essentially impossible to know what the economy will do in given circumstances, and it is not essentially impossible to know the circumstances themselves through and through so that nothing which matters is hidden from us. It may be, for all I know, that this assumption will be confirmed. No experiment could have a more overwhelming claim on the interest of all economists, or indeed of philosophers in general, than to find out if Prof. Tustin is justified.

G. L. S. Shackle

FOOD AND POPULATION

The Limits of the Earth

By Fairfield Osborn. Pp. 175. (London: Faber and Faber, Ltd., 1954.) 12*s*. 6*d*. net.

The author of "Our Plundered Planet", which succeeded in bringing to a large section of the American public some idea of the current profligate use of natural resources, now presents primarily to the same audience a broad picture of increasing population pressure on world food output. He does not attempt, as the title of the book might suggest, either a definition or a delimitation of the *oecumene* or habitable area of the globe, but passes in review, based on such statistics as are available, through the principal regions. Accepting a world population increase of 75,000 a day, he assesses their ability to meet the food needs of the increase.

Australia, New Zealand, Canada and Argentina are considered as the four main 'food surplus' countries, but where nationalism, rightly condemned industrialization and urbanization all threaten the home food supply and deprive the world of badly needed food surpluses. The Amazon is regarded with a certain cautious optimism; but tropical Africa, whatever its future line of development, can help the world position but little because the "African will take the land for his own". South Africa is regarded as the supreme example of the forces of science and technology frustrated by social and political conditions. The chapter on the United States underlines the author's insistence that the resources of the erstwhile "land of boundless resources" are in fact strictly limited.

The regional treatment is popular rather than profound, and least satisfactory is the chapter on Europe, where the economic position is naïvely over-simplified to fit some of the author's preconceived theories: thus, "when petroleum came into general use, the coal of England and Wales began to lose its high premium value. The strength of England's economic structure simultaneously began to diminish"; Holland has lost the East Indies, and Sweden is pioneering in new ways of population control untrammelled by religious dogma and therefore "contrasts in the ways of life of peoples living in close proximity could not be more vividly exemplified than by comparing the situation of Holland with that of Sweden" (p. 27).

A chapter on "Horizons and Mirages", devoted to additional resources, touches briefly on possibilities of increasing fisheries, using plankton, seaweeds and pond culture, and technical developments in agriculture such as soil conditioners and synthesis of proteins. On the other hand, certain obvious developments really within our grasp the author seems content to ignore. He appears satisfied, for example, with low American acre-yields needing three acres of improved farm land to support one person (against one acre over much of Europe) and quotes the U.S.S.R. with its far greater climatic handicaps as about the same standard in land requirements *per capita*. The stultifying effect of tariffs and other international trade barriers does not get a mention: the assumption seems to be that each political unit must support its own population from its own home food resources. A special word of praise is due to the publishers for continuing to bring current American thought before a wider public.

L. Dudley Stamp

METALLURGY OF CHROMIUM

Chromium

By Dr. A. H. Sully. (Metallurgy of the Rarer Metals No. 1.) Pp. xii+272. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1954.) 35*s*. net.

This book is described as the first of a series on the metallurgy of "what are commonly referred to as 'rare metals'". The book is well printed and attractively illustrated, and contains much information of value to both students and research workers. It is divided into seven parts which deal with: (1) history and occurrence of chromium; (2) production of chromium ferro-alloys and pure chromium; (3) physical properties of pure chromium; (4) melting and casting, powder metallurgy and workability of chromium; (5) electroplating and properties of electrodeposits; (6) chromizing; (7) constitution and properties of chromium alloys.

The author's style is rather diffuse, and many sentences could be shortened without loss of clarity or subject-matter. In general, however, the writing is clear and easily understood, although occasional unfortunate mistakes or ambiguous sentences are to be found. Thus the statement on p. 254 is an incorrect description of the work of Raynor and Pfeil, and suggests the formation of a phase Cr,Al, which does not exist, while the first two sentences of the paragraph 4.4.6. are unfortunate. These are, however, minor faults in a book which will be read with much profit by all who are interested in chromium or its alloys. It emphasizes the difficulties of preparing the metal in a state of high purity, and also the lack of knowledge about the really pure metal. It is well established that the temperature variations of some properties, such as the electrical resistance, undergo abnormal and quite unexplained changes about room temperature, while the apparently unrelated change from brittle to ductile fracture occurs between 50° and 100° C., and is of extreme interest. The physical properties of transition metals such as chromium and their alloys are, in fact, a direct challenge to both theoretical and experimental workers, and a reading of this book will suggest many subjects for research. W. Hume-Rothery

A THEORY OF SOCIAL CHANGE

Political Systems of Highland Burma

A Study of Kachin Social Structure. By E. R. Leach. Pp. xii+324. (London: The London School of Economics and Political Science (University of London), and G. Bell and Sons, Ltd., 1954.) 35s. net.

THIS book, an account of the social structure of the Kachin–Shan population of north-east Burma, has a value quite independent of its descriptive content. To-day a very powerful and extensive school of anthropologists adopts what is known as the 'functionalist' approach. Institutions are thought of as functioning within a social structure which, itself, consists of individuals who are so connected up by social relations as to form an integrated whole. The social system is a functional unity and vice versa—the functional unit is a social system. All institutions support one another, all mutually determine one another, and the result will be the picture of a society in stable equilibrium.

Dr. E. R. Leach attacks this theory root and branch. He is interested in cultural change, and he frankly confesses that he finds no place for a theory of internal change in the functionalist approach. Why, he argues, should we suppose that equilibrium is 'normal'? Why should we even suppose that the societies hitherto pictured by functionalists as being in stable equilibrium really are so? On the contrary, there is every reason to suppose that these societies do change, that they are at any given moment in a state of flux. In fact, Dr. Leach goes on, the functionalists do not and have not described the societies as they really are. What they have produced as a true picture of these societies is, in fact, nothing but a highly intellectualized conceptual model; and the reason for this, to his mind, is that they are attempting to impart a precision into the mutual relationships of individuals in such societies which in fact does not exist.

The anthropologist is using a set of scientific, highly precise and highly abstract categories, and into these he is trying to fit the data of native life; but in fact the native himself does not express his social relationships except in a symbolic and highly inconsistent form. He expresses it, that is to say, through ritual. He expresses it through myth. These specific and concrete activities are, moreover, interpretable in many ways, and individuals manipulate them to suit their own self-interest and in particular their interest in acquiring power and authority. In this way the system of myth and ritual is ambiguous enough to permit shifts of power-structure and to legitimize such shifts of power-structure once they have occurred. Thus Dr. Leach would (I think) hold that only unless an anthropologist is prepared to take as his assumption the vagueness and inconsistency of myth and ritual can he advance an explanation of indigenous political and social change. If myth and ritual were as tidy as the functionalists' assumptions tend to make them, then there is no room for shifts of power and status within the system described. It is only when myth and ritual are regarded as being a sort of arsenal from which legitimizing authority can be extracted that a theory of indigenous change becomes possible at all.

The major part of the book is devoted to an attempt to work out this theory in terms of the Kachin–Shan population. Here again Dr. Leach is an iconoclast: he admits blandly that his own interpretation of their cultures is at variance with practically everything that has hitherto been published.

His view can be briefly put in the following way: we have here three sub-types of social structure—there is the Shan type, which is feudal and hierarchical; the Kachin *gumlao* type, which is equalitarian; and in between them, the Kachin *gumsa* type, which he maintains is in unstable equilibrium. This is a sort of cross-roads. It represents societies which are moving either from the *gumlao* to the Shan type or from the Shan type to the *gumlao* type. The *gumsa* type may move in either direction; its relations are not fixed. "I assume," he says, "that within a somewhat arbitrarily defined area—namely, the Kachin Hills Area—a social system exists. The valleys between the hills are included in this area so that Shan and Kachin are, at this level, part of a single social system. Within this major social system there are, at any given time, a number of significantly different sub-systems which are interdependent. Three such sub-systems might be typed as Shan, Kachin *gumsa*, Kachin *gumlao*. Considered simply as patterns of organisation, these sub-systems may be thought of as variations on a theme. The Kachin *gumsa* organisation modified in one direction would be indistinguishable from the Shan; modified in another direction it would be indistinguishable from Kachin *gumlao*. Viewed historically such modifications actually occur and it is legitimate to speak of Kachins becoming Shans or of Shans becoming Kachins. When therefore I, as an anthropologist, examine a particular Kachin or Shan locality I need to recognise that any such equilibrium as may appear to exist may in fact be of a very transient and unstable kind."

This thesis Dr. Leach pursues through material of great intricacy. Yet is this single example, drawn as it is from one particular area, typical of all situations? *Prima facie*, one would not think so. It is perfectly possible, and indeed highly probable, that certain communities are in fact in the state of equilibrium. On the other hand, it must be conceded that it was high time that a field anthropologist put his finger on a crucial difficulty in functionalist theory—that is, the great problems it raises in constructing theories of indigenous change. The importance of this book therefore stands independently of the truth or falsity of Dr. Leach's proof. Its major importance is as a well-deserved challenge to a dominant anthropological theory. S. E. Finer

THE RADON CONTENT OF THE ATMOSPHERE

By W. ANDERSON, PROF. W. V. MAYNEORD and R. C. TURNER

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MEASUREMENTS of the radon content of the atmosphere were made so long ago as 1905 by Eve[1,2] in Montreal, in 1908 by Satterley[3] in Cambridge and Ashman[4] in Chicago. The values obtained by these workers ranged from $2 \cdot 0 \times 10^{-14}$ to $2 \cdot 0 \times 10^{-13}$ curie per litre, and the results as a whole seemed to support the original suggestion of Elster and Geitel[5] in 1903 that the radon in the atmosphere arises mainly from the soil. These workers noted that the highest level of active material in the atmosphere was found in fog conditions. It is interesting to note that these early workers sometimes discarded the values obtained from smoky atmospheres as appearing to be high or erratic. Since this early work, little seems to have been added to the subject except for isolated series of measurements[6]. The subject seemed of importance only in laboratories where bulk radium was being handled[7]. Even in the case of the Meuse Valley fog of 1930[8], no observations of radioactive content were reported, although investigations were carried out on a large number of chemical constituents of the fog. The purpose of this article is to present measurements relevant to this subject which have been made by us during the past two years.

Early in 1952, a series of measurements was made of the radon contents of various rooms and laboratories in the Physics Department of the Institute of Cancer Research, Royal Cancer Hospital, London, by drawing air samples of 10,000 litres through fine-grain Whatman filter papers by means of a vacuum cleaner fitted with an air-flow meter. The activity of the filter-paper samples, which was afterwards shown to have a half-life corresponding to radium A, B and C, was estimated in a lead castle arrangement of known geometry using a *GM4* Geiger counter and scaling system. The values deduced, assuming equilibrium, for various rooms, ranged from 2×10^{-15} curie of radon per litre upwards, depending to some extent on the past history of the particular site. Air samples taken on the roof of the building on sunny, dry days showed values of only 2×10^{-15} curie per litre, that is, fifty times less than the 10^{-13} average value found by the authors above.

Uncertainty as to the fraction of the atmospheric radium A, B and C being collected by such filter papers led to a series of measurements being made during which filter samples and whole-air samples were taken simultaneously, the latter being collected in previously evacuated flasks of known volume. The filter-paper activities measured with the Geiger system showed values only 2–3 per cent of those measured at the National Physical Laboratory on the whole-air samples. The latter measurements were made by transferring the air to a previously calibrated ion chamber and observing the ionization current when the radon had reached equilibrium with its solid decay products.

The inference at this stage appeared to be that the filter-paper method had a low collection efficiency of only 2–3 per cent, and that this might be the reason for the low values obtained. The ion chamber method of measurement seemed altogether less equivocal, and the construction was undertaken of a suitable three-litre chamber used with a Townsend balanced Lindeman electrometer. Before this equipment became available, the London 'smog' of December 1952 occurred and only the filter-paper method could be used for measurement.

The highest activity found on the filter papers on the first day of the smog proved to be equivalent to 8×10^{-13} curie of radon per litre, that is, four hundred times the clear, sunny day value of 2×10^{-15} curie per litre. If this value of 8×10^{-13} curie per litre in fact represented only 2–3 per cent of the total activity present, then the maximum activity of the smog on the first day could have been 4×10^{-11} curie per litre; but it must be remembered that the fraction of the active deposit collected under smog conditions may be much larger than in a clear atmosphere.

Using a reflectometer (and calibrations supplied by the Fuel Research Board) the blackenings of a daily series of filter-paper samples were converted into approximate weights in milligrams per cubic metre of solid matter from the air and these weights plotted against the measured activities of the samples. The resultant graph (Fig. 1) shows increasing activities with increasing weight of solid matter collected by the filter, from the lowest observed values to the highest figure of 3·8 mgm. per cubic metre found on the first day of the smog. There seems little doubt that when the solid matter in suspension consists of particles or aggregates of particles large enough to be collected by such filter papers, then the activity of the filter sample is related to the weight of solid matter collected by it. On the other hand, when the suspended particles are so small that the collection efficiency is very low, such a method could give a

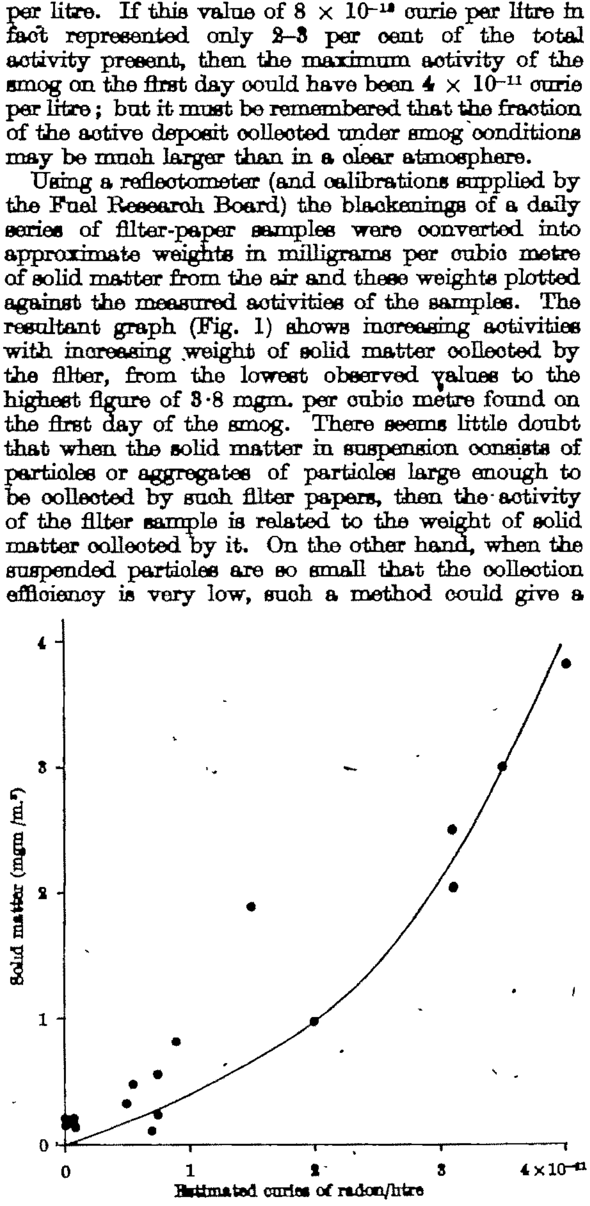

Fig. 1

low and completely misleading value for the atmospheric radon.

In May 1953, the ion-chamber apparatus became available and an extensive series of whole-air measurements was undertaken. The values obtained were greater by factors of 10–100 than those given by the filter-paper method, and the average roof value turned out to be 2–3 × 10^{-12} curie per litre, which is some twenty times that obtained early in the century by the original workers. It was suggested that these higher figures might be specific to London, and in the absence of any further smog or even fog conditions attention was turned to the possible causes of this higher radon concentration. The explanation of the relatively high radon-levels observed during fog conditions may lie partially in the retention, by the fog blanket, of radon diffusing naturally from the soil and from city structures. These conditions could reduce the dilution normally arising from mixing with higher atmospheric layers. In seeking other relevant factors, we have been led to consider the possibility that a significant fraction of atmospheric radon is derived from the burning of coal.

A few studies[9–11] have been reported in the literature on the radium content of certain coals, and values found ranging from 0·05 to 9·0 × 10^{-12} gm. radium/gm. coal ash, or 0·001 to 1·0 × 10^{-12} gm. radium/gm. coal. We have carried out preliminary estimations on six samples of coal, as supplied for domestic use, and have found values ranging from 2 to 4 × 10^{-12} gm. radium/gm. ash, or 0·05 to 0·3 × 10^{-12} gm. radium/gm. coal. The measurements were made by estimating in the ion chamber the equilibrium radon released from samples of coal ash, using modifications of both classical methods, namely, boiling off from acid solutions, or fusion with alkali carbonates[12]. Some of the samples were taken from the combined ash obtained from the burning of several kilograms of domestic coal; later, more representative samples of known origin and rank were made available. The active material was characterized unequivocally by measuring its rate of decay and also the rate of decay of the 'active deposit' remaining in the ionization chamber after replacement of the gases with aged nitrogen. Good agreement was found between values obtained by the two methods. Careful control experiments conducted on the reagents used gave negative results.

Measurements have been carried out by the fusion method on the radon content of ash, derived from coal burned in a domestic grate, at various intervals after the burning process. The results indicate that 70–80 per cent of the equilibrium radon is liberated into the atmosphere during normal burning.

We have further demonstrated that the combustion of coal gas contributes to the atmospheric radon content. Preliminary measurements on coal gas, from the normal main, introduced directly into the ionization chamber, indicated the presence of radioactivity equivalent to about 0·5 × 10^{-12} c. radon/lit. of gas. A simple method of concentrating the active material was devised in which the gas was burned with aged cylinder oxygen and the combustion gases led into the ionization chamber after removal of carbon dioxide and water vapour. In this way a five- to seven-fold concentration was achieved, and at the same time the gases were freed from undesirable tarry constituents. The activity was shown to be due to radon, using the same criteria described above. Values obtained in several tests over a few weeks ranged from 0·3 to 1 × 10^{-12} c. radon/lit. coal gas. Careful control was again exercised on the reagents and equipment employed in this work. Successive positive results of the same order of activities obtained over several weeks using the same cylinder of oxygen removed the possibility of radon contamination from this source.

The need for great care in these experiments was emphasized in earlier tests which we had conducted and in which rather higher radon values than quoted above had been found from coal gas combustion. In a control run designed to parallel the combustion experiment, carbon dioxide and nitrogen from cylinders were passed through the combustion assembly; approximately half the amount of radon found in the test run was measured in this control. It was discovered that the radon appearing in the control had been liberated from the soda-lime used for the absorption of carbon dioxide. An independent estimation placed the radium level in the soda-lime at 0·25 × 10^{-12} c./gm. Under the experimental conditions during combustion, approximately 100 gm. soda-lime were used, and were found to yield 9 × 10^{-12} c. radon (= 36 per cent total radon available). This phenomenon, unusual in that the radon is liberated under comparatively mild temperature conditions (the soda-lime is warmed to 60–80° C. by the heat of reaction), might be understood in terms of the rupture of the occluding structures caused by the chemical changes accompanying absorption of carbon dioxide. In subsequent work the soda-lime was replaced by solutions of potassium hydroxide; the control runs were then found to give negative results. It is interesting to note that the classical fusion method of radon estimation[13], which gave values generally double those obtained from the corresponding solution method, employed soda-lime tubes for removal of the carbon dioxide evolved.

It is not possible at present to assess with any accuracy what fraction of atmospheric radon may be attributed to the burning of coal and coal gas. There are wide variations with respect to time and location of the contributions from such processes, and furthermore, comparatively few figures are available on atmospheric radon-levels. The radium content of coal, and the radon content of coal gas, appear very small when considered per gram of coal or per litre of coal gas; but, on the other hand, these materials are consumed in very large quantities daily. For example, in the Greater London Area during 1953, the daily consumptions were: coal, 55,000 tons, and coal gas, 10^{10} litres. It would therefore seem desirable that further information be obtained on the significance of such contributions to total radon concentration in the atmosphere. The increased levels measured during fog conditions would find at least partial explanation if these processes are significant.

We are at present extending the scope of our measurements of the radium content of British coals and of atmospheric radioactivity at a variety of locations. The work forms part of a wider research into possible health hazards associated with prolonged exposure to small amounts of radioactive materials.

We gratefully acknowledge the help of Mr. W. J. Callow, of the National Physical Laboratory, and Dr. E. T. Wilkins, of the Fuel Research Board. We are also indebted to Sir Charles Ellis and Mr. A. M. Wandless (National Coal Board) for providing coal samples. Acknowledgments are also due to the Governors of the Royal Cancer Hospital, who supported the work by a fellowship to one of us (W. A.). Valuable technical assistance in the experimental work was given by Mr. J. G. Crookall.

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NEW FACTS ABOUT COELACANTHS

By Prof. J. MILLOT

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THE researches upon the Coelacanths which my co-workers and I are actively pursuing, not only in the Muséum National d'Histoire naturelle at Paris and the Institut de Recherche Scientifique de Madagascar but also in the field round about the Comoro Islands, are gradually bringing into sharper focus our picture of these remarkable fishes. I have already published various papers and observations concerning them in *La Revue de Madagascar* (December 1953), in the Paris *La Nature* (April 1954), in *The Times* (June 3, 1954) and in a bulky supplement to *Le Naturaliste Malgache* (June 1954). In the present article I am able to present further new information.

From the point of view of anatomy, we are still in the initial period of descriptive studies: comparisons and interpretations, though so very tempting, would still be premature. In my article in *The Times* I have given the first indications of the arrangement of the heart and of the persistence of a vestige of a pulmonary organ. To these I am now able to add observations relating to the digestive system and kidney.

The œsophagus, remarkably wide, strongly fluted along its length and very muscular, allows the animal quite easily to swallow entire living fishes of fifteen centimetres or more, for such have been recovered intact. It is continuous with the stomach, without any anatomical differentiation: the transition from one organ to the other cannot be distinguished save under the microscope, following the transformation of the mucosa and the appearance of the characteristic long, tubular glands of the fundus present throughout the vertebrate series and already perfectly differentiated in the Coelacanths. The stomach is, like the oesophagus, very capacious, longitudinally furrowed and yellowish in colour. Its thick musculosa is exceptionally dense. Its shape is that of a V opening anteriorly and having two wide limbs of unequal length: the dorsal one, following directly upon the oesophagus, is relatively short (twenty centimetres or so) although the blunt point of the V is situated beyond the opening of the cloaca; the other limb, ventral and of more than double the length, gradually narrows and ends by a tubular pyloric portion curved into a knee-bend in the anterior part of the abdominal cavity. It opens through an annular sphincter (the pronounced differentiation of which contrasts with the total absence of a cardia) into a very short chamber, an adumbration probably of the bursa entiana or *zwischen darm* which is found more or less developed in many fishes. This, devoid of any appendage or cæcum, is in the Coelacanths no more than the antechamber to a sub-fusiform spiral intestine *en rouleau* showing nearly a score of concentric turns.

This spiral intestine, in one form or another characteristic of primitive fishes, is directly followed by the hind-gut (coprodæum), in which may be distinguished (*a*) a sub-horizontal rectum which rises in its terminal portion at the level of the vent to bend at a right-angle towards this, and (*b*) a cloacal pouch directed almost vertically downwards and the inner posterior wall of which bears a urino-genital papilla and receives besides the secretion of a median and unpaired nodular gland which is bound to it. The latter, of serous type, surrounded by a tough capsule and the size of a large hazel-nut, is of very dense texture and exceptionally firm consistency; it is probably homologous with the digitiform gland of Selachians, although of very different structure. The inner walls of the rectum and cloaca are thin and distensible, but reinforced by longitudinal muscle bands.

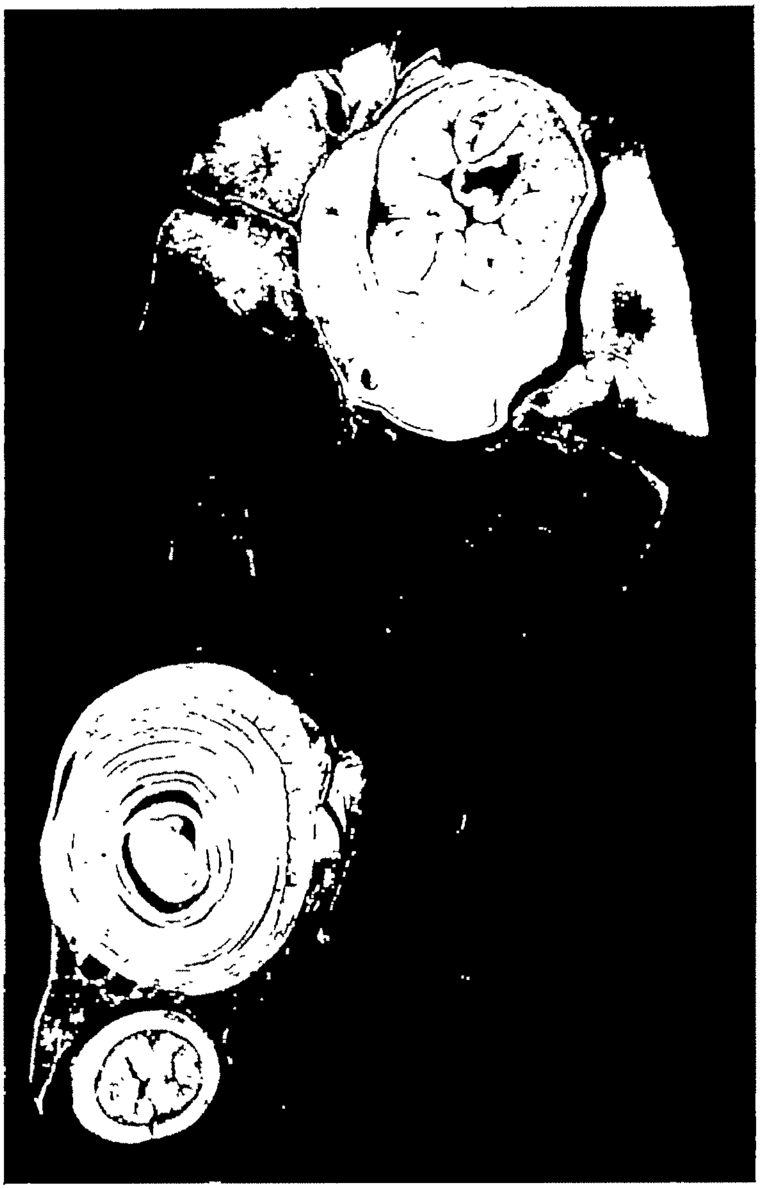
The liver, the pale slate colour of which varies appreciably from one specimen to another, comprises two lobes: the right occupies two-thirds of the length of the visceral mass; the left is a little broader but only about half as long. The hepatic cells are rich in fatty inclusions, but not specialized more or less exclusively for the storage of fat reserves as is the case with many sharks. The gall-bladder, partially buried in the bridge of connecting tissue which unites the anterior ends of the lobes of the liver, is relatively voluminous; by tapping that of specimen C^3 I was able to extract 50 c.c. of bile.

The pancreas, also well developed, forms a long yellow band, in section triangular, in structure partly fatty, occupying on the right side of the visceral mass all the depression situated between the ventral branch of the gastric V, the spiral intestine and the rectum.

The kidneys are fused together into a single median organ the position of which is unusual: it is in fact applied to the ventral wall of the abdominal cavity, behind the cloacal opening, although the testes are situated in the middle of the dorsal part of the visceral mass and therefore entirely pre-cloacal. There are two symmetrical ureters the free portions of which are quite short and expand dorsally each into a voluminous ear-shaped bladder. The bladder is thus in Coelacanths a paired formation, though the kidney is unpaired—an uncommon arrangement. The urethras approach symmetrically toward the sides of the urino-genital papilla before opening into it.

The kidney is provided with large pine-cone-shaped glomeruli and with well-developed Malpighian tubules. Its structure, markedly different from that of other fish kidneys which I have had occasion to examine, is of the highest interest; but it is complicated and requires prolonged and intricate study. Eosinophile secretions have been observed in certain tubules, as well as cavities lined with ciliated epithelium, which are probably nephridial but the disposition of which I have not yet been able to work out. Unlike that of many Teleosteans, the kidney does not contain any lymphoidal tissue, but shows considerable infiltrations of pseudo-eosinophile leucocytes. The extreme abundance of these leucocytes, their intense and diffuse hæmapoiesis, the more or less penetrating sheaths which they form around the greater part of the abdominal organs, seem likewise to be one of the histological peculiarities of the Coelacanths.

From the point of view of biology, some quite recent complementary investigations which I have just carried out with Commander Cousteau and his team from the *Calypso* confirm that the modern Coelacanths inhabit, around the Comoro Islands, basalt rocky bottoms which slope very steeply (25°–45°). They seem to live normally on the actual bottom or quite close to it, between 200 and 400 metres depth at least; specimen C^4, for example, was taken fifty centimetres from the bottom in a depth of 370 metres and over a slope of 45°. But there is every possibility that their habitat may extend very much deeper still. It would be as well, in fact, to emphasize that fishing off the Comoro coasts has never yet been carried out beyond 370–380 metres depth, and that two of these fishes have been taken at that extreme limit. The fact, moreover, that among the five specimens captured there is no adult female leads us to believe that these may be out of reach because they live at a depth of more than 400 metres.



Complete transverse section through the anterior quarter of the abdominal viscera of Coelacanth C^4

Note, in the centre of the upper portion, the oesophagus (wrinkled opening) and, closely applied to its ventral surface, the vestige of the pulmonary organ, represented by a fatty crescent-shaped mass centring around a very short tubular diverticulum. The centre of the photograph is occupied by the two large hepatic lobes, here very dark. Below these lies the spiral intestine. At the very bottom of the illustration is the narrow pyloric region of the stomach with, to its left, the pancreas, which is triangular in section

Preparation made with the collaboration of Dr. Decérisy. Photo: J. M. Banflé

An attractive theory has been formulated in Grand Comoro, where the last three specimens were taken: namely, that the Coelacanths live in the upwellings of fresh water off that island, the hydrographic conditions of which are very peculiar. There is a great deal of rain—more than 5 metres rainfall per annum in certain places—but nevertheless the island suffers from a serious and permanent shortage of water. There is not a single river, and even after the heaviest downpours there is an almost complete absence of surface water; this is because the soil is formed of very permeable volcanic scoria into which practically the entire rainfall is absorbed. This then flows away into the sea by a multitude of coastal springs and important submarine upwellings, in such a way that during a spell of drought, when the level of the reservoirs falls in the most alarming manner, the people often come at low tide to draw water from these littoral springs. Now Coelacanths, as we know, have during long periods in the past lived in brackish or nearly fresh waters—from which comes the very interesting notion that they may have been able to survive among the Comoros, and among the Comoros only, because the submarine upwellings of fresh water would have assured them the maintenance of their ancestral environment at depths where reduced competition allowed them a better chance of existence.

Unfortunately, the most ingenious explanations are not always the true ones. This one does not seem to be tenable because, for one thing, the upwellings in question do not seem to occur except in the intertidal zone; and again, because also the seawater samples taken by my collaborator Menaché in the places where the Coelacanths of Anjouan were captured have revealed quite normal marine salinities. Further, there is every likelihood that the samples of water which have just been obtained by the *Calypso* at the location and depth at which the first Coelacanth of Grand Comoro was taken will produce similar results.

[Translation by Denys W. Tucker, British Museum (Natural History).]

NEWS and VIEWS

James Cook Medal of the Royal Society of New South Wales: Sir David Rivett, K.C.M.G., F.R.S.

THE Royal Society of New South Wales has awarded the James Cook Medal for 1953 to Sir David Rivett. The presentation was made by the president of the Society, Prof. R. S. Nyholm, of the N.S.W. University of Technology and professor-elect of chemistry in University College, London. Prof. Nyholm remarked that Sir David Rivett, after graduating at the University of Melbourne, proceeded in 1907 as a Rhodes Scholar to Oxford. At Oxford, and later at the Nobel Institute, Stockholm, he carried out research in physical chemistry. He returned to Australia as lecturer in chemistry at the University of Melbourne in 1911, where he succeeded Sir David Orme Masson in the chair of chemistry in 1924. His main research interests were in the field of heterogeneous equilibria, to which he made many major contributions. Rivett had frequently stressed the importance of scientific research in the development of Australian primary and secondary industries. It was not surprising, therefore, that when the Institute of Science and Industry was reconstituted in 1926 as the Council for Scientific and Industrial Research, the Commonwealth Government appointed him as the chief executive officer and deputy-chairman. The success of the Council (now the Commonwealth Scientific and Industrial Research Organization) has been due, in a large measure, to Rivett's vision and leadership. Many difficulties were encountered in the formative years through Federal and State jealousies, impatience of politicians expecting quick results, and the often niggardly provision of money by Governments. Rivett overcame these difficulties by his persuasiveness in negotiation, courageous public utterances and his high personal and scientific integrity. The growth of fundamental research work in the Council was constantly encouraged by Rivett and, by the time he retired from direct work with the Council in 1949, fundamental studies occupied a major part of its activities. Rivett's leadership in science has been recognized by the conferring of a knighthood in 1936 and election to fellowship of the Royal Society in 1941. He was president of the Australian and New Zealand Association for the Advancement of Science during 1936–39 and president of the Society of Chemical Industry of Great Britain in 1950. The James Cook Medal is awarded annually "for outstanding contributions to Science and Human Welfare in and for the Southern Hemisphere".

Indian Independence Day Decorations

AMONG decorations awarded by the President of India on Independence Day were the following:

The Bharat Ratna to Sir C. V. Raman, F.R.S., director of the Raman Research Institute, Bangalore.

The Padma Vibhushnan Pahela Varg (first class) to Dr. S. Bose (physicist) and Dr. Z. Hussain (educationist).

The Padma Vibhushnan Dusra Varg (second class) to Dr. H. J. Bhabha, F.R.S., director of the Tata Institute of Fundamental Research, Bombay; Sir Shanti S. Bhatnagar, F.R.S., secretary to the Ministry of Natural Resources and Scientific Research and director of Scientific and Industrial Research, Government of India; and Sir K. S. Krishnan, F.R.S., director of the National Physical Laboratory of India, New Delhi.

Agriculture at Reading: Mr. A. N. Duckham, C.B.E.

THE appointment of Mr. A. N. Duckham to the chair of agriculture at Reading in succession to Prof. H. G. Sanders (see *Nature*, April 10, p. 662) will be warmly welcomed. From the Agricultural VI at Oundle he went in 1922 to Cambridge, where he took the Natural Science Tripos and the diploma in agriculture. In the latter he obtained the very rare 'distinction', and an essay based on his thesis work on baby beef was awarded the silver medal for research by the Royal Agricultural Society of England. From 1927 onwards he was concerned mostly with pigs at Cambridge (where with Mr. H. R. Davidson he started and ran the East Anglian pig recording scheme), Belfast and Aberdeen, and in 1935 he became the research officer of the Bacon Development Board. In addition, he carried through two special assignments with conspicuous success: a survey of the economics of grass drying for the Empire Marketing Board, and the preparation of an account of animal industry in the British Empire which involved much travel. War brought service with the Ministry of Food as chairman of that Ministry's agricultural committees and collaboration with Sir Jack Drummond on dietary problems in Great Britain and other countries. He attended the Hot Springs Conference in 1942 and has continued as agricultural adviser to the United Kingdom delegation to the U.N. Food and Agriculture Organization. In 1945 he was appointed agricultural attaché at Washington, where he was extremely successful. After his return to become head of the General Division of the Ministry of Agriculture, he produced a monograph on American agriculture which is held in very high esteem. The University of Reading will gain one whose knowledge of agriculture is almost world wide, and whose interests also include painting and music.

Bernard Price Institute of Geophysical Research, Johannesburg: Prof. A. L. Hales

THE University of the Witwatersrand has appointed Prof. A. L. Hales to succeed Dr. B. F. J. Schonland as director of the Bernard Price Institute of Geophysical Research, Johannesburg, when the latter leaves on October 1 of this year to take up his new position in Britain as assistant director of the Atomic Energy Research Establishment, Harwell. Prof. Hales, who at present occupies the chair of applied mathematics in the University of Cape Town, took his M.Sc. degree at the University and then proceeded to Cambridge, where he studied under Sir Harold Jeffreys. His first university appointments were in the Departments of Mathematics and of Applied Mathematics at the University of the Witwatersrand. After war service, including geophysical work in the Middle East theatre, he served on the staff of the Bernard Price Institute during 1945–49 before proceeding to Cape Town. Prof. Hales has made a number of important contributions to geophysical subjects connected with the crustal structure of the earth and the theory of mountain building. Some years ago he carried out a gravity survey of southern Africa in association with Dr. D. I. Gough.

National Institute of Agricultural Botany, Cambridge: Report for 1953

At the annual general meeting of the Fellows of the National Institute of Agricultural Botany, Cambridge, on July 16, the chairman, Prof. T. J. Jenkin, presented the annual report of the Council for the year ending December 31, 1953 (pp. 48. From the Institute), and referred to some new developments in the work of the Institute proposed for the future. From the report, it is evident that the year under review was one of both progress and consolidation, and the improved staffing, authorized by the Ministry of Agriculture in 1952, has been fully implemented. Since publication of the results of field trials is one of the Institute's chief concerns, it is satisfactory that two issues of its *Journal* appeared during the year, together with new or revised editions of seven "Farmer's Leaflets", while interim comments on the performance of some seventy different varieties of cereals, varieties or strains of root and fodder crops, beans, peas, vegetables and potatoes were available in the report itself. Development of the Field Inspection and Certification schemes co-ordinated by the Seed Production Committee of the Institute continued, and the acreage of cereal seed crops inspected under the Field Approval Scheme reached a total of 66,000 in 1953, compared with 26,800 in 1947.

As regards the future, Prof. Jenkin announced that the Ministry of Agriculture has agreed to the request of the Welsh Plant Breeding Station that the Institute should accept responsibility for the production of stock seed and for the certification of the Aberystwyth strains of grasses and clovers. It is recognized, however, that two or three years must elapse before the necessary equipment and facilities can be provided to enable the Institute to undertake full responsibility in this matter. Developments in the international field are also contemplated, for help of the Institute has been sought by the Organization for European Economic Co-operation to co-ordinate two new projects. The first of these is a scheme for international grass strain trials designed to test the value of strains. This will involve three stages—namely, identification and classification, preliminary assessment and agronomic trials—and will be undertaken in close co-operation with the Grassland Research Station at Hurley. The second is an attempt to obtain greater uniformity in the terminology used to designate the different stages of herbage seed production, for at present each country has its own system, and confusion is liable to occur with regard to certification schemes. The meeting concluded with an address by Sir John Russell (see p. 446 of this issue).

The Royal Botanic Gardens, Kew

With the publication of the first number of the *Kew Bulletin* for 1954, the work of the Royal Botanic Gardens, Kew, during 1953 is reviewed in some detail. This is a matter of general interest, to the public and to professional botanists alike. During the year the centenary of the Herbarium and Library was celebrated by an exhibition illustrating the work of these Departments during the past hundred years (see *Nature*, 171, 1086; 1953). The continuing activity of the herbarium is well illustrated by the following statistics: specimens received from outside sources, 60,496; sheets received on loan, 4,558; sheets sent on loan, 4,446; sheets distributed as duplicates, 12,268; sheets mounted (with certain exclusions), 46,465; and so on. Visits by botanists numbered 3,964. Inquiries and plant consignments dealt with numbered 2,667. In the midst of the routine tasks, of which there are many, the long-term projects have been pursued, for example, the preparation of the "Flora of Tropical East Africa", and other floras, and members of the staff have taken an active part in contemporary botanical and other activities. Special work on particular systematic groups has also been undertaken, for example, Bignoniaceae, Orchidaceae, vascular cryptogams, etc. An outstanding event of the year was the publication of Supplement XI (1941–50) of the *Index Kewensis*, and progress has been made with the succeeding volume. The work of the Library, the Museum and of the Jodrell Laboratory, where work on the systematic anatomy of the monocotyledons is being steadily pursued, as well as routine inquiries, some of a curious character, is also reviewed. In the Gardens, the work in the arboretum, the alpine and herbaceous sections, and the temperate, decorative, tropical and other departments is recorded and discussed. The *Bulletin* concludes with a list of publications and the roll of scientific and administrative staff.

Science in China To-day

An interesting but pessimistic appreciation of the position of scientists in Communist China is contributed to *Science* (119, 785; 1954) by A. Z. Chang, now working at the Centre for International Studies, Massachusetts Institute of Technology. Reviewing the education and activities of those of the fifty scientific workers constituting the national committee of the 'Ko-lien' (All-China Association for Natural Sciences) for whom information is available, Dr. Chang points out that their average age so far as is known is more than fifty-five years, and none is a product of post-war education. Of the eleven institutes within the Academia Sinica, six are directed by leading scientists who are members of the 'Ko-lien' National Committee and three others by scientists who are not members of that Committee. Most of these leading scientists retain their teaching positions while serving in government positions; of the fifty members of the 'Ko-Lien' National Committee, fifteen retain full-time professorships and five serve on committees. A few hold key positions in functional departments. Throughout the Second World War there was no evidence that the Communists made any progress in training or absorbing scientific personnel, while the leading scientific workers of the older generation are being subjected gradually to as great pressure as any other intellectual group. Dr. Chang considers that the most serious challenge is the particular Communist concept of science in general and the Communist inherent antagonism against 'bourgeois science' in general; in main construction projects the Communists rely more on their ability and ruthlessness in organizing masses than on technical knowledge. Indigenous technology and the scientific approach on the China mainland are in a highly State-controlled condition to-day, and the future of science in this area is likely to conform to that within the general Soviet pattern.

Scientific Research in South African Universities

The Library and Information Division of the Council for Scientific and Industrial Research, Pretoria, has published a "Register of Current

Scientific Research at South African Universities" (pp. 212; 1953), this being the second volume, the first volume, covering research in progress during 1951, having been issued in 1952, and it is hoped to issue the register annually in future. It is a companion to the "Register of Current Research in the Humanities", issued annually since 1946 by the Council. Investigations are arranged by subjects according to the university department, with occasional cross-references, and the departments are listed alphabetically under their English names. Details of the scope of the investigations are given in the language in which it was received from the university department, but the omission to translate subjects or titles consistently into English somewhat militates against the usefulness of the register. Particulars of the qualifications and status of the investigator and of the director of the investigation are included.

East African Research Board: Report for 1953

THE eleventh annual report of the East African Industrial Research Board of the East African High Commission (pp. 11. Nairobi: Government Printer, 1954) covers the year ended December 31, 1953, and records good progress in the project to extract hecogenin from sisal waste on a pilot scale. Pure hecogenin acetate is now becoming available in the United Kingdom in research quantities for the synthesis of cortisone and related compounds, and a hydraulic press and extrusion cylinder has been designed for the expression of juice from sisal waste which should prove more efficient than the squeezing rolls hitherto used. Work on the refining of sisal wax indicates that fractional extraction with alcohols will yield more highly coloured fractions first, which might be used where colour is unimportant, and that later fractions might be used to obtain a paler product. The method of pelletizing fine kainite for heating in a rotary kiln has been worked out on a commercial scale, and the addition of alumina as bauxite has proved to be the most reactive for converting the silica, released from the kyanite molecule on calcining, to mullite. Detailed performance tests have been made on the use of wood producer gas in dual-fuel diesel engines, but experiments on the fermentation of sisal waste and papyrus roots and stalks to give combustible gases had to be suspended, although yields of 400–500 c.c. gas containing about 60 per cent of methane and 40 per cent carbon dioxide can be expected per gram of dry sisal waste with an output 0·9–1·5 times the volume of the digesting mass per day. Preliminary experiments indicate the possibility of producing pepsin of more consistent quality by processing the latex obtained from the juice of the pawpaw fruit. Trials with a Swiss mechanical briquetting machine indicated that the machine was unsuitable for handling coffee parchment, cotton seed husk and brine coffee husk without further treatment, but excellent briquettes were obtained from sawdust and satisfactory briquettes from brine coffee husk which had been passed through a disintegrator. An investigation into the whole process of coffee curing was commenced.

National Foundation for Scientific Research, Brussels: Report for 1952–53

THE twenty-sixth annual report of the National Foundation for Scientific Research, Brussels, covering the year 1952–53 (pp. 231; 1954), records the completion under the Inter-university Microfilm Commission, created in October 1949, of an inventory of microfilms in the archives of the French Departments of Lille and Dijon, copies of which are deposited in each of the Belgian universities. The Council made a third grant of 1,485,000 francs to the Special Commissión for Clinical Research, which has been distributed by the Commission among the four university centres engaged in work on cortisone and adrenocorticotropic hormone, and brief reports from each centre on this work, with a list of publications, are included. A sum of two million francs was put at the disposal of the Royal Observatory of Belgium for the establishment of a radioastronomy laboratory. Brief accounts are included of the work on calculating machines at the Universities of Brussels, Ghent, Liège and Louvain, for which a further credit of 50,000 francs has been voted, while 200,000 francs were voted for the reconstruction of the Marine Biology Station at Wimereux, destroyed during the War. Ninety-three grants, totalling 247,289 francs, were made to assist Belgian scientists and research workers to attend overseas conferences and meetings. Extraordinary credits granted during the year, totalling 6,110,000 francs, included two million francs to the Inter-university Microfilm Commission, 25,000 francs to the International Institute of Meteorology, Stockholm, 50,000 francs to the Zoological Station, Naples, and 250,000 to Prof. R. de Langhe for his archæological expedition to explore systematically the grottoes of the borders of the Dead Sea and the desert of Judea in Palestine. Lists of recipients of research grants for 1953–54 and of publications during 1952–53 by recipients of grants are included. The report includes an account of the distribution of radioisotopes in Belgium and the researches carried on by this means in the university laboratories and at the Institute of Cancer, as well as in the Polytechnic Faculty of Mons, the State Agronomic Institute at Gembloux and in industry and horticulture.

Central American Scientific Institutions and Scientists

A FIRST list for Central America in the series "Scientific Institutions and Scientists in Latin America", covering Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama (pp. 202; 1954), has been issued by the United Nations Educational, Scientific and Cultural Organization, at Montevideo. The list was prepared by the Organization's Field Science Co-operation Office for Latin America, with the collaboration of Ibero-American organizations, and is expected to be completed in several volumes during the next few months. Under each country are given lists, in Spanish, first of institutions and second of scientific workers; these include the address of the institution and some details of its functions, interests and officials, and, for the scientists, of their special interests, career and publications.

The Scientist: A New Pakistani Journal

IN Nos. 2 and 3 of the first volume of a new journal, *The Scientist*, which has recently been started in Pakistan, there are articles upon the following topics: the agricultural industries of Pakistan; the problem of Pakistan railways; symmetrical incomplete block designs; a field key to the identification of fishes; the biology of a mango defoliator; and the theory of liquids. *The Scientist* is published by the Department of Zoology, University of Karachi, the chief editor being Dr. M. A. H. Qadri.

Scientific Literature in New Delhi

THE "Insdoc List of Current Scientific Literature", the first issue of which is dated June 1, 1954 (pp. 16. New Delhi: National Scientific Documentation Centre; Rs. 10 a year), is being published semi-monthly to inform scientific workers in India and neighbouring countries of the latest papers published in some two hundred and fifty leading scientific and technical periodicals of the world. It also includes information on scientific reports received at the National Physical Laboratory—Insdoc Library, New Delhi, as well as the titles of translations available or on which information has been received. Titles of papers in languages other than English are given in English translation. The entries are arranged in broad subject groups according to the Colon Classification, but Universal Decimal Classification numbers are also given.

Bibliography of French Biological Books

THE first issue (No. 9, December 1953) of the second series of the "French Bibliographical Digest", which is planned to give a selected bibliography of significant scientific and technical books, of at least university level, published in France since 1949, includes an article by Prof. L. Plantefol on botany in France to-day and a list of French scientific and technical periodicals. Under each subject the abstracts or reviews of each book are given alphabetically by authors, and there is also an index of authors. The entries in this issue are limited to biology, botany and zoology, and the Digest is intended primarily to introduce French books to the United States. It will be supplied free, upon request, to libraries, university departments and scientific workers who indicate the subjects in which they are interested. It is edited and published by the Cultural Division of the French Embassy, 972 Fifth Avenue, New York City, 21.

Yale Medical Library and Historical Library: Report for 1952–53

THE annual report of the Yale Medical Library, which includes the report of the Historical Library, for the year ended June 30, 1953 (pp. 47. New Haven, Conn.: Yale Medical Library, 1953), stresses changes made to increase the availability of periodicals. The 'current use' of a periodical appears to continue for about five years, the second year after publication being the time of heaviest use and also the time when the periodical is at the binders. Two periodicals were used as much as 158 of the least popular on the list combined, and with thirty-eight others these two periodicals accounted for nearly 50 per cent of the use made of periodicals. By duplicating subscriptions to the more heavily used periodicals, discontinuing the binding of four hundred little-used periodicals, restricting the more complete set to use within the Library, and certain other changes, it is hoped to check the sharp decline in the recorded use of the Library. A list of periodicals available in the reading room is appended, and the report of the Historical Library gives details of important accessions during the year.

The Early Developments in Atomic Energy

AT the meeting of the Education Group of the Institute of Physics on October 20, 1953, Prof. O. R. Frisch, of the University of Cambridge, who was one of the pioneer workers in the atomic energy project during the Second World War, delivered an interesting talk on "Atomic Energy—how it all Began". The text is reprinted as a special article in the March number of the *British Journal of Applied Physics* (5, 81; 1954). Prof. Frisch gives a brief review of important developments following the first direct manifestation of atomic energy by Becquerel in 1896, in particular of Rutherford's 1912 picture of the atomic nucleus and of Chadwick's discovery of the neutron in 1932. He then discusses why physicists with all the data available in 1935 did not discover fission at that time. Next, the exciting events which followed Hahn and Strassmann's publication in 1939 are most vividly told, and Prof. Frisch includes some personal reminiscences of details of his conversations and discussions with Prof. Lise Meitner. Finally, the feasibility of controlled and explosive controlled reactions and the development of controlled nuclear reactors are discussed. Prof. Frisch concludes by remarking that he likes to remember the days when chain reactors were a new toy for physicists to play with and recalls how for a few exciting weeks in Los Alamos he and others were allowed to study the growing amounts of uranium-235 which were then being prepared for the first atomic bomb.

Diamond Tool Industry during 1953

AN eight-page brochure, entitled "The Diamond Tool Industry in 1953", issued free of charge by the Industrial Diamond Information Bureau, 32–34 Holborn Viaduct, London, E.C.1, is the ninth in the series of reports on the diamond tool industry and summarizes the main developments during 1953 under the following headings: physical properties; hardness; surface finish; fine boring and turning; trueing of grinding wheels; diamond powders; impregnated diamond tools; sintered carbide grinding; glass grinding and stone working; rock drilling; wire drawing; diamond use and salvage; new machining methods; and jewel bearing production. Reference is made to 155 articles, and a detailed bibliography is appended. The report, which will be of interest to all those engaged in the use and production of diamond tools, has been compiled from the monthly "Bibliography of Industrial Diamond Applications", also published by the Industrial Diamond Information Bureau.

Protecting Cleaned Iron Objects

IN the *Museums Journal* of May 1954, L. Biek, E. S. Cripps and D. M. D. Thacker, of the Ancient Monuments Branch, Ministry of Works, describe a series of experiments undertaken to protect iron objects that have been cleaned. Some keys, of the eighteenth to early nineteenth centuries, were used. All were heavily rusted, with some deep pockets of hard oxide. The keys were cleaned in an inhibited phosphoric acid formulation ('Deoxidine No. 125', I.C.I.) and scrubbed with steel wire brushes to remove the rust. They were then soaked in acetone to prevent the formation of the rust-coloured film which appears when wet ironwork dries in air. Various protective coverings were then applied, including bleached beeswax, chlorinated rubber solution, celluloid solution, polyvinyl acetate solution in toluene, polymethacrylic ester solution ('Bedacryl' 144 TL., I.C.I.) and graphite powder rubbed into the surface. The amount of rusting was assessed and other factors, such as convenience, cost, time and appearance, were taken into account. By and large, waxing seems to have a slight advantage over steel wire brushing followed by 'Bedacryl'; coating with polyvinyl acetate and the graphite/'Bedacryl' treatment are also satisfactory.

Education for Management

The British Institute of Management has now published the second of the booklets dealing with education and training in the field of management. The first was concerned with the facilities available in technical colleges and other educational institutions, while the second describes short courses held at residential establishments and by professional and other bodies. These include courses for senior management organized at the Administrative Staff College and by the National Council of Y.M.C.A.'s; courses for middle management and other supervisors arranged by certain professional and voluntary organizations, adult education colleges, university departments and such bodies as the Hull Junior Chamber of Commerce; courses for young workers, apprentices and other entrants to industry, organized mainly at residential educational colleges; courses for trade unionists organized mainly by the National Council of Labour Colleges; as well as courses in such topics as joint consultation, communications, work study and method engineering held at a variety of centres. The booklet also contains details of special courses arranged for education, training and personnel officers. The sponsors of the booklet are to be commended both for undertaking such an important work and for the succinctness and accuracy of their presentation.

The Fourth Douglas Lea Memorial Lecture

The fourth Douglas Lea Memorial Lecture, entitled "Douglas Lea: Physicist into Biologist", will be delivered by Prof. C. A. Coulson, Rouse Ball professor of applied mathematics in the University of Oxford, at a meeting of the Hospital Physicists' Association on October 1 in the Reid-Knox Hall of the British Institute of Radiology, 32 Welbeck Street, London, W.1, at 8 p.m. The meeting is open to the public.

Announcements

The eighth annual congress and festival of scientific films of the International Scientific Film Association will be held in Rome during November 6–12 at the University City and also at the National Research Council. Public performances of outstanding films of general appeal will be given, and specialized films will be shown and papers read at the meetings of the sections concerned with the film in medicine and veterinary science, in industry and technology, in scientific research, and in other subjects. Inquiries in Britain concerning the congress should be sent to the Scientific Film Association, 164 Shaftesbury Avenue, London, W.C.2. All other inquiries should be sent to the Segreteria VIII Congresso Internazionale della Cinematografia Scientifica, Commissione per la Cinematografia Scientifica del Consiglio Nazionale delle Ricerche, Piazzale delle Scienze 7, Roma.

The fourth annual Eastern Joint Computer Conference and Exhibition, which is jointly sponsored by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the Association for Computing Machinery, will be held in the Bellevue-Stratford Hotel, Philadelphia, Pa., during December 8–10, the theme this year being the "Design and Application of Small Digital Computers". Proceedings of the Conference will be published by the sponsoring societies and may be ordered from any one of them. The meeting will be open to all. Applications for registration should be sent to the Eastern Joint Computer Conference, P.O. Box 7825, Philadelphia 1, Pa.

The Iron and Steel Institute, in association with the Institute of Metals, is organizing a symposium on powder metallurgy, to be held in Church House, Westminster, London, S.W.1, during December 1–2. Both ferrous and non-ferrous aspects of powder metallurgy will be considered, and there will be a small exhibition of components used in the various processes. The papers will be divided into three groups: metal powders and their assessment; research and production practice; and production and properties of engineering materials. The symposium will be open to all, whether or not they are members of either Institute, on application to the Secretary of the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1, from whom further information can be obtained.

The autumn conference of the Scientific and Technical Group of the Royal Photographic Society will be held this year on October 2 in the Lecture Theatre of the Stephenson Building, King's College, Newcastle upon Tyne, in conjunction with the University of Durham. The theme will be "The Scientific and Technical Applications of Photography", and, besides the reading of eight papers, visits will be made to the Departments of Naval Architecture, Physical Chemistry, and Photography of King's College. The conference will be open to all, no tickets being necessary. Further information can be obtained from Mr. C. J. Duncan, Director, Department of Photography, Medical School, Newcastle upon Tyne 1, or from the honorary conference secretary of the Scientific and Technical Group, Dr. R. S. Schultze, Research Library, Kodak, Ltd., Harrow, Middlesex.

The Edison Swan Electric Co., Ltd. (155 Charing Cross Road, London, W.C.2), has published the third in its series of educational booklets, entitled "Electrons", this latest one being on screened-grid and pentode valves. It surveys the disadvantages of the triode in order to show how, for certain purposes, improvement can be obtained by an additional grid as in the screened-grid or tetrode valve, and by two additional grids as in the pentode. In addition to explanatory circuit diagrams, the booklet contains a specially prepared sectional drawing of the Ediswan Mazda high-slope screened radio-frequency pentode 6F1 valve, showing the electrode assembly and full details as to its operating conditions.

The "Bibliography of Articles appearing in Turkish Periodicals, No. 5" (pp. 138. Istanbul: Milli Egitim Basimevi), covering the period October–December 1952, contains some nine hundred entries, arranged according to the Universal Decimal Classification (first two figures only), and alphabetically by authors within each section. Slightly more than half the entries fall under science and applied science or technology. A list of periodicals covered, with the place of publication, and an author index are included, and the explanatory preface is in Turkish and in French.

BRITISH ASSOCIATION MEETING AT OXFORD

SCIENCE AND HUMAN NATURE

By Dr. E. D. ADRIAN, O.M., P.R.S.

PRESIDENTIAL ADDRESS

THREE hundred years ago a scientific society used to meet in Oxford every week in the rooms of Dr. Wilkins of Wadham College. It was the first of its kind in Britain and it had what we should now call an escapist motive. Fifty years before, Francis Bacon had published his great plan for a new road to knowledge, by concerted observation and experiment, and Harvey soon after had made the experiments which proved the circulation of the blood. But then the country had been torn by civil war. It had killed its King and could not see how to reach settled government. Dr. Wilkins had collected a band of scholars of inquiring mind, Boyle, Wren, Willis and others whose names are now part of the history of science, and they met together to take what comfort they could in the new kind of knowledge which could be confirmed by experiment instead of the appeal to authority. "Their first purpose was no more than only the satisfaction of breathing a freer air and of conversing in quiet with one another without being engaged in the passions and madness of that dismal age."

So it was in Oxford that the scientific age was conceived in England, with the conflicting loyalties of the Commonwealth as a background, and I can admit Oxford's claim the more cheerfully because Dr. Wilkins moved to Cambridge and was for a short time Master of Trinity College, just before Isaac Newton came there as a young undergraduate.

When the King came to his own again the temper of opinion changed. There were great prospects ahead. The philosophers moved to London, convinced that their inquiries would lead to material prosperity as well as to deeper knowledge. They founded the Royal Society, and Isaac Newton's "Principia" established the mechanical order of the world. The material progress followed more slowly; but one hundred years after Newton's death it had already begun to affect the lives of half the people in Britain. Scientists, as usual, were in no doubt about the value of what they were doing and they felt it was high time to share their faith and some of their responsibilities.

In 1831, therefore, the British Association was founded for the advancement of science and at the annual meeting our leading scientists assembled in one big town after another to spread the news of this fresh source of knowledge and of material advance; and the Association has gone round ever since on much the same errand, announcing new discoveries and airing controversies before an audience which has grown steadily in size and in its understanding of what the scientists are about.

But now the products of science are everywhere. Knowledge of the material world is constantly growing, and its consequences are of such a spectacular nature that everyone is aware of them: few people now can doubt that the scientist's picture of the world must have some validity if it enables him to deliver such remarkable goods. So it has come about that the advancement of science is in everyone's mind. Why then are we here to-day? What is there left for the British Association to do if it can only preach to the converted?

For scientists it can do a great deal. We are all specialists nowadays, and here we can learn what is happening in fields outside our own; but it is true that these meetings must lack some of the appeal they had when the whole territory of science was so much smaller. Progress is too rapid for the new discoveries to be saved up as a birthday present, and controversies have become too technical to be aired in the market place. Yet there is one very great and worthy task which needs the help of a body like ours which brings scientists and laymen together. The Association must show the layman where the scientific age is leading him. It is by its impact on public opinion that the success of these meetings must be judged.

No meeting of the Association at Oxford could pass without reference to that famous occasion when its impact on public opinion was highest, when it was made quite clear that the pursuit of natural science would mean a painful revision of beliefs as well as a gain of material comfort, when it claimed acceptance for the theory that denied the special creation of mankind.

It was in 1860, the year after the publication of Darwin's book on "The Origin of Species". Bishop Wilberforce was to speak and Huxley was Darwin's champion. The audience was too large for the lecture room and they moved to the long west room of the Museum; but the first paper was dull, it was on "The Intellectual Development of Europe considered with reference to the views of Mr. Darwin", and after an hour of it the audience was restless and wanted something more dramatic. They had it from the Bishop, who spoke with eloquence and wit against the idea that man and the monkey could have a common ancestor. He ended with an ill-conceived joke about Huxley's claim that he was descended from the apes; but he sat down to general acclamation and the fluttering handkerchiefs waved by the ladies. Huxley had a more harshly coloured picture to present: the aim of life was merely to go on living, the road to progress was by the slaughter of the weak and the survival of the strong, and man was cousin to senseless brutes. The scientists were demanding that the search must go on, that the evidence must be followed wherever it led, but until then it had not led to anything quite so bleak.

All this was no doubt implicit in Huxley's speech; but the audience at the British Association is human and what really stirred them was Huxley's grand indignation at the idea of a bishop condescending to such a paltry joke on so high a theme. His scorn forced the excitement to such a pitch that one lady fainted and had to be carried out, and afterwards no one, not even Huxley, could remember exactly what he had said. It did not matter so much, for the chief issue was no longer the origin of species, but whether Bishop Wilberforce had really been guilty of a breach of good manners. But the dispute had been on the scientific plane and the evidence could not be ruled out because it was unpalatable:

within a few years the battle for Darwin's theory was won and it seemed that the discoveries of science had forced the human race to give up beliefs on which it had relied for centuries.

Naturally the change came gradually, bringing discord into a good many families where the rising generation were zealous converts to the new creed. But now the scars are mostly healed. Advancing understanding of what was really at stake has made it possible for both sides to keep their ideals. The theory of evolution has lost its power to arouse passionate resentment or passionate faith.

I have mentioned that meeting for two reasons: because it emphasized that man himself was part of the natural world and because it emphasized also his right, at all events his determination, to go on searching for knowledge, for without his curiosity he would be nothing.

We all know where our curiosity has now landed us: with advances in atomic physics which might be applied to devastate half the world, and if they were so applied would certainly make life in the other half extremely precarious. Our grandfathers here were faced with scientific discoveries which were no laughing matter, for to many of them they spelled the end of all worthy human aims; but we face discoveries which might spell the end of all human aims, worthy or not.

We can regret that atomic bombs are possible without regretting the discoveries that have led to them. Advances in natural science cannot avoid advancing the methods of warfare; they do so when they make armies more healthy as well as when they increase the power of their weapons. But although the strategists have to think mainly of immense explosions and great devastation, it would be a mistake to suppose that these are the only dangers. Even if we can survive them we must face the possibility that repeated atomic explosions will lead to a degree of general radioactivity which no one can tolerate or escape.

The level would not rise rapidly and there is a large margin in hand; but the physicists can estimate the persistent contamination which must follow an atomic explosion of a given magnitude and the biologists can assign limits to the amount of contamination which could be let loose on the world without serious danger to every part of it. When atomic energy is used for supplying power for industry the dangers of contamination are real enough, but due precautions can be taken to avoid them. In a major war they would soon be set aside. Powerful nations who think they could win quickly might accept the risk. A few hundred large bombs would not raise the level of radiation to the point where it would become a general danger, and no doubt a country of small area like ours could be reduced to ashes by a relatively small mass of explosion. Though the ashes would be deadly, the rest of the world might escape them. But a long war between powers well armed with bombs would certainly involve an order of radioactive contamination which would involve us all—victors as well as vanquished.

Arguments that war does not pay will not count much when ideals are threatened. It is true that a war which would probably end in wholesale destruction can appeal only to people who are desperate; but they can be made desperate and that is the end we have to guard against. There are conceivable safeguards, of course; but controls and conventions are not foolproof, and in future whenever the world is split into two opposing groups with large stores of atomic weapons it must face this added risk of catastrophe.

Yet we have surely no right to feel that our predicament is so much worse than that of earlier generations. Our grandfathers could do nothing to ward off the danger which seemed to face their cherished beliefs; but our fate is in our own hands. We are afraid, and rightly, because we cannot trust ourselves to act peaceably, because we know that unless we are ready to give up some of our old loyalties we may be forced into a fight which might end the human race. Our predicament is the inevitable result of our curiosity and of the physical nature of the world we live in; but if we can make our behaviour worthy of our increased knowledge we can live safely. The scientist, therefore, has a double responsibility. He must apply his science to learn as much as possible about the mental and physical causes which make us behave as we do, he must study human nature to prevent its failures; but he cannot wait for the discoveries which might make us act more wisely: he must take us as we are and make it his task at meetings like this to point out that the human race cannot stand more than a few thousand large atomic explosions whether they hit their target or miss it. If we can make this known universally our Association will not have failed in its purpose.

It may be optimistic to think that our dangers would recede if we had a better understanding of human reactions: in fact, if we must continue to make war there is no kind of scientific investigation which might not be used for making it more effective, and there can be no guarantee that discoveries in the field of human conduct would be harmless. A drug or a system of education which would make us all do as we are told, a method of producing radical conversion to a new system of belief, a knowledge of new ways of rousing patriotic ardour, all these might be used with consequences almost as grim as the genetical deterioration in a radioactive world. The psychiatrist who discovers a cure for paranoia may find that he has also revealed a convenient way of producing it.

Our novelists have made us aware of these dangers; but it is some comfort to feel that in this case the increased knowledge could be used for defence as well as attack. We can only be protected from radioactivity by living in caves on uncontaminated food and drink; but an increased knowledge of how the mind can be influenced could certainly forestall many of the influences which might be used for undermining our integrity.

It is certainly true that discoveries relating to our own nature may mean a painful readjustment of our beliefs: that, however, is a fair price for increased understanding and, in fact, our ideas about our own behaviour have already been assailed in such a way that further revelations are unlikely to shock us. There is a fairly close parallel between the impact of the theory of natural selection one hundred years ago and that of Freud's theories on our own generation. The British Association does not come into it, because Freud's evidence was all on the medical side; but his views made the same kind of attack on our pride and met with the same passionate resentment or approval. The theory of unconscious forces moulding our thought has certainly diminished our stature as intelligent beings; yet the parallel still holds, for again we have recovered our equanimity.

We are reconciled to the unconscious, though we may not have digested all the elaborations of psychoanalytic theory. We are no doubt less sure of ourselves, inclined to spare the rod and to put nothing in its place; but, on the whole, Freud has left us with a better understanding of human conduct and we are not down-hearted at finding it less rational then we used to suppose.

Freud would have liked to build up a system based on the physiology of the brain; but he was soon too deeply committed to the psychological side. Pavlov's conception of human behaviour was based on brain physiology and it was less disturbing because it did not go into such uncomfortable detail. It is now perhaps more disturbing than Freud's, because Pavlov's notion of the conditioned reflex has come to dominate one side of the world; but we must not think the less of it because it has been used for justifying a political system foreign to ours. Pavlov and Freud were both scientists of surprising originality. They gave a new impetus to research on human activity; but the fields they explored are still waiting for the next advance to show how much they will yield.

The difficulty is that there are so many fields of inquiry to cover, each with its own limited range of facts and deductions. Freud studied dreams and neuroses and explained them as the product of repressed desires. Pavlov studied learning in animals and explained it in terms of conditioned reflexes. But physiologists ever since Galvani have studied the reactions of nerve fibres and nerve cells, the units of the nervous system, in the hope of explaining what they do in the terms of physics and chemistry. This approach at the lowest level can tell us little about the way in which units are organized; but when we keep to physical and chemical problems we are in the familiar territory of the exact sciences, we know how experiments should be conducted and there are great technical advances at our disposal. It is when we begin to think of organisms rather than molecules that we seem to part company with mechanism.

At this end of the scale, then, our actions are found to depend on the vast mass of cellular material which makes up the nervous system, receiving signals about the outside world from the sense organs and sending out signals to the muscles to produce the complex movements of intelligent behaviour. The nervous signals can be recorded and analysed because they are revealed by brief electrical effects, and we are rapidly gaining a fairly clear picture of the energy transformations which make them possible (and incidentally we should never have gone so far if there had been no radioactive sodium and potassium for tracing ionic movements).

The sensory inflow brings information about the events taking place outside us and progress reports to show how successfully we are dealing with them; signals from the muscles are needed to adjust the simplest movements and we are handicapped if we cannot hear what we are saying and cannot watch our step. But the great central mass of nerve cells has to fabricate a radically different pattern of messages to send out to the muscles and it is a pattern which depends on past as well as present information, on what happened to us a year ago as well as on what is happening now. Unfortunately, it is a great deal easier to study the immediate reactions of the nervous system than the more persistent changes which alter its habits and give us our memories. We know next to nothing about the plasticity which is the most important feature of the brain and that is the next hurdle for the biophysicists and biochemists.

But we do know that the cells of the brain do not behave as passive agents for conducting and combining the signals that reach them. As long as we are awake many of them are in continuous rhythmic activity. The system has its own reserves of energy and is unstable; at all events, it is so constituted that a slight disturbance of equilibrium will start up a cycle of discharge and recovery repeated many times a second and extended through much of its substance. It is no great surprise to find that we are driven to our daily activity by a cell system of this kind with energy to be dissipated; but we are now learning something about the interplay of the different parts of the system. It is found, for example, that a relatively small collection of cells at the base of the brain has a profound effect on the general level of activity, so that we are aroused when it is stimulated and fall into coma if it is injured. We can see too how the chief focus of disturbance shifts from one region of the cerebrum to another when we transfer our attention. In fact, we are beginning to trace a closer connexion between what is going on in the different parts of the brain and what we happen to be doing from moment to moment. For what it is worth, we can see a physical reason for our restless lives and our insatiable curiosity.

One may well feel that the most detailed knowledge of brain physiology will never help us much in our efforts to live peaceably; but it would be rash to prophesy. Certainly there are people now who lead more placid, if perhaps less useful lives, because their anxieties have been diminished by leucotomy, an operation on the frontal lobes of the brain; and long before the advent of leucotomy we had become accustomed to adjusting the activity of our nervous system by chemical agents. Tea and coffee, alcohol and tobacco are the stimulants and sedatives of the pre-scientific age and now, to quote the preacher, there is no end to the works of the apothecary, and we seem to be much less afraid of using the confections he gives us to take away our pains.

Only the writers of science fiction would suggest a future in which the problems of civilization will be dealt with by tampering with the brains of some or all of mankind. It will help us a little to settle our differences if we have the means of ensuring a clear head and an even temper after a long journey and a resetting of the daily rhythm; but clearly we must look beyond physiology for an adequate picture of the human brain in action. Though it should start at the molecular or the cellular level, the evidence for it must include the activities of the finished product. We must find out what human behaviour is like before we try to explain how it is produced.

We do know, of course, an immense deal about human behaviour, from our own experience and from the accumulated wisdom of the past; but it is only in recent times that we have tried to check our knowledge by the methods of natural science. The development of physical science dates from the time when direct observation and experiment were accepted as better guides than the principles which had seemed self-evident to the philosophers and the schoolmen. They were wise enough, but it was found that they could be mistaken. So now we can look to the many branches of social science to make a dispassionate study of what actually happens in our society without regard to what might be expected to happen if we are to believe all we have been taught.

The picture of human behaviour which the social scientist has to draw is of a system in which the units are men and women rather than cells or molecules. It is true that one man behaves very differently from another—it is part of our political creed that they must be allowed, within limits, to differ as much as they like. But, although we can insist that the units are not all alike, the general principles which determine their behaviour ought to stand out when we deal with millions rather than individuals.

There is, in fact, one branch of social science which can adopt this plan without difficulty. This is the science of economics, which considers only the human activities of producing and consuming, and studies the way in which these activities are to be balanced. When the balance is lost, credit and currencies fail and we may blame the economists for the plight we are in; but the status of their science is unquestioned, and no one would dream of saying that our complex civilization could have done as well without them.

It must be admitted, however, that the strength of economic theories rests very largely on the fact that they can be worked out with very little regard to human nature. Men must be assumed to be capable of trading with one another and they must have a variety of skills and needs and possessions; but that is all, or nearly all, that the economist has to consider. Few of the many branches of social science can proceed on such a simple basis, and it is because of this that the subject as a whole has still to win full recognition in Britain where the science of economics is so firmly established.

Theories describing or explaining other kinds of social activity are nothing new, they existed long before the theories of economics; but the economists have had the figures to check their conclusions and until recently the sociologists have had little but their own philosophy and their own reading of history. Even Durkheim, who broke away from the philosophic tradition, could only point the way to a truly objective study of human society. Now the position is quite different. A century and a half ago it had only just been decided that the population of Britain was on the increase. Many had thought that might be so, but there were no figures to show whether they were right or wrong. Now there are all the modern techniques for fact finding, the questionnaires, the punched cards, the sorting machines and the statistical methods. It is far easier now to deal with large groups, and the psychologists have far more knowledge of the irrational factors which can sway the smaller groups as well as the family and the individual. The stage seems to be set for the new development, and it might well be the most important scientific development of this century. Why are we still so reluctant to think well of it?

The answer, I suppose, is that we are not yet convinced that the kind of observations that the social scientist can make will be sufficiently objective and sufficiently precise. Those of us who work in laboratories have a far easier task in selecting what we should observe, yet we know how difficult it is for us to select and observe fairly. We have to school ourselves not to reject the exceptional result as worthless when it does not fit a cherished theory: we have to be continually aware of our own fallibility even though we have all the figures and controls to keep us straight. We are loth to believe that the social scientists are more open-minded than we are, and the material they have to deal with seems to need an almost superhuman open-mindedness combined with an almost superhuman power of selection, of seeing the wood as well as the trees in it. We feel that we should be lost in such a wood where everyone must feel the bias of his own upbringing and social ties, where there is so much that cannot be measured and may or may not be relevant and where there is rarely an opportunity of checking the conclusions by experiment.

Our distrust is probably intensified by the layman's tendency to speak of experiments in the social field as though they were comparable with the experiments which obey all the exacting rules of the laboratory. There we can at least hope to proceed by changing one factor at a time. The social scientist would be the last to cherish any such hope: his whole training warns him of the complexity of any situation where human beings are involved. But many people seem to think that if something in the social field is done in a new and usually more expensive way we have only to call it an experiment to justify the conclusions we wish to draw. Certainly we must try new methods and hope to find out why they succeed or fail; but although a new way to check juvenile delinquency or develop a housing estate may give the most favourable results, it is very seldom an experiment from which one can infer the precise factors that have made for its success. A change in the birth-rate, a wet summer or a newspaper campaign are the kind of disturbing element which would be too obvious to mention were it not that everyone who has worked in a laboratory must be aware of having overlooked disturbing factors which should have been just as obvious. We were lucky if our control experiments saved us from exposing our folly; but controls are far easier in the laboratory than in the world outside.

This is a minor grudge. If we harbour it we shall be visiting the sins of the enthusiast on the very people who exist to keep them in check, and we must surely welcome any new branch of study which tries to substitute the methods of natural science for unchecked speculation. It is very easy for us to forget our own rules when we allow our feelings to take charge, to say that a result was too obvious to be worth the proof if we happen to like it, and if we dislike it to say that statistics can be made to prove anything. Perhaps we have forgotten how much we distrusted some new development near our own field of science because it was unfamiliar and because we thought its backers claimed too much for it. We ought to remember that the now flourishing science of biochemistry was once distrusted by chemists as well as physiologists. It is human nature for the guild of natural scientists to delay admitting a new member until he has paid his dues and satisfied the examiners of his competence in the craft.

At present there are many kinds of investigation grouped under the umbrella of social science: the groups seem to have little in common and few of them can put their results into figures; but I think all of us, scientists and laymen alike, are becoming more aware of the value of social investigation and of the degree of certainty it can bring. We may have distrusted the army psychologists who classed us by our aptitudes, we may have read the Kinsey report from unscientific motives and we may continue to allow the accident-prone to drive their motor-cars. We can see none the less that there are facts to be found out about our usefulness in society, about our relations to one another and about the risks we take. We can see too that the search for these facts can be conducted on reasonably scientific lines. It is too early to be cautious in spending money on large-scale investigations. They are bound to be costly, and those of the social scientist deserve not only the support of national and international funds. There is this kind of support for the subject already; but it is too important a plant to be left in the hot-house atmosphere of research institutes and Unesco teams. It deserves to be in full contact with all the conservative and academic people in universities, the lawyers and historians as well as the economists, biologists and statisticians. There must be more social scientists in our universities so that the rising generation can see what they are like.

I have put in this plea for a subject about which I know so little because it seems to be developing more rapidly in other countries, particularly in the United States. We are handicapped, no doubt, by smaller resources and perhaps by the remains of a national temperament which has made us prefer to work by ourselves and not as members of a large team. We ought not to expect too much. Social scientists, like economists, may be able to foretell the consequences which are likely to follow in a particular situation; but the statesman who goes to consult them may come away with little to comfort him and may turn to the quack doctor in the next street. We may find out a great deal about the tensions which lead to war without seeing the way to keep ourselves clear of it.

But human beings, when we consider them as material for the biologist, are not to be thought of as incapable of improvement. Other kinds of animal have been found to possess unexpected power of communicating with one another; but we are the one kind endowed with a brain which gives us the power of communicating by putting our impressions into words and appreciating the meaning of the words we hear. Speech would be little use to us unless we could remember what it means; but memory, the ability to learn, is a property of the simplest kinds of nervous system. We alone possess a nervous system which gives us the power to order our ideas in words. We alone have this way of thought which allows us to compare a new problem with an old one.

With this unique equipment for thinking and communicating we can form our habits not only from what happens to us personally but from what happens to our fellows and from what has happened to countless generations in the past; and although the storage capacity of a single human brain is limited, we have learnt to make permanent records of what has occurred, in visible symbols, so that what cannot be remembered can be found in a book. In this scientific era our store of knowledge is growing so fast that we shall soon need new ways to keep it available. Books have done duty for a thousand years and we should be sorry to lose them; but we can change our habits rapidly and it is already old-fashioned to write a letter with a pen.

This increasing background of experience has meant that we are constantly acquiring new habits and new ways of thought. It does not take us very long to see the way round old quarrels. Darwin and Freud no longer trouble us. We are no doubt born with brains like those of our remote ancestors and when we are grown up we have no more native intelligence than they had; but our brains must have been so modified by what we have learnt that they are physically and chemically different, better adapted for the complex social life of our time. We have more knowledge at our disposal. If all goes well with our training, the brains we have ought to be more civilized than those of our fathers and those of the next generation more civilized than ours.

I have claimed that the scientific investigation of mankind can help the process of civilization by finding the weak points in our equipment and suggesting remedies; but these scientific activities will play only a limited part in the development of human society in the scientific age. The power we have acquired over the forces of Nature has made it possible to increase our mental training as well as our standard of comfort. Of the two or three thousand million people in the world, perhaps not more than five million are receiving a full university training, though no doubt more are trained in a narrow technology. Yet the number has risen steeply in spite of wars, perhaps even because of them, and it continues to rise. In the United Kingdom we have 85,000 students at our universities, about 1 in 30 of the whole age-group, and that may be all we should contemplate with our present system. A few years ago, however, it was only 1 in 60, and there must be many parts of the world where the university, as we know it, is only now beginning to play its part in civilizing the most intelligent citizens. This could never have happened without all the scientific inventions which have been blamed for our troubles, the improved transport, the cheap printing, the electricity and the internal combustion engine. And a university training would have been far less civilizing if it had never left the old authoritarian pattern which roused Huxley to speak in Oxford nearly one hundred years ago.

University students, however intelligent, are not usually considered to be the most peaceful members of the community. They have been more welcome in small country towns than in the capitals where they can join revolts against the government of the day, and they tend wherever they are to be critical of those in authority. Long may students remain so. If they were not, if they believed all they read in an officially inspired press, or even what they were taught by unrestrained professors of the greatest integrity, there would be little chance of their learning how to use their knowledge for solving the new problems of our time. The plodding methods of the laboratory and the card index must be there to check their enthusiasm and to show them how the problems have come about. Even if they get no help from that, it is something to know that there are many more people in the world to-day with brains better trained to deal with their environment by learning how its problems have been dealt with in the past.

The British Association is concerned with the advance of natural science. It began when we had little control over the forces of Nature, and we have now so much that we might soon become able to destroy two-thirds of the world by pressing a button. Yet the control which has been achieved by science has made it possible for us to improve our own natures by more education in the arts of civilized life. We may perhaps improve ourselves more rapidly if we can gain more insight into human behaviour. That is something which the Association can encourage; but it is only a small part of what it must do. It must not cease to encourage every kind of scientific inquiry, for it is human nature to inquire, to learn by experience, and to profit by what it finds out.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

RECENT DEVELOPMENTS IN NUCLEAR PHYSICS

THE post-war development of accelerators for atomic particles has enabled a new high-energy branch of nuclear physics to be developed, the main objective of which is the study of the forces between nucleons and their relation to mesons and the meson fields. This forms the subject of the presidential address to Section A (Mathematics and Physics) by Sir John Cockcroft.

In Britain we have brought into operation within the past year, for the study of this field of physics, a billion-volt proton synchrotron, a 400-million volt cyclotron and a 330-million volt electron synchrotron, while the Harwell cyclotron has produced protons and neutrons of energies up to 180 million volts. In the United States, in addition to machines of these types, proton synchrotrons of 2 and 6 billion volts are now operating.

Experiments on the scattering of protons by protons and protons by neutrons have demonstrated the exchange nature of the nuclear forces. The scattering of protons in succession from carbon and hydrogen targets have shown that protons after scattering have about 80 per cent of their spin axes pointing in one direction, that is, they become polarized. This results in four times as many being scattered to the left as compared to the right from the second target. This demonstrates another characteristic of nuclear forces—the very strong interaction between the spin of the nucleon and its orbital motion—which produces a non-central force.

The high-energy collision of nucleons produce π-mesons at nuclear energies greater than 200 million volts. At energies of a billion volts pairs of heavier mesons have been created. One of them is the excited proton first discovered by Rochester and Butler, originally called the V^0 meson. The other is a θ^0 meson, which decays into two π-mesons.

These and other mesons are very closely connected with nuclear forces. In nucleon collisions of medium energy, momentum is transferred through the intermediary of the 'meson cloud' associated with a nucleon. When the collisions are energetic enough, the π-mesons materialize, live for a hundred-millionth of a second and decay. In still closer encounters the heavy meson must play a similar part in nuclear forces, giving rise to shorter-range components of the force.

Mesons are now produced in such large numbers by the accelerators that they can be used for experiments on the properties of the meson. Thus the π-meson has been shown to have zero spin—like an alpha-particle or light quantum. It can form a compound nucleus with a nucleon of a very high degree of excitation. It can also form mesic atoms in which the meson plays a similar part to an electron in the atom, and mesic X-rays are produced in orbital transitions.

The address concludes with a reference to the dangers and peaceful potentialities of these powerful nuclear forces.

NEW IDEAS IN CHEMISTRY

SIR JOHN LENNARD-JONES, president of Section B (Chemistry), remarks in his presidential address to that Section that when the British Association last met in Oxford in 1926 physicists pictured electrons in atoms as rotating in orbits around a central nucleus like a solar system. Though this view had great success in clarifying the behaviour of atoms under the influence of light, and in providing a theoretical basis for the periodic table of elements, it had little influence on chemistry, for it did not prove possible to extend the mode of description to molecules. It was the wave theory of matter which opened the way. This provided a novel way of describing the states of electrons in atoms and molecules and a new technique for calculating their stationary states.

In the new theory two ideas were found to have an important place. The first one was that electrons are indistinguishable from one another, so that an interchange of any two does not produce an observable change. The second one was that electrons in atoms and molecules obey strictly the rule that no two take the same role at the same time. Electrons are said to have the 'property of exclusion'. No theoretical proof has been given of this—it is injected into current theories as a working rule and is justified only by its success in predicting the properties of matter.

These two ideas, together with the wave description of electrons, have proved of great importance in explaining the properties of molecules; in fact, it may be said that a unification of atomic physics and chemistry has thus been brought about. The property of exclusion appears to be more powerful than the forces of repulsion or attraction such as exist between electrical charges of like or unlike kind. These latter are of short range and cease to be effective beyond lengths of atomic dimensions; but the 'awareness' which one electron seems to have of another of the same kind of spin seems to extend throughout a molecule, however large it may be. Electrons can thus influence each other over distances many times greater than the sizes of the atoms which a molecule may contain.

The property of exclusion implies that electrons of the same spin avoid each other as though there were a powerful force of repulsion between them. This plays a vital part in fixing the shapes of molecules and, in particular, in producing the directed valencies of carbon. The occurrence of 'lone pairs' of electrons and the asymmetric distribution of charge in molecules can be traced back to the same property. Thus this seems to be the primary cause of electron-rich regions and the agent impelling chemical reactions to go.

One of the most interesting and profitable applications of the new ideas has been to the structure of conjugated molecules. Many of their characteristic properties, such as alternating polarity and the shifts of electrons under the influence of substituents, can now be understood in principle in terms of the same concepts used for saturated molecules.

THE RELATIONSHIP OF PALÆONTOLOGY TO STRATIGRAPHY

In his presidential address to Section C (Geology), Dr. C. J. Stubblefield points out that Oxford is a shrine of British palæontology, for from Oxford came the first printed illustrations of British fossils. These appeared in the "Natural History of Oxfordshire", published in 1677, from the work of the first curator of the Ashmolean Museum, Robert Plot. Oxfordshire has other claims for pilgrimage. It contains the birthplace of William Smith; a man whose discovery, that the fossils contained in rocks could be the means of identifying strata, gave a new approach to stratigraphy. Furthermore, the richly fossiliferous Jurassic rocks of which the county is composed have here and elsewhere, by their fossils, provided the key to many basic principles of stratigraphy.

The stratigrapher produces geological maps showing the identification and disposition of the strata in available areas; he describes the geology of the earth's crust. The palæontologist works to ensure accurately determined fossils, with knowledge of their conditions of life, structure, relationships and distribution.

At the time of William Smith's discovery, palæontology was very young; but it was nurtured by three distinguished French biologists, Lamarck, Cuvier and Brongniart. The first two noticed in mapping and tracing upwards the rock succession in the Paris basin that the fossil Mollusca became progressively more like living forms; this observation eventually became perpetuated in the formational names Eocene, Oligocene, Miocene and Pliocene. On a broader basis the changing pattern of life revealed by what is now known to be a quarter or less of the history of the earth's crust is also expressed in J. Phillips's terms Palæozoic, Mesozoic and Cainozoic.

The most striking aspect of the application of palæontology to stratigraphy has been in the classification of the stratal column into successively smaller divisions and in correlating rocks found in different parts of the world.

Palæontology, coupled with an appreciation of lithological changes in contemporaneous deposits, played a prominent part in the establishment of the Devonian or Old Red Sandstone System; in the founding of the Ordovician System the faunas were also an important consideration. Stratal divisions known as stages were formulated by d'Orbigny entirely from palæontological studies, and, in revised and extended form, are useful standards of comparison for regional correlation particularly when considered as unit sequences of zones, that is, of rocks containing successive assemblages of fossils. Such sequences of zones have also helped stratigraphers to find evidence of stratal gaps, and of folding and faulting.

While a geological map is the published outcome of a particular local geological study, in Britain it is now regrettably rare to find, in the accompanying account, pictures of the fossils on which critical age determinations are based. On the other hand, the typical large-scale geological map is required to show the distribution of the different lithological units for several purposes, some non-geological. Though palæontology is used for ensuring accuracy in the local correlations, the mapped divisions should not be too subjectively palæontological. Nevertheless, when such maps are combined for reduction to smaller scales, palæontological data are appreciated as being vital for regional correlation of the rock units.

ARCHAEOPTERYX AND EVOLUTION

In his presidential address to Section D (Zoology), Sir Gavin de Beer states that the specimen of *Archaeopteryx* preserved in the British Museum (Natural History) has been subjected to a complete re-investigation with the help of modern methods. Making use of the fact that fossil bone shows fluorescence under ultra-violet light whereas the matrix does not, the sternum has been discovered and its bony nature confirmed by X-rays. It is flat and accords with all the other features of the fossil to show that in life it was incapable of active flapping flight but glided from branch to branch of trees. The endocranial cast of the brain has been studied, and Dr. Tilly Edinger's surmises have been confirmed. The cerebral hemispheres were smooth, elongated, and narrow. The cerebellum was small and situated behind the mid-brain, instead of overlapping it from behind and pressing it down to a more ventral level as in modern birds. For the purposes of its limited powers of flight *Archaeopteryx* did not require a high degree of cerebellar co-ordination. Portions of additional vertebræ have been found, confirming that the articulation between their centra was simple.

It has long been realized that *Archaeopteryx* presents a beautifully intermediate condition between reptiles and birds. In principle, an organism intermediate between two groups might be intermediate in structure in all or many of its parts; or it might be composed of a number of structures completely characteristic of one group, a number of other structures equally characteristic of the other group, and few or no features intermediate in structure at all. It is quite clear that the transition from reptiles to birds exemplified by *Archaeopteryx* conforms to the latter alternative, for *Archaeopteryx* is a mosaic of typical reptilian and typical avine characters. The reptilian characters are: the long tail of twenty free vertebræ, the simple articulation between the vertebral centra, the short sacrum involving six vertebræ, the separate metacarpal bones and the presence of claws on all digits of the hand, the separate metatarsal bones, the simple ribs and gastralia, the simple brain with elongated narrow cerebral hemispheres and small cerebellum behind the optic lobes. The avine characters of *Archaeopteryx* are: the feathers identical in structure with those of modern birds, the arrangement of the feathers on the arm identical with that in modern birds, the fusion of the clavicles to form the furcula, the backwardly projecting pubes, and the opposable hallux of the foot.

The transition from reptiles to birds is therefore regarded as providing an example of a mode of evolution termed mosaic evolution, and the question arises whether this mode is also found in the transitions between other classes of vertebrates. The structure of the Ichthyostegalia suggests that this was in fact the case in the evolution of amphibia from fish, and *Seymouria* provides evidence of the same thing in the evolution of reptiles from amphibia. The transition from reptiles to mammals is more complicated to follow, largely because the conventional definition of mammals as vertebrates possessing hair and a squamosal-dentary articulation of the jaws has led to the retention within the reptilian class of most of the stages of the conversion of reptiles into mammals. Nevertheless, it is extremely probable from the evidence furnished by the ictidosaurs and by the monotremes that the mosaic mode of evolution applied there also.

The emergence of each of the classes of living vertebrates has been characterized by the acquisition of key-characters which have enabled the organisms to become adapted to and radiate widely in an ecological medium previously denied to them: land-and-water, dry land, air. The break-through into the new medium has been made possible by a change in a very small number of pieces of the mosaic, the other pieces remaining as they were for a considerable time. The significance and wide application of the mosaic mode of evolution was clearly recognized by D. M. S. Watson, who provided irrefutable evidence from *Seymouria* in its support, for which reason it is proposed to refer to it as Watson's Principle.

THE COAST AND THE GEOGRAPHER

IN his presidential address to Section E (Geography), Prof. J. A. Steers points out that the geographer has many, but by no means exclusive, interests in the coast. The borderline between land and sea at any one moment of time may seem relatively stable. But changes, both vertical and horizontal, are constantly going on, and those due to erosion and deposition are clearly noticeable in the course of a few years—and sometimes much less. Vertical changes are measurable locally in decades, and in the period since the beginning of the Ice Age they have been profound.

Vegetation, especially on low coasts, can bring about impressive changes in even a few years, and there is much room for experimental work in this field.

The still wider question of the primary origin of coasts is geological rather than geographical; but the study of off-shore contours and evidence of recent movements of a vertical nature, in so far as they affect an 'original' coastline, are of great geographical interest. Apart from physiographical implications, there are many others which concern the geographer. Not least among these is the general picture of the use of the coast by man—ports, industry, dwellings, holidays, etc. The details of planning are scarcely his direct concern; but in presenting an overall view the geographer by his training in the appreciation of regions ought to be able to contribute something of importance.

The geographer can make valuable observations on the factors—waves, winds, tides, etc.—acting on a coast, and since he is probably working on a problem from a purely personal and scientific point of view he is not likely to be concerned only with short-term factors. Hence his contribution to morphology and other aspects of the coast is of use to students in general as well as to engineers.

But when all is said and done, the understanding of the coast is by no means the province of any one group of workers. The more there can be active and friendly collaboration between engineers, geologists, ecologists, and geographers, the better. To achieve this end, there is no need for any very precise organization.

Geographers have great scope for their own particular interests, and the historian or historical geographer has much to give in this respect. There are many examples in Great Britain, and especially around the Mediterranean and North Seas, where the changes affecting ports and harbours and the growth of deltas need the double approach that a geographer trained in both the historical and physical branches of his subject can make. A great deal of the literature at present dealing with such matters minimizes or even overlooks the significance of this double approach. Moreover, there may well be a practical lesson to be learned from such studies. None, for example, would ignore the long history of change wrought by storm and waves along the East Anglian coast in considering new defence or harbour works.

In tropical waters, too, there is plenty of work for the geographer. Much of the significance of coral reefs, of the sand formations resting in them, and of beach-rock formation has yet to be learned. In this connexion, too, co-operation with a biologist will be more than worth while.

Many of the problems with which the geographer is concerned on a coast may be partly investigated in laboratories in which models of the coast are built. These, however, are expensive and not likely to be made unless valuable land or property is affected. Nevertheless, whenever or wherever it is possible for laboratory experiments to be made, full advantage should be taken of them.

THE CHANGING STRUCTURE OF THE BRITISH ECONOMY

THE development of an economy is a process of adjustment to changing technology and changing quantities and distributions of materials and skills. The economic structure at any moment reflects only imperfectly the needs of that moment, since structure changes slowly, and only in periods of less rapid change are the ideal and actual structures likely to be similar. The main elements of structure are the patterns of employment and activity, of export and import, and of consumption.

In his presidential address to Section F (Economics), Prof. E. A. G. Robinson points out that these patterns have changed greatly in the United Kingdom during the past two and a half centuries, when their measurement has been reasonably possible. When Gregory King first estimated many of the relevant statistics in 1688, the population of the United Kingdom was about 7·4 millions. Its retained imports were equal to about 5¼ per cent of national income; exports were primarily manufactures of indigenous materials; about two-thirds of all man-power was engaged in agriculture, and England was still a net exporter of agricultural produce.

By 1820, the proportion of employment in agriculture had fallen to about 35 per cent; the import ratio had risen to about 12 per cent; manufactures formed about 90 per cent of all exports, and textile manufactures 67 per cent; coal formed about 1 per cent of total exports. Raw material imports were now about 60 per cent of retained imports, of which textile materials accounted for about 24 per cent.

This process of specialization, of dependence on imported materials and on exports of textiles took a more extreme form as the century went on. By 1870 the import ratio had risen to about 28 per cent (its peak was about 33 per cent in the 1880's). The proportion of retained imports represented by food had risen to 35 per cent (of which grain was 9 per cent); but we probably provided three-quarters of our food from home agriculture. Textile exports were still the main source of payment for imports, representing 56 per cent of the whole; exports of metals and metal manufactures were beginning to grow and now formed 21 per cent of the whole.

By 1913 the import ratio was back to 28 per cent; with growing population (it was now about six times that of 1688) we had become dependent to the extent of about 55 per cent of our food consumption on imported food, which now formed about 40 per cent of retained imports. At the same time, we were much more dependent on imported materials; home supplies of wool had covered 50 per cent of consumption in 1860; they covered only 16 per cent by 1913. Textile exports were now 34 per cent of total exports; metal and engineering exports had risen to 27 per cent.

Some of these trends continued through the inter-war years. But the import ratio declined, and by 1937 was 21 per cent, partly as a result of lower import prices, but chiefly as a result of balance-of-payments difficulties. The reliance on imported food increased and imports probably provided 65 per cent of food consumption in the years before 1939; but by 1951 this had been reduced to about 50 per cent. Agriculture, which had given employment to 14 per cent of the working population of Britain in 1870 and 8 per cent in 1913, was now down to about 5¼ per cent. Textile exports declined greatly; by 1937 they were 24 per cent of the whole, and by 1951 only 19 per cent; the share of metals and engineering exports rose to 35 per cent in 1937 and to 49 per cent in 1951.

It is interesting to contrast the structures of the United Kingdom and of Western Germany. They have almost identical populations, very similar areas, but very different structures. In 1953 the United Kingdom import ratio was 26 per cent, that of Western Germany about 16 per cent. Western Germany maintains an industrial production about two-thirds as great as that of the United Kingdom on raw material imports about one-third as great. It is dependent on imports for only about one-fifth of its food consumption. Each country has much to learn from the other.

It may be difficult for the United Kingdom to continue to find markets for exports on a scale sufficient to maintain its existing import ratio. The high degree of specialization of the second half of the nineteenth century was based on a degree of technical leadership which we cannot hope to recover, and on obstacles to the dissemination of scientific and technical knowledge which, once they have disappeared, cannot be recreated. There is probably less technical advantage now from a high degree of specialization and exchange. The United Kingdom's advantage lay also in the fact that everywhere the terms of trade between primary production and manufacture were very favourable to the latter; we were increasing our imports of primary products from countries, particularly in North America, where there were very considerable gains from moving out of primary production. Circumstances may thus demand considerable change in the United Kingdom's structure. But if there is reluctance to modify the structure, the consequences may be balance-of-payments difficulties which can only be remedied by measures that diminish imports by diminishing activity and employment.

EFFECTS OF NEW MATERIALS ON ENGINEERING PROGRESS

THE dependence of engineering progress on improvements in the existing materials of construction and on the discovery and economic development of new ones forms the subject of Dr. Willis Jackson's presidential address to Section G (Engineering).

Choosing his examples mainly from electrical engineering, he deals first with the insulation of high-voltage power cables and submarine cables. In the former, impregnated lapped paper, introduced by Ferranti in 1898, remains the only form of dielectric structure which can be seriously considered for the highest transmission voltages, notwithstanding the wide range of new synthetic materials which have since become available. From some points of view this may appear to suggest too conservative an attitude on the part of the cable manufacturers; but it can be more properly regarded as a tribute to their ingenuity in overcoming the limitations of the constituent materials, paper and oil, and in introducing new techniques of construction, which have proved adequate to meet the increasingly severe operating requirements. In submarine cables, on the other hand, the previously well-established gutta percha insulation has now been displaced by polyethylene (polythene). The material emerged from the research stage just in time to play a vital part in our early war-time radar installations as the dielectric of the high-frequency cables used for interconnecting the transmitter and aerial systems. Stocks of polyethylene-insulated submarine cables were built up later during the War in preparation for the invasion of the Continent, and the trans-Atlantic telephone cable incorporating submerged repeaters, soon to be embarked upon, is to be made of the same material.

Speaking next of the effect which the development of the low-carbon silicon steels has had on the performance of power transformers, Dr. Willis Jackson explains how the marked crystal orientation which can be produced in silicon steel sheet by appropriate cold-rolling and annealing treatments has made it possible to take advantage of the directional properties exhibited by single crystals of ferromagnetic materials. A more spectacular advance has occurred in magnetic materials for telecommunication applications arising from the introduction of the nickel–iron alloys and of powder-core technique and, more recently, from the war-time development of the ferrites, a range of non-conducting materials derived by replacing one of the iron atoms of Fe_3O_4 by atoms of other elements such as nickel, zinc, manganese, etc.

As an illustration of the way in which the discovery, and recognition of the potentialities, of some special property of a material may lead to the development of a new engineering technique, Dr. Willis Jackson describes the evolution of the germanium crystal triode, the transistor, an amplifying device which can perform many of the functions of the thermionic triode valve with the advantages over it of being simpler in construction, much smaller in size and not requiring a heated electrode as its source of charge carriers. Many difficulties have had to be overcome in the extraction and extreme purification of germanium; but the new device has a wide sphere of application in computers, guided missiles and telecommunications equipment generally.

The conversion of the nuclear energy of uranium into electrical energy affords another example of this type of development. The practicability of this conversion is dependent on the use of other materials also possessing special properties, though of a different kind, which have led to the rapid rise to engineering importance of such materials as heavy water, liquid sodium and zirconium.

Finally, after referring to the new ceramic materials based on barium titanate, to the emergence of titanium as a structural material and to the recently discovered beneficial effects on the physical properties of certain plastics which result from their irradiation by high-energy particles, Dr. Willis Jackson emphasizes the growing interdependence of progress in chemistry, physics, metallurgy and engineering.

ARCHÆOLOGY IN THE BRITISH COLONIES

SIR MORTIMER WHEELER'S address to Section H (Archæology) is entitled "Colonial Archæology" and is a plea for the urgent need to safeguard cultural and, in particular, historical and archæological evidence in and relating to British Colonial territories. Sir Mortimer is especially concerned with territories of British East Africa—Zanzibar, Kenya, Uganda and Tanganyika—but he also gives evidence showing that the position is bad in the Somaliland Protectorate and Aden and scarcely less unsatisfactory in West Africa, so that by extrapolation it can be surmised that the conservation of cultural treasures is sadly neglected to a greater or lesser degree throughout all the Colonial territories of the British Commonwealth.

The examples quoted from East Africa make indeed a sorry tale. Sir Mortimer gives chapter and verse of priceless buildings, many of them mosques of unique features, that have been pillaged for one reason or another, often quite recently, and in some cases they have even been deliberately destroyed by public works departments to make way for new roads or to supply building materials. The situation is chaotic in that each Colony has its own regulations with regard to conservation, and even where the laws are comprehensive and sensibly framed, their interpretation or execution is often left to officials with many other pressing duties or to persons with little or no interest in the matter. Now and then the story is relieved by examples of excellent (and timely) work; but these bright spots in the pervading gloom are all too often due to the fortuitous hand of some exceptionally enlightened person who struggles alone amidst apathy.

In July last year a widely attended Conference on African History was held in London under the chairmanship of Prof. C. H. Philips, of the London School of Oriental and African Studies, and from the three-day discussion six resolutions were drafted: the outlines of African history could be reconstructed by the co-operation of historians and archæologists; this implies the adequate preservation of ancient and historical sites, monuments and documents, and the development of museums and public record offices; immediate government action and control is therefore needed in the various territories; ultimately departments of antiquities will need to be set up to plan field-work and publish results; record offices, with archivists to run them, will need to be improved or, in some cases, to be created; and as an immediate step, a school of history and archæology in East Africa needs to be established on the lines of the British schools in Rome, Athens and Ankara. These resolutions have been sympathetically received by the Colonial Office, which is ready to be advised on these points by a committee set up by the British Academy; the committee is at present discussing the matter.

Sir Mortimer is of the opinion that finance is not the prime hindrance. He believes that the foremost need is to introduce an adequate antiquities law for each territory. Then the interpretation of the law must not be left solely to the governors and district commissioners; they must be guided by experts, who will in fact be the staff of a territorial archæological department. Such a department needs as an absolute minimum a director, one or more assistant inspectors, normally of local origin, a skilled local foreman, and a museum-cum-store in the charge of a trained curator. A skeleton staff of this pattern will not be over-expensive, for already many territories are bearing certain charges—for example, museums—often in an ill-organized way. But fundamentally the need is for an awakened appreciation by the general public, particularly those in the territories themselves, of the high priority of these problems. The African must be acclimatized to cultural values as much as to political and social evolution. What Lord Curzon did for India and what the French are already doing in their African Empire must be repeated in the British African territories. Though his address deals for the most part with a sorry record of shortcomings, Sir Mortimer Wheeler believes that the present British Colonial administration is concerned about the situation, and he looks forward to the time when good intentions will be translated into actual deeds.

THE RELIEF OF PAIN

PROF. A. D. MACDONALD, in his presidential address to Section I (Physiology), remarks that the problems of pain were discussed by the Section at St. Andrews during the final day of the 1939 meeting of the British Association. At that time the relief of pain by drugs was largely limited to opiates, though the late Dr. T. F. Todd discussed the value of intrathecal injections of alcohol in the terminal stages of malignant disease of the pelvis. His aim was to block sensation, if possible without destroying the motor pathways.

Since then, because of the many drawbacks to morphine, much research has been devoted to the modification of the morphine molecule and to synthetic substitutes in the hope of reducing the disadvantages of morphine. Much ingenuity has been directed to methods of comparative assay of analgesics; but their study in experimental animals is difficult and probably only of value as a screening measure, to be followed by tests on man in both laboratory and hospital. Many compounds have failed to fulfil their initial promises.

Perhaps the most interesting of the morphine derivatives of recent introduction are lævorphan and dextromethorphan, and of the morphine substitutes pethidine and methadone, both of which may be regarded as stepping-stones to long series of related compounds. As a rule, when a derivative is found to be more powerful as an analgesic, it is more toxic and has other grave disadvantages. Pethidine itself has the support of the Medical Research Council

Committee on Analgesia for Labour and is widely used in combination with nitrous oxide or, better, trichloroethylene. The dithienylbutenylamines are more active than pethidine but inferior to morphine. Methadone is in the morphine class as an analgesic, but is less effective in reducing anxiety and promoting sleep.

Potent analgesics are potential drugs of addiction and are, like morphine, carefully controlled by law. Tolerance and dependence may develop even with pethidine, and the need for a reliable analgesic which is not addiction-producing has still to be met. As a laboratory-worker Prof. Macdonald was fortunate in having, to follow him, Dr. P. O. Wolff, of the World Health Organization, Geneva, to discuss some of the problems of addiction, and Mr. J. Pennybacker, of Oxford, to deal with some of the contributions of neurosurgery to the relief of pain.

RECENT STUDIES IN THE PSYCHOLOGY OF THINKING

THERE is a growing sense among psychologists that the psychology of thinking is not only one of the most important areas of psychology both theoretically and practically, but also that it is an area that can be profitably investigated by scientific methods. Thinking is a complex activity rendered possible only as the result of a long period of evolutionary and individual development, and it depends on the co-operation of favourable organic and environmental conditions. The three major aims of the psychologist are: first, to study in detail the development of thinking from its simplest forms to the most highly developed logical and mathematical thinking; secondly, to study the conditions upon which thinking depends; and thirdly, to throw some light upon the general nature of the processes involved in thinking. The purpose of the presidential address by Prof. L. S. Hearnshaw to Section J (Psychology) is to present a sort of interim report on some of the more recent work and speculations of psychologists in the field of normal psychology.

Among this recent work a very high place must be given to the developmental studies of children's thinking carried out by Piaget in Switzerland. Piaget's recent work is not as yet well known in Great Britain. The importance of Piaget's studies is not merely that they constitute by far the most detailed account of children's thinking from the hour of birth to adolescence that has yet been made; it has much more in the comprehensiveness of their scope and their systematic theoretical organization which links the two poles of biology and logic. His studies of the genesis of mathematical and scientific thinking should be of great interest to scientists.

The work of experimental psychologists, though much more fragmentary than that of Piaget, has thrown some light on the subtlety of the personal, emotional and environmental factors that may influence thinking. Though the results of experiments in this field are still meagre in quantity, they indicate the practicability of an experimental approach which may in the course of time place our intuitive art of thought upon firmer foundations.

The tendency of contemporary psychologists is to regard thinking as a high-level skill, derived and built up, therefore, not, as in older views, from special cognitive elements, but compacted, as all skills must be, of both sensory and motor components. Skills are essentially activities, and skills are learned. The gestalt psychologists rightly emphasized organization as an essential feature of all skills, including thinking; but their further contention that this organization is immediate, unlearned, and unanalysable is much less acceptable. In a series of important experiments with monkeys, Harlow has traced the development of apparently immediate insightful behaviour through the establishment of what he terms "learning sets". Insightful behaviour is an end product, the result of a mature skill gradually acquired by experience, and marked increasingly by flexibility, transfer and generalization.

No theory of thinking as yet comes near comprehending the full range of the phenomena we know as thinking. Thinking cannot be equated with problem solving. An adequate theory must embrace every kind of thinking, normal and pathological. Recent studies suggest, however, that the psychology of thinking is no longer an esoteric study, but a branch of psychology which can be objectively studied, and which joins hands not only with better settled areas of psychology, but also with subjects like biology and logic, which lie beyond its own frontiers.

PLANT GROWTH AND PRODUCTION

IN his presidential address to Section K (Botany), Prof. W. H. Pearsall points out that botanists are faced to-day with many developments arising from new and exciting techniques. These have suggested to many that botany is liable to split up into a great number of highly specialized lines of inquiry. On the contrary, these new methods of inquiry should, from various directions, throw new light on the fundamental botanical problems which centre around the organization and growth of plant cells and tissues. Just as growth is the integration of the plant's activities, so the study of growth will serve to integrate inquiries on different aspects of botany.

If the botanist is thus interested in plant growth as a fundamental process, *per se*, the general public is interested in it because it is the means of producing food and raw materials, of which the world is in danger of being starved. It may be useful, therefore, to look on this latter subject somewhat systematically.

Methods of growth analysis devised by F. G. Gregory and his colleagues show that most plants appear to have similar values for their photosynthetical efficiency in growth. The efficiency of a crop thus depends generally more on climatic variations and on the extent and duration of plant-cover than on the nature of the individual plant. This can be illustrated in various ways, particularly by reference to J. D. Ovington's figures for the annual production of dry matter by various types of planted tree. In natural vegetation, too, dry-weight production seems to fall between similar quantitatively definable limits which bear little relation to the type of plant involved, or to some of the obvious ecological factors. Thus, in terms of annual dry-weight yield, waterlogged swamp-soils may be as productive as drained or normal ones.

It appears that very considerable increases in the production of food or raw materials are possible with more continuous crop-cover and improved methods of land-use; but methods of food collection also merit more attention. The use of animals to concentrate proteins is wasteful, especially as the high value of leaf proteins is now established and new methods of isolating and storing them are becoming available. The development of these conventional methods of increasing production may well satisfy human needs for many years.

However, other points of view are now becoming prominent. It is evident that the current methods of agriculture are open to criticism on three theoretical grounds: they absorb only a very small part of the incident sun's energy—usually less than 0·1 per cent; they are subject to all the vagaries of uncontrollable climatic variation; and finally, the yields compare unfavourably with those of modern industrial processes. For these three reasons an unconventional approach to the problems of food production has frequently been suggested, and the possibility of controlled employment of micro-organisms in a photosynthetical unit has been canvassed. A discussion of the use of an alga like *Chlorella* in this connexion reveals the practical difficulties that are involved, though real advances in the future are likely from the use of this type of organism.

What is really being envisaged is the development of controllable systems in which the organism acts as an enzyme complex, such that both rate of reaction and type of product can be strictly determined. The problem is whether a sufficiently high rate of photosynthesis can be maintained to give the very large increase in yields which would be industrially desirable in such a system. Botanists would emphasize the unrealized possibilities for synthesis existing in such autotrophic systems. They will also realize the greatly increased knowledge of cellular organization which must be acquired before such methods become possible.

THE TEACHER IN THE TWENTIETH CENTURY

MR. RONALD GOULD in his presidential address to Section L (Education) remarks that the quality of teachers will always be one of the determinants of the quality of succeeding generations. The characteristics of a teacher of high quality are technical competence; a knowledge of the subject to be taught; the power to communicate knowledge; a broad educational background; and personality (that combination of personal characteristics, difficult to define but easily recognized, which enables him to stimulate and encourage his pupils individually and collectively).

Three conditions, however, must be satisfied if the qualities of the teaching profession are to be improved. First, teachers must realize the need for continuing their education. The training college course should be extended to three years. More adequate attention could then be paid to the theory and practice of education, and higher educational standards achieved. Further, every serving teacher should look to his own education, working out his own philosophy, striving to achieve that maturity of mind which would enable him to sift the wheat from the chaff in current educational thinking and practice. This could be done by organizing more refresher courses, the extension of exchanges with American and Dominion teachers, and the release of experienced teachers from school, for six months or a year, for the purpose of undertaking worthwhile educational investigation. Above all, teachers should read widely and keep abreast of modern thought.

Second, teachers must be assured of considerable freedom in their professional work. Freedom from the fear of arbitrary dismissal is essential: so are civic freedom, freedom from compulsory duties not concerned with the work of the school, and academic freedom. After long and hard struggles, teachers have now attained security of tenure. Civic freedom is not a freedom established by law but has been conceded by local authorities because of constant pressure from teachers. This freedom, however, is still threatened. Freedom from compulsory extraneous duties has but recently been established, since only a short time ago teachers were sometimes appointed to county schools not on the basis of their qualifications as teachers, but because they were prepared to be choir masters, Sunday school superintendents, parish clerks, or to assume some other responsibility in the district. Academic freedom is of enormous importance. Within the limits imposed by law, public opinion and the broad consensus of professional opinion, the teacher should be free to choose both the content of his curriculum and the methods to be used. All these freedoms have been acquired in the past fifty years.

The third condition necessary to establish real quality in the teaching profession is that all concerned with the education system—teachers, local authorities, the Government and parents—should regard themselves as a partnership. There is now real partnership, in spite of some misunderstandings and conflicts as to the speed of advance or the means to be adopted, for all these parties are conscious that they serve the child. This is, however, a recent conception. In the eighteenth century, there were three basic ideas about the provision of popular education: it was a charity, it was a voluntary and not a State effort, and it was under ecclesiastical auspices. Such conditions made partnership with teachers impossible. There was little change even after the establishment of School Boards in 1870. From 1902, however, relationships between the teachers and H.M. inspectors, and between teachers and local authorities, slowly improved. Under the Education Act, 1944, administrative power in education was divided among the Minister of Education, 146 local authorities, hundreds of divisional executives, thousands of managerial and governing bodies and a quarter of a million teachers. Such a dispersal of power was politically sound. Successive Ministers, to their credit, have willingly shared with others powers legally their own, and the establishment of many advisory committees by the Minister is evidence of the voluntary sharing of power and the desire for a real partnership. Parent–teacher co-operation, too, has shown marked improvement.

The future, however, holds some dangerous possibilities—the possible reform of local government and in 1956 the review of the education grant formula. Neither of these should be allowed to affect adversely the freedom of the teacher and existing partnerships.

AGRICULTURE: THE INDUSTRY AND THE SCIENCE

THE art and practice of agriculture advanced very little during the two thousand years prior to 1900, the principal change being the evolution of a system of farming which combined the Saxon plough with the Roman knowledge of agriculture. But, Dr. R. E. Slade points out in his presidential address to Section M (Agriculture), during the past fifty years there have been great changes. The tractor has replaced the horse; the combine harvester is replacing the reaper and binder and the threshing machine. We have improved the fertility of the land by our knowledge of fertilizers and other mineral requirements. We have supplies of phosphates, potash and nitrogen fertilizers. We have insecticides which protect our crops from practically all insects. We can protect our seeds from fungus diseases and we have selective weed killers by which we can destroy the weeds without affecting the crop. We have developed silage and grass-drying for the preservation of summer crops for the winter. We have applied the advances in medicine to veterinary science and we have got control of most of the ills from which animals suffer. We produce only clean milk, and we have increased the yield of our cows by 20 or 30 per cent. We can keep pigs and poultry under labour-saving intensive conditions without getting into trouble through deficiency diseases.

The agricultural industry in Great Britain comes very much under government control. This control of the industry was designed for war conditions and it has lasted until this year. Some industries were decontrolled almost immediately after the end of the Second World War and were able to reorganize for peace-time production when other nations were unable to flood our market with their goods. While agriculture has been under control, the methods of marketing agricultural produce have remained completely stagnant. Now we have neither the organization nor the physical assets to sell our produce in competition with well-organized imports. Organizations are being improvised; but we sadly lack well-equipped abattoirs, cold-storage plants, bacon factories and milk conversion factories as well as organized markets. The annual gross value of the agricultural produce of Britain is now about £1,000,000,000, so farming is one of our largest industries.

An examination of some examples of the introduction of science into the service of the industry indicates that scientific knowledge and inventions are most rapidly adopted when they are introduced to the industry by well-informed salesmen, backed by scientific advisers. The Milk Marketing Board has had a considerable effect on the development of dairying and has been the intermediary for applying science to the industry.

The Agricultural Research Council under the Lord President of the Council spends about £3,000,000 per annum on research. The Agricultural Improvement Council under the Ministry of Agriculture has experimental husbandry farms, and there is also the Agricultural Advisory-Service which covers the country. There are thus three layers each covering all agriculture: (1) research, (2) experimental husbandry, and (3) advisory service. Each layer is in itself doing very fine work and excellently co-ordinated. But there is no vertical drive through the three layers. Perhaps some day the present organization will have added to it vertical as well as horizontal direction, and there will be a freer interchange of personnel between the different layers. Then we may expect to see our scientific discoveries rapidly brought into use on the farms.

PHENOLOGY—THE STUDY OF THE SEASONS

In an introduction to his presidential address to Section X (Assembly of Corresponding Societies), Dr. C. B. Williams compares the young naturalist in the British Isles with one living in the tropics. In Britain there are books, museums and societies, all ready to help and encourage, and Nature is on the whole benign, so that children can be encouraged to study in the fields. In the tropics, Nature is often malignant and there are so many dangerous animals and plants that children have to be taught to fear until they have the knowledge to study. There are also so few books, museums and societies that many possible naturalists lose their enthusiasm from the lack of companionship in their studies.

The study of phenology—or the sequence of biological events in the changing seasons—is an example of a branch of field natural history, covering both animals and plants, in which for many years most of the work in Britain has been done by amateurs. One of the most remarkable examples of continued amateur effort is the series of observations taken in the village of Hevingham in Norfolk of the first date in each spring of the leafing and flowering of certain trees (hawthorn, oak, ash, etc.), the arrival of certain birds (such as the swallow and cuckoo) and the first appearance of some insects. The observations were started in 1736 by Robert Marsham, were continued by him until his death in 1797, and were carried on by his son until 1810. There was then a gap of twenty-five years; but in 1835 the observations were resumed and have been carried on ever since by different members of the same family. The series covers nearly two hundred and twenty years, with only one relatively short break. In the middle of the past century there was a general spread of interest in the subject, and the Royal Meteorological Society formed a Phenological Committee which issued regular annual reports from 1874 until 1947. All the observations were sent in by amateurs scattered over the country, who reached a maximum of more than six hundred in 1931. Unfortunately, interest then waned and in 1947 the Committee gave up this work.

Observations of this type are of great importance for studying the relation of the dates of natural events to changes in weather, climate and geographical position; and the research scientist and the amateur naturalist should co-operate to put the work on a sound basis.

Unfortunately, the analysis of the records is complicated by many accidental sources of error. Some of these can be avoided by greater care, greater regularity of observation, and an increased number of observers scattered widely over the country. Other errors are more difficult to reduce—such as differences in ease of observation between plants and animals, between birds which sing and those that do not, differences due to variation in the abundance of the animal or plant to be observed, and in the ability and experience of observers. For a proper study of the problem events should be selected to cover the whole year round, without so much emphasis—as in the past—on the return of spring.

An appeal is made by Dr. Williams for a better understanding between the research scientist and the amateur, so that each can appreciate the desires and difficulties of the other.

THE NATIONAL INSTITUTE OF AGRICULTURAL BOTANY: ITS PAST, PRESENT AND FUTURE*

By SIR JOHN RUSSELL, O.B.E., F.R.S.

THE National Institute of Agricultural Botany, Cambridge, was founded in 1919 at the time when scientific plant breeding was first being used for the improvement of agricultural crops; its purpose was to test, multiply and popularize new and desirable varieties as they were produced. With it was incorporated the Seed Testing Station that had been founded two years previously. The work has proved so successful that the original staff of four technical officers has now expanded to fifty-three.

The need for the Institute's work to-day is at least as great as ever it has been: Hunter, Engledow and Bell are still producing new varieties of cereals. Others too are active; during the past twelve months the Institute has received fifty-six new varieties of cereals, more than half of which are already approved or recommended in their own countries. It is a great service to our agricultural community to have these thoroughly tested in Cambridge before they are widely taken up by farmers. Moreover, British agriculture is now in a period of some uncertainty. The clear-cut situation of the Second World War, when calories—in practice, wheat and potatoes—and also milk, were our overmastering needs to be achieved at all costs, no longer exists; nor is the immediate post-war problem of saving dollar imports quite so insistent as it was, especially so far as Canada is concerned. Instead, farmers have a general request to produce all they can. But as against this, farmers are conscious of huge surpluses of wheat and other agricultural products piling up unsaleable in the United States, and many of them fear that if they do go all out for increased production they will simply be creating unsaleable surpluses that will be left on their hands. I do not think they are justified, for the surpluses are mainly local and largely confined to North America; the other great producers, the Argentine, Australia and Europe, produce little more than before the War. If and when the United States reduces its acreage of wheat, the surplus will shrink. The European and Mediterranean buyers of wheat are almost certain to increase their imports as their populations increase and their standard of living rises; some of them have already considerably increased their imports of wheat compared with the pre-war days. So also has Egypt, for the very interesting reason that where wheat will grow so will the valuable long-stapled cotton, and in a recent barter with the U.S.S.R. (February 1952) Egypt obtained in exchange for one acre of cotton as much wheat as would have required three or four acres of land to produce. Taking the long view, I see no reason to fear a continued over-production of wheat any more than I fear a coming shortage for those peoples that can afford to buy it.

If there is some anxiety about the future markets for agricultural produce, there need be none about the British farmers' ability to produce. Some of our soils have been cultivated for a thousand years, and some even for double this period; yet they have suffered neither deterioration nor loss by soil erosion, and the yields of crops have steadily increased and, so far as one can judge, are still steadily increasing. The average yield of wheat in Britain before the Second World War was 18 cwt. per acre; it is now 21·5. Barley has gone up from 16·7 cwt. per acre to 20, and oats from 16·3 to 18. Potatoes and sugar beet also show impressive increases. These values are among the highest in the world. But they do not represent anything like what the fields could produce if only we knew all the secrets. Our present average yield of 21·5 cwt. of wheat per acre is, of course, much exceeded by good farmers, who would commonly expect 30–35 cwt. per acre; but these quantities look puny compared with the yields of well over 3 tons per acre recorded in some of the Institute's trials and the 70 cwt. per acre obtained on a commercial farm in East Anglia quite recently. The average yield of potatoes in Britain, 7·4 tons per acre, and the yield expected by good farmers, 10–12 tons per acre, are put in the shade by the 27 tons per acre obtained in Lincolnshire in 1950. We do not know how these big yields are obtained; but they show clearly that we are nowhere near Nature's limits yet, and if we could only let in a little more light we could hope to get such further knowledge as would enable us considerably to increase our yields. Some good teams of scientific workers at Cambridge, Rothamsted, Oxford and elsewhere are striving to learn more about the growth of crops, and if they are left in peace to get on with the job we may reasonably hope for results, though no one can foretell when they may come.

The achievements since pre-war days have been most impressive. Before the War some 30 per cent of the calories being consumed in Britain were produced; this was the equivalent of feeding 14½ million people. By 1950 the production of calories was the equivalent of feeding 20 million people, an increase of roughly 50 per cent in about twelve years—a really astonishing result. In the meantime, the population had increased, and the new production represented 40 per cent of the nation's need for calories; the 30 per cent of pre-war days is now raised to 40 per cent. But the cost has been heavy. To step up from 30 per cent of our requirements to 40 per cent in 1950, the consumption of fertilizers had more than trebled; the number of tractors increased nearly six times; subsidies for farm operations amounted to £24·37 million; expenditure on the agricultural departments—supervision, advice and other activities of ministry officials—rose from the pre-war £8·9 million to £63·7 million, a sevenfold increase; and the cost of producing the food was such that a subsidy of £246 million was needed to enable it to be sold at the prices actually charged. We could, of course, push up this production of 40 per cent of our requirements to 50 per cent, and quite serious people have even claimed 100 per cent; it would be an interesting parlour game to try and calculate the cost. One fact is impressive. The subsidy of £246 million was for the 40 per cent of food that we produced; whereas for the 60 per cent that we imported the subsidy was only £164 million; this looks like 50 per cent more food at 30 per cent less cost. Actually it is not as simple as that, as the foods are not the same. But the fact remains that the same foods cost more to produce in Britain than they do in Denmark or Holland. One of our most urgent problems is to reduce this cost of production. Good farmers have long tried to do it, many of them with conspicuous success: agricultural economists who study farmers' accounts report differences up to 100 per cent in the cost of production of the same article on different farms in the same region. This article is not the place to discuss the reasons for that, but one can emphasize that the use of high-quality seed and of improved varieties is one of the surest and least-expensive ways of reducing costs of production.

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* Substance of an address given at the annual general meeting of Fellows of the National Institute of Agricultural Botany on July 16.

No country of comparable size stands in need of so wide a range of crop varieties as Great Britain, because no country of comparable size, except perhaps New Zealand, shows so wide a range of soils and climates in such a small space. A horticulturist to whom time and money were no object could probably persuade one and the same variety of a plant to grow in almost any pocket of soil and climate in the country. But the agriculturist is not so placed, and he must grow the varieties best suited to his conditions and requirements. First he must find them. Plant breeding has now become so highly developed that new varieties are constantly being produced, and there is always the chance that one of them may be better on a particular group of farms than any now in existence. The chance cannot be left untested. The National Institute of Agricultural Botany is prepared to examine any promising new variety provided that it is uniform and really new: to study its behaviour at Cambridge and on twelve testing stations in other parts of the country under farming conditions of high and low fertility—an extremely important point. In the case of cereals, the resistance to certain diseases and the power to stand up against lodging are studied. All normal agricultural crops, including the farmer's vegetable crops, the common brassicas, carrots, peas and others, are included in the Institute's purview—though not all the intensive horticultural crops. If the new variety justifies inclusion in the Institute's recommended varieties, the Institute helps it on to the market, multiplying up the few pounds of seed produced by the breeder to the fifty or eighty tons required for the first distribution to the trade; and then, when the seedsman has put out his allocation to his selected farmers so that they can multiply it still further, the Institute has a voluntary inspection scheme under the Seed Production Committee for all recommended varieties to see whether the crop is pure enough to go as seed. So thorough is the inspection that some 30 per cent of the crops are rejected because of weed infestation, diseases or other causes. A recent development, and one which seems to me of great importance, is that the Institute is now prepared to test some of the plant breeder's intermediates which otherwise might be discarded and lost; this has already been done at Seale-Hayne College in Devon, and an extension is planned into Norfolk and Yorkshire in the next twelve months. So the Institute acts as the link that completes the chain joining the plant breeder, the seed distributor and the farmer, and the link is strengthened by the happy relationships that exist between the Institute's staff and the National Agricultural Advisory Service.

I have had occasion to study the workings of this combination in a number of countries, and I am greatly impressed by its efficiency in Britain. Beginning with the plant breeders, we have, of course, long been fortunate. We have long had among us artists in plant breeding—you can use no other word, for they were so obviously guided by intuition and a vision of perfection for which they must always strive, though they might never attain. Such was Rowland Biffen, who fifty years ago gave us some superb wheats beginning with Little Joss—which was on the market ten years after his first crossings, compared with the fifteen or twenty years needed now; he also gave us Yeoman. Then there was E. S. Beaven, that sturdy individualist, who, scorning all State aid, with indomitable courage and persistence carried on single-handed his barley-breeding for years and produced Plumage-Archer; and there was Findlay, with the artist's eye for the potato and the artist's reluctance to divulge his technique, and Donald MacKelvie who bred the Arran potatoes. All these men, unprotected by any copyright or royalty system (such as functions in Holland) gave their productions to the world, gaining but little themselves. Dr. R. N. Salaman has recorded their labours in his very interesting book on the potato. But they are gone, and so far as I know only John Clarke, of Ballycastle, Northern Ireland, remains as a private breeder devoting most of his time to raising new varieties of potatoes. The leading seed firms, of course, maintain their plant breeding activities with results known to all of us.

But plant breeding itself has changed. I shall not discuss here whether it has become a science or a complex craft; but it has certainly steadily become more and more reduced to precise expressions and subjected to critical statistical treatment: tests of significance are replacing the artist's eye, and a staff of technical assistants is needed to cope with the great mass of detailed observations now involved. Happily, an organization of this sort can be built up wherever a good secondary school exists, and we are perhaps no longer completely dependent on that elusive creature the genius—who cannot be produced by any system of education but only discovered and nurtured. So far as can be seen, the future of plant breeding is assured in Britain. It is equally so in France. The services to Western Europeans of the great plant breeders of France—the Vilmorins, Desprez, Blondeau, Tourneur and others—are well known; indeed, France has more private plant breeders than Britain; so also has Holland. The contributions of Sweden, both from the official plant breeding station at Svalov which gave us Star, Victory and its displacer Sun II oats, and from the Weibulls at Landskrona, are equally valuable. Denmark, too, is building up an important export trade in pedigree seeds. It is an interesting fact that the exceptionally wide range of conditions in Britain makes it possible to use with advantage varieties from all these countries and from Belgium; they, however, in their much more restricted conditions, can neither draw from each other nor from the British to anything like the same extent that we can draw from them. We have even been able to use varieties which in their own country were not specially good: the most notable example of this, of course, is Atle wheat, produced in Sweden by the Weibulls, and discarded because it was too late in ripening; but it is doing remarkably well in Britain, succeeding alike in the Fens and on the thin chalk soils, and is equally popular with millers and with farmers. Yet it might so easily have never survived. Remembering how long the famous Marquis wheat of Canada remained unnoticed among the many plots at Ottawa until Charles Saunders detected it by his inelegant chewing test, one wonders whether there are other plants at present unappreciated on some experimental plots because they are too interesting to throw away but not good enough to carry forward.

Therein, of course, lies one of the great advantages of international collaboration. The Institute at Cambridge has been asked by the Organization for European Economic Co-operation to undertake two important international inquiries: a classification of the various strains of grasses, which will be done in collaboration with Dr. W. Davies, of the Grassland Research Station, Hurley; and the preparation of a scheme for uniform nomenclature and terminology for seeds. The National Institute of Agricultural Botany has also been responsible in conjunction with the French Barley Station at Maule for the preparation of a complete set of descriptions of the more important varieties of barley grown and exchanged throughout Europe. Dr. P. S. Wellington has been asked by the same Organization to conduct an international course on seed testing. Such international activities facilitate discussion and the exchange of information, thus expediting progress with the solution of one's own problems.

The search for improved varieties by plant breeding and selection and the search in the wild places by botanical exploration is going on in many lands, and many interesting and potentially valuable sorts are being produced. But in many countries the work gets but little further. When I was last in India in 1951 seeing with admiration the excellent plant-breeding done at New Delhi, Coimbatore and other centres, I asked as to what proportion of the total acreage is sown with these improved varieties. The answer was very interesting. For sugar cane and cotton the proportion was high. The peasant grows sugar cane for the factory, and delivers it there; from the factory also he receives the seed for the new crop. Nearly 90 per cent of the total area was under improved varieties using selected seed. The same applies to cotton. But for the other crops—the cereals, the millets, and the oil seeds grown for local consumption—the proportion was much less: about 20 per cent in the case of wheat, less for rice (by far the most important food crop in India) and very small for the millets, the pulses and the oil seeds. For these crops there is no effective machinery whereby the improved varieties can get into the peasant's hands; there is no reputable and completely trustworthy seed trade in close touch with the peasants to take over the plant-breeder's small stock, and arrange for its multiplication and distribution to them. A government department has undertaken the task; but retail distribution on a credit basis is not really an appropriate government activity. The same problem arises in Africa. New and better strains of some of the crops have already been produced; but in the absence of a completely reliable seed trade the multiplication and distribution of the seed is impeded. We rather take our seed trade in Britain for granted, and would never doubt a guarantee of one of our great houses: it is difficult for us to realize how drastically this whole business of crop improvement would be hampered without it.

Although systematic plant breeding is so recent a development—within the lifetime of some of us—is has already achieved a surprising number of triumphs. Among cereals the extension of spring wheat it perhaps the most remarkable. Even as recently as twenty years ago there was very little in Britain, and few sorts could really be recommended; but now, thanks to the Swedish plant breeders, some excellent varieties are available. Atle I have already mentioned; another is Atson, also a Weibull product, and a third is Fylgia, which comes from Svalov, and in England in the West Country has proved even better than Atle because it ripens earlier. The Finns also have done great things with spring wheat and have evolved strains requiring less and less time between sowing and harvesting so that they can be grown farther and farther to the north: in 1922 the northern limit of wheat cultivation in Finland was about lat. 63° N.; by 1946 it had been pushed up a line stretching from beyond lat. 66° in the west to lat. 64° in the east—a really remarkable extension. The War stopped further developments; but they are being resumed. The greatest triumphs with spring wheat are, of course, in Canada, where plant breeders have been so successful that the Prairie Provinces, which as late as 1860 were deemed little suited to farming and were sold by the Hudsons Bay Company to the Canadian Government for £300,000, are now the second largest wheat producing region in the world.

There still remain problems for the plant breeder. We have got to face the fact that plant diseases and pests are likely to increase. Of course, we hope they will not, but we are steadily making conditions more favourable for them by improving transport and upsetting Nature's equilibrium in many ways. For many of these diseases and pests the chemist has devised potent destroyers; but not by any means for all—the virus diseases cannot yet be cured though their carriers may be killed. By far the best way of avoiding disease is to grow resistant varieties. Fortunately, resistant varieties are at times found wild; but by one of Nature's little ironies resistance is often tied up with commercial uselessness, and it is for the plant breeder to untie the knot and carry the genes of resistance into commercially desirable varieties.

The supply of home-grown protein ought to be increased. The bean crop is not yet all we could like. Can anything be done about aphis and chocolate spot? Or to ensure heavier podding? It is not easy to understand why so little lucerne is grown. Various lines of work are proceeding at the National Institute of Agricultural Botany which bear directly or indirectly on these problems. Even worse is the shortage of oil-producing crops in Britain. Large quantities of vegetable oil are consumed; but very little is produced. Yet we shall need it in increasing quantities, for it is made into margarine, which is likely more and more to replace butter. Prof. G. E. Blackman at Oxford and the Institute have shown that existing varieties of the edible oil crops are not generally suitable in Britain (I am not referring to linseed). Before the War, Prof. Southworth, of Manitoba, who had been very successful there in improving the soya bean, tried a number of apparently promising sorts at Rothamsted without result. So far, only one oil-producing family seems to grow well in these latitudes: the rape family. The Germans, the Swedes and the Finns have had considerable success with it: varieties have been produced in Sweden giving as much as 600 lb. of oil per acre (the average yield of oil is, of course, much less: in 1951 it was 320 lb. per acre), which would give roughly 600 lb. of margarine: in practice a mixture of oils is used, but rape oil gives roughly its own weight of margarine. Remembering that on well-managed farms in Britain, Holland and New Zealand the yield of butter fat is only 100–150 lb. per acre, and even by intensive close folding and high manuring it goes only to about 200 lb., one can see why margarine is so much cheaper than butter. Unfortunately, about half of the rape oil consists of the 22-carbon atom erucic acid type, while most of the other vegetable oils—palm kernel, coconut, groundnut, sunflower or soya—used for making margarine are of the 18-carbon atom oleic and linoleic acid types, which are perhaps better metabolized by the human body. Would it be possible to change the genetical composition of the rape by irradiation or otherwise so that the 18-carbon atom fats are built up instead of the 22? One scarcely dares to hope this: if it could be done, it would revolutionize our fat problem.

Turning from Britain to lands for the development of which we have responsibility, one of the greatest problems of the African territories is the maintenance of the soil fertility. In Britain we can do it by growing leguminous crops, especially the clovers. In the genial climate of the southern part of Australia subterranean clover has been marvellously successful —so long as the rainfall exceeds some 15–18 in. a year. But over large parts of East and Central Africa the rainfall is too low or, what comes to the same thing, the dry season is too prolonged to allow the growth of clover. It would be a great advance if some leguminous crop could be found or bred that would do for the African farmer what clover has done in Britain and in Australia. The wet regions of Africa call even more urgently for some new soil-ameliorating crops.

The National Institute of Agricultural Botany does not itself deal with these problems; but it does deal with the resulting products, and as cytology and genetics advance, new techniques of plant breeding will certainly be evolved. Already the Swedes have used artificially induced tetraploidy for getting a new variety of rye, and an X-ray technique for a new variety of winter mustard; but this is only a foreshadowing of what may come. (An important monograph on artificially induced mutations has just been published by the Royal Swedish Academy of Agriculture as a memorial to the great Nilsson-Ehle.) When the plant breeder has done all he can in finding and transferring desirable characters, some artificially induced mutation may enable him to make still further advances. In Britain also mutants are being sought: a cobalt unit has been set up at Aberystwyth for this purpose. We may be sure that the numbers of new varieties and strains will continually increase and their range will widen, making more and more demands on the staff of the Institute. We can be equally sure that the Director and staff will cope satisfactorily with these new problems, and in congratulating them on the impressive results of this year's work, we sincerely wish them equal success in the years that are to come.

THE LIPIDS IN FLOUR

OXIDATIVE CHANGES INDUCED BY STORAGE AND IMPROVER TREATMENT

By DR. T. MORAN, C.B.E., DR. J. PACE and E. E. McDERMOTT

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THE fat content of wheaten flour depends on the rate of extraction, increasing from about 0·8 per cent at 40 per cent extraction to about 2·5 per cent in a wholemeal[1]. Flour is thus a relatively poor source of lipids; but they, together with lipid-soluble constituents, are important in problems both of practical and fundamental interest. Thus, for example, while oxidative deterioration of lipids is the factor limiting the prolonged storage of flour[2] yet, on the other hand, some degree of oxidation appears to be associated with the improvement in baking quality which occurs when flour is stored in air or when it is treated with certain chemical improvers. There is also an increase in the degree of oxidation of the lipids during the mixing of dough in breadmaking, and the extent of this oxidation influences the quality of the bread made from untreated flour. Another practical point is that the colour of flour is in part determined by the extent of the oxidation of some of the fat-soluble pigments. Among the questions of more fundamental interest are those concerned with nutritional aspects, including the stability of the fat-soluble, biologically active forms of the tocopherols and the degree of oxidation of the unsaturated fatty acids[3].

Some of the effects produced by the action of the flour improver, chlorine dioxide, on the lipid fraction of flour have already been examined, mainly in a qualitative manner, and reported in a previous communication[4]. It was then noted that, under certain conditions, oxidation led to the formation of polymer-like material, presumably via an initial formation of hydroperoxides[5], and that there was a reduction in tocopherol content. These changes have now been studied in greater detail.

Oxidation of Lipids in Flour subjected to Different Treatments

In the earlier article a qualitative picture of the degree of oxidation or peroxide value was obtained by adapting the thiobarbituric acid method of Wilbur *et al.*[6] to whole flour suspensions. This method, which has also been used on milk[7,8], is particularly useful in the present connexion both because of its sensitivity and its specificity. Furthermore, applied as below, it gives clear solutions suitable for measurement in a photoelectric colorimeter. The measurements have usually been made with petroleum ether extracts of the flour.

Method. The principle of the method involves: (1) reaction of the lipids with the thiobarbituric acid reagent and (2) separation of a clear solution of the pink complex (formed by the reagent with oxidized unsaturated fatty acid) from the reaction mixture. The conditions chosen for step (2) depend on the total amount of lipids present, since this influences the partition of the coloured complex between immiscible phases.

Details of the procedure, using samples containing about 50 mgm. total solids, are as follows:

Stage 1. *Reaction with the thiobarbituric reagent.* To an appropriate volume of extract, in a boiling tube, were added 1 ml. of a 5 per cent solution of trichloroacetic acid, 0·25 ml. of the commercial detergent 'Teepol' and 1 ml. distilled water. The solvent was evaporated off and 2 ml. of the thiobarbituric acid reagent of Kohn and Liversedge[9] added. The tube was heated in boiling water for 10 min. After cooling, 0·25 ml. of 'Teepol' was added and the contents transferred to a separating funnel.

Stage 2. *Extraction of the coloured complex.* The tube was washed out into the separating funnel with 1 ml. distilled water followed by 7 ml. of ethyl ether – ethanol mixture (2 : 1 v/v). The mixture was shaken vigorously, the phases allowed to separate, and the bottom phase, containing the coloured thiobarbituric acid complex, run into a 10-ml. volumetric flask. The phase remaining in the funnel was washed twice, each time with 1 ml. of aqueous ethanol (1 : 1 v/v). Each time the bottom phase was run into the flask. The contents of the flask were made up to the mark with an ethyl ether – ethanol mixture (1 : 2 v/v). Measurement of the colour of the solution from the graduated flask was made with an Eel colorimeter, filter 624, using as blank a volume of the solvent which had been subjected to the same procedure, namely, addition of reagents, boiling and phase separation. Aliquot volumes were chosen so that readings on the Eel scale were less than 40.

Table 1 gives the thiobarbituric acid values determined in this way for the lipids extracted from an untreated 80 per cent extraction flour, one week old, and for the lipids extracted from the same flour after treatment in the laboratory with the average commercial dose of nitrogen trichloride (NCl_3 or agene) and chlorine dioxide (ClO_2), namely, 60 and 30 p.p.m., respectively, applied to the whole flour. The lipids were extracted three days after treatment of the flour and the thiobarbituric acid values determined immediately.

Table 1

Flour	Untreated	Treated with nitrogen trichloride	Treated with chlorine dioxide
Thiobarbituric acid value (per 5 gm. flour)	2·1	9·7	7·0

Treatment of the flour results in an immediate small rise in the peroxide value. Differentiation between the treated and untreated flours becomes more marked, however, if the petroleum ether extracts are held at room temperature in the light.

Changes in petroleum ether extracts with time. (*a*) *Effect of different flour treatments.* The flours (untreated or treated with nitrogen trichloride or chlorine dioxide at commercial levels) were extracted at room temperature by percolating petroleum ether (40°–60°) through a column of flour (50 gm.) contained in a glass tube 2·5 cm. diameter and 45 cm. long. In each case 100 ml. extract was collected. The extracts were kept in stoppered flasks at room temperature in the light. Under these conditions, the thiobarbituric acid value increased, and eventually insoluble polymer-like material was deposited. The colour of the extracts was also measured, in the Eel photoelectric colorimeter using filter 622. Table 2 shows that these developments occur at different rates depending on the pretreatment of the flour.

In nine days the peroxide value of the extract of fresh untreated flour increased only slightly; there was a slow increase in the extract of five-week old untreated flour, a more rapid one with an eight-month old untreated flour. The value increased most rapidly in the extracts from flours treated with nitrogen trichloride and chlorine dioxide. Polymer-like material was eventually deposited in all the extracts. The time at which it occurs is related to the increase in the peroxide value. Under the conditions we have employed, deposition appears to occur when the thiobarbituric acid value reaches about 160–280 per 5 gm. flour. This means that an extract from a treated flour usually deposits material much sooner than one from an untreated flour. As the polymer-like material is deposited, the thiobarbituric acid value of the supernatant liquid falls. The effect of treatment upon the colour of the extracts is apparent in the initial readings, and relatively little further differentiation in this respect occurred within the nine days.

(*b*) *Effect of solvent used for extraction.* With each solvent, 200 gm. of an 80 per cent extraction untreated flour, two weeks old, were extracted, by irrigation through columns at room temperature. 250 ml. of each extract were collected. 100-ml.

Table 2

Time (days)	Flour *A*, untreated, freshly milled		Flour *A*, treated NCl_3, 60 p.p.m.		Flour *A*, treated ClO_2, 30 p.p.m.		Flour *B*, untreated, 8 months old		Flour *B*, treated NCl_3 in mill, 8 months old		Flour *C*, untreated, 5 weeks old	
	T.B.A.* value	Colour†	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour
0	2·1	10·5	9·7	2·6	7·0	2·9	2·4	10·5	3·0	4·0	1·6	10·2
3	2·4	10·4	11·3	1·8	6·3	2·6	4·8	10·6	7·7	4·0	1·7	10·0
6	2·8	10·0	18·5	1·3	8·3	2·6	6·0	10·5	9·8	4·0	3·2	10·0
9	2·8	10·0	30·6	0·7	16·6	2·6	11·1	10·6	14·8	3·9	4·1	9·9

* Thiobarbituric acid value expressed per 5 gm. flour. † Colour of petroleum ether extract (100 ml. extract from 50 gm. flour).

Table 3

Held in the light

Time (days)	Carbon tetrachloride		Chloroform		Benzene		Ethyl ether		Pet. ether b.p. 40°–60°	
	Colour	T.B.A.* value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value
0	22·0	0·5	23·5	0·4	25·6	1·3	20·7	0·7	16·8	1·0
1	1·0		10·4		24·1		20·0		16·8	
3	0·6	10·6	4·5	2·5	22·0	0·7	18·9	0·9	16·5	0·6
6	0·2	37·0	2·5	6·8	17·0	3·5	15·7	2·0	15·5	1·5
11	Polymer deposit	47·0	0·3	29·4	4·8	14·3	4·5	8·1	14·3	3·1
16	nil	54·5	nil	54·2	nil	21·3	nil	11·8	11·2	4·3
50										

Held in the dark

Time (days)	Carbon tetrachloride		Chloroform		Benzene		Ethyl ether		Pet. ether b.p. 40°–60°	
	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value	Colour	T.B.A. value
0	22·0	0·5	28·5	0·4	25·6	1·3	20·7	0·7	16·8	1·0
1	22·0		28·7		25·7		20·9		17·0	
3	21·9	0·9	28·7	0·7	25·3	1·0	21·0	0·6	16·6	0·8
6										
11										
16	21·0		27·2		23·9		20·3		16·5	
50	20·5	2·3	27·7	4·6	23·8	0·9	20·4	1·8	15·7	2·0

* Thiobarbituric acid values expressed per 0·8 gm. flour

Days in light for perceptible deposition of polymer-like material: carbon tetrachloride, 10; chloroform, 19; benzene, 20; petroleum ether 27 ethyl ether, 30 (the longer time with ethyl ether is probably due to the material having a relatively higher solubility in this solvent. Thus, polymer-like material from petroleum ether is partially soluble in ethyl ether)

samples of each were held in the light and in the dark, and measurements of the colour and the thiobarbituric acid values were made initially and at intervals thereafter. The thiobarbituric acid values were determined on 1 ml. of extract, which is equivalent to 0·8 gm. of flour. For these extracts containing less than 10 mgm. total solids, a modified procedure was followed. In stage 1, 3 ml. distilled water and 1 ml. of the thiobarbituric reagent were used; addition of 'Teepol' after heating was omitted. In stage 2 the tube was washed out with 1 ml. distilled water followed by 5 ml. ethyl ether – ethanol mixture (2 : 1 v/v). The upper phase was washed only once with 1 ml. distilled water and the contents of the flask made up to the mark with ethyl ether – ethanol mixture of 1 : 2 (v/v). For this particular experiment a small sample was chosen because of the large increase in the thiobarbituric acid value which occurs in the extracts kept in the light. This results, however, in a larger experimental error with samples with a low thiobarbituric acid value. For these it is preferable to use, as in Table 2, a volume of extract equivalent to 5 gm. flour. The results obtained are given in Table 3.

In the dark all the extracts are comparatively stable. In the light, extracts in carbon tetrachloride and chloroform rapidly autoxidize and become bleached. This also occurs with the other solvents but less quickly, petroleum ether extracts showing the greatest stability.

Reducing Substances in the Unsaponifiable Fraction

The unsaponifiable fraction of flour lipids contains pigments, steroids and tocopherols. It is an important fraction, since it contains components which contribute to the antioxidant properties of the parent flour. These influence the colour and determine the vitamin E content; some of them are extremely sensitive to oxidation, and this is reflected in a diminution of the total reducing value of the unsaponifiable fraction[4].

The reducing value of the unsaponifiable fraction towards the system ferric chloride α-α′-dipyridyl is largely due to α- and β-tocopherols, to an unidentified substance first noted by Brown[10,11] on paper chromatograms, afterwards observed by Eggitt and Ward[12] and in the present work, to carotenoid pigments and possibly sterols. From our observations using chromatographic techniques, about 40 per cent of the total reducing value is due to α- and β-tocopherols and about 30 per cent is due to the unidentified substance. Details of this aspect of the work will be published elsewhere.

Saponification of the flour lipids and measurement of the total reducing value of the unsaponifiable fraction were carried out by the methods of Tosic and Moore[13]. The colorimetric estimations were made with an Eel photoelectric colorimeter (filter 624). A standard curve was prepared using synthetic α-tocopherol, and the figures for total reducing value are expressed in terms of the reducing value of α-tocopherol.

The sensitivity of the total reducing value as an index of the treatment of flour with an oxidizing agent is illustrated in Table 4, in which values for an untreated flour are compared with those for the same flour when treated with nitrogen trichloride in the laboratory at about the commercial level. (In commercial practice it is not the final flour which is treated; instead, the constituent mill-streams are given different levels of treatment. The figures of 60 and 30 p.p.m. for nitrogen trichloride and chlorine dioxide respectively are the mean values calculated on the weight of the final flour.) The table also includes values for two flours (80 per cent extraction) both of which had been stored under the same con-

Table 4

Flour	Treatment	Total reducing value of unsaponifiable fraction (μgm./100 gm flour)
Same stock 2 weeks old	None	2,220
	NCl_3 15 p.p.m.	1 660
	,, 30 ,,	1,180
	,, 60 ,,	410
Same stock 8 months old	None	2,140
	Treated with NCl_3 at mill	470

ditions for eight months. One of these was untreated and the other was from the same batch of flour but which had been treated with nitrogen trichloride at the mill.

Lipids extracted from Different Types of Flour

Measurements of the kind described above have been made on lipids extracted from a range of flours, and are given in Table 5. These include flours freshly milled in the laboratory, of 80, 70, 85 and 100 per cent extraction, from a good-quality Manitoba wheat, and samples sent to us of recently imported commercial consignments of Canadian National flour.

Table 5

Flour	Total reducing value of unsaponifiable fraction (μgm. /100 gm. flour)	Colour of petroleum ether extract (100 ml. extract from 50 gm. flour)	Thiobarbituric acid value expressed per 5 gm. flour
Series 1. Untreated and chemically treated 80% extraction flour			
Untreated flour *A* 2 weeks old	2,830	10 5	2·1
Treated flour *A*			
ClO_2 7·5 p.p.m.	1,030	9·3	—
,, 15 p.p.m.	465	6·2	—
,, 30 p.p.m.	120	2·6	7·0
NCl_3 15 p.p.m.	1.660	6·1	—
,, 30 p.p.m.	1,180	4 5	—
,, 60 p.p.m.	410	2 6	9·7
Untreated flour *B*, 8 months old	2,140	10·5	2·4
Same flour *B*, but treated NCl_3 at mill	470	4 0	3·0
Series 2. Laboratory milled untreated flours of different extraction (Manitoba grist)			
80% extraction	1,600	9·7	—
70% extraction	1,930	10·0	—
85% extraction	3,020	12·2	—
100% extraction	3,420	8·2	—
Bran	5,700	7·8	—
Commercial germ	33,700	84·0	—
Series 3. Imported Canadian National flours (history unknown)			
Sample 1	2,360	10·1	2·0
,, 2	1,256	5 0	—
,, 3	1,270	5·2	—
,, 4	1,410	5·9	—
,, 5	750	3·4	19 0
,, 6	1,290	4·6	2 0
,, 7	1,200	4·7	6·6
,, 8	750	3·7	18·8
,, 9	330	1·8	8·0
,, 10	1,830	8·3	2·0

These data show that the total reducing value is the most sensitive index of the effect of the gaseous flour improvers. These agents have an immediate marked effect on this value, which is much less affected by storage of the flour. Similarly, the colour of the extracted pigment is more sensitive to the action of the improvers than it is to normal atmospheric oxidation. It should be noted that this may not hold when the flour is wetted, made into a dough and agitated in air or oxygen. These conditions are then more favourable for the action of oxidizing enzyme systems which may be coupled with the bleaching of the pigments. Although flour stored in air for several months shows only a relatively small reduction in the figure for total reducing value and the colour of the extracted pigment, there is a steady rise in the peroxide value of the extracted lipids, as measured by the thiobarbituric acid test.

These observations suggest that one of the immediate results of the application of the gaseous improvers is a reduction in the effectiveness of the antioxidants present in the flour, notably the tocopherols. This is consistent with the comparatively rapid rise in the peroxide value when extracts from flours so treated are held at room temperature in the light. By contrast, the antioxidants are less susceptible to atmospheric oxidation; but the lipids, possibly the phospholipid fraction, undergo a slow oxidation which is reflected in the peroxide value.

The results with the flours of different extraction are of interest in relation to the anatomical parts of the wheat grain. The figure for total reduction value rises with the extraction, while the colour due to pigment extracted with petroleum ether rises up to 85 per cent extraction, but is less with a wholemeal than a 70 per cent extraction flour. This behaviour is due to the high figure for the total reducing substances in the germ and bran, the high value of the figure for the extracted pigment from germ and the relatively low value for bran. The 80 and 70 per cent flours are mainly endosperm material, while much of the germ and some bran is contained in the 85 per cent extraction flour.

One practical application of these observations is that they indicate the basis of a method of deciding whether or not a flour has been treated with one of the gaseous improvers (nitrogen trichloride or chlorine dioxide). (The bleaching agent, benzoyl peroxide, would probably react in similar fashion; but as it leaves an equivalent residue of benzoic acid its use could readily be checked.) Thus, in the Canadian samples examined it would be inferred, for example, that sample 1 and probably 10 were wholly untreated, whereas sample 9 and probably samples 5 and 8 had been given our normal commercial improver treatment for 80 per cent flour. It would also appear that the remaining five samples had received some degree of treatment. This aspect of the work, however, requires a comprehensive survey with a wide range of samples of flour of known history (grist, extraction-rate, age, etc.) in order to standardize it.

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RADIOISOTOPE CONFERENCE AT OXFORD

THE Second Radioisotope Conference organized by the Atomic Energy Research Establishment, Harwell, was held at Oxford during July 19–23, with the object of discussing the experimental uses of radioisotopes and new techniques in their various applications in medicine, biology, agriculture, chemistry, physics, engineering and industry. The organizers of the Conference took the bold step of accepting only seventy-one out of more than two hundred papers which were proffered; this removed the usual scourge of conferences—an overcrowded programme and multiple sessions in parallel. Another notable achievement was the issue of preprints of all the papers well in advance of the Conference, and the limitation of the time of reading each paper to ten minutes; this allowed a considerable amount of time for discussion, which was very lively and stimulating.

The Conference started off with several papers dealing with the therapeutic applications of radioactive isotopes. Some of these are used as external applicators much in the same way as radium, but utilizing the special advantages offered by the new radioactive substances. R. C. Tudway, H. F. Freundlich and T. S. M. Marshall (Bristol) used iridium-192 as a cervix applicator; the soft γ-rays from iridium make shielding of neighbouring organs much easier. Similarly, yttrium-90, which was used by F. Crainz (Catania), lends itself to intra-uterine application, as it is a pure β-ray emitter. F. Ellis and R. Oliver (Oxford) demonstrated the use of tantalum wire containing tantalum-182 as an applicator; the great flexibility of these wires makes them less likely to obstruct blood vessels than the rigid radium needles.

The internal use of radioisotopes in therapy depends on the ability to concentrate the radioactivity in the organ to be irradiated. One such method, which may be used for the treatment of cancer of the lung, was developed by E. E. Pochin, G. B. Cook, R. M. Cunningham, A. Hollman, F. Hudswell and B. R. Payne (University College Hospital, London, and A.E.R.E., Harwell). Colloidal gold, containing gold-198, is precipitated on sugar charcoal particles which are too large (30–43 μ in diameter) to pass through the lung capillaries. If injected intravenously they will therefore be concentrated in the lungs, with only a very small fraction reaching the liver. This preparation can also be localized in any specified area of the lung by means of cardiac catheterization. J. Van der Werff (Nijmegen) described a somewhat similar use of bismuth-206 for deposition in the reticulo-endothelial system.

In the field of diagnosis, radioiodine is still the chief isotope employed in a variety of new problems. Very interesting results were obtained by H. G. Thode, C. H. Jaimet and S. Kirkwood (Hamilton, Ontario) on the uptake of iodine-131 by the salivary glands. It appears that a simple procedure, the comparison of the activity in a sample of saliva with that in the blood, provides a very sensitive method of discriminating between various types of thyroid disorders; the mechanism of the uptake in the salivary glands is not quite clear. The possibility of diagnosing carcinoma of the thyroid by means of a simple iodine-131 test was described by J. Rotblat and G. Owen (St. Bartholomew's Hospital, London), and the technique of outlining the thyroid and the location of tumours was improved by H. C. Allen, jun., J. R. Risser and J. A. Greene (Houston, Texas), who employed for this purpose a crystal spectrometer with a double discriminator coupled to a scanning and recording device. A comparison of the behaviour in the body of iodine-131 and its analogue astatine-211 has been carried out by J. G. Hamilton, P. Wallace-Durbin and M. W. Parrott (Berkeley, California); astatine, being an α-emitter, offers many advantages over the β-emitting iodine isotopes, but Dr. Hamilton emphasized the dangers involved in handling this element. Most of the experiments were carried out on rats; but the few studies on humans indicated some promising applications. The use of serum albumin labelled with iodine-131 for the determination of cardiac output was described by N. Veall, J. D. Pearson, T. Hanley and A. E. Lowe (Guy's Hospital and Hammersmith, London), who used a scintillation counter placed over the region of the heart and connected to a ratemeter and chart recorder; the method has still to prove its value, but the advantages it offers as compared with older methods of cardiac output measurements merits further study.

Iron-59 has been used in several investigations carried out in the Royal Cancer Hospital, London. E. M. Ledlie and C. Baxter described some clinical applications of this isotope in hæmatological investigations, particularly in the study of erythropoiesis bone marrow diseases. L. F. Lamerton, E. B. Harriss and E. H. Belcher carried out animal experiments on erythropoiesis and the effects of X-ray irradiation; they obtained very interesting results on protection achieved by shielding of the spleen. S. Rowlands, T. Freeman and P. C. Fleming (St. Mary's Hospital, London) developed a technique for making blood volume determinations in animals by the simultaneous use of two isotopes, phosphorus-32 and chromium-51. The latter isotope was also used by J. S. Robertson, R. Milne and S. H. Cohn (San Francisco) for observing the distribution of blood platelets in rats.

A somewhat unique use of radioisotopes was presented in a paper by F. P. Bowden, J. B. P. Williamson and P. Laing (Cambridge) on the metallic transfer in screwing and bolting which they studied by the autoradiograph technique using radiochromium. The connexion of this work with medicine arises from the fact that in operations on fractured bones a certain amount of metallic transfer may occur, sufficient to form an electrolytic couple which has a harmful effect on the healing of tissue.

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One session was devoted to methods of labelling compounds with carbon-14, tritium and iodine-131, three of the nuclides most used in medical and biochemical studies. In addition, the method of preparation of tritium used at the Atomic Energy Research Establishment was outlined by W. J. Arrol,

J. Chadwick, J. Eakins, C. Evans and E. J. Wilson. R. F. Glascock (National Institute for Research in Dairying) reported on the use of tritiated compounds for studying the metabolism of dietary stearic acid by the lactating goat. Acetic anhydride labelled with tritium and carbon-14 had been employed by P. Avivi, Sylvia A. Simpson, J. F. Tait and J. K. Whitehead (Middlesex Hospital) to elucidate the structure of electrocortin and to estimate it and hydrocortisone in human peripheral blood. A paper from the National Institute for Medical Research described how high specific activity rabbit fibrinogen, albumin, normal and antibody globulins had been formed by biosynthesis using whole dried algae, labelled with carbon-14. The preparation of the algae had already been reported to the conference by J. Catch (Radiochemical Centre, Amersham). G. Wolf, B. Connor Johnson and S. G. Kahn (University of Illinois), who have synthesized vitamin A-2-^{14}C, gave preliminary experimental results on its metabolism after injection into rats. An invigorating discussion followed the note by E. Kallee (Tubingen) on the detection of as little as 0·001 μgm. of proteohormone insulin by paper electrophoresis after intravenous injection of rats with radioactive iodide, iodine-131 labelled serum and insulin. The use of cobalt-60 labelled vitamin B_{12} (C. Rosenblum, U.S.A.), the biosynthesis of penicillin (H. R. V. Arnstein) and the use of carbon-14 labelled sugars in the study of carbohydrate metabolism of the leaf (Helen K. Porter and L. H. May) were among some of the other contributions of interest to biochemists.

Among the papers dealing with plant nutrition and allied subjects, L. Ehrenberg, I. Granhall, A. Gustafsson and N. Nybom (Sweden) gave an interesting description of their first season's work on the irradiation of growing plants (barley, fruit trees, etc.) with a cobalt-60 gamma-ray source. The fruit trees showed a series of morphological aberrations such as clustering of leaves and shoots, formation of bifurcated shoots and irregular leaves. The topical subject of foliar fertilization has been studied by K. Kamdl (Austria) with phosphorus-32 labelled phosphatic nutrient. In the discussion, R. Scott Russell (Oxford) pointed out the large amount of fundamental work still to be done before the practical usefulness of foliar nutrition could be assessed. Another approach to the problem of making phosphorus available to plants was that of O. Talibudeen (Rothamsted), who had carried out experiments using phosphorus-32 to determine the readily exchangeable phosphates in soils.

Papers of interest to chemists included a description of the meticulous work by C. J. Collins and W. A. Bonner (Oak Ridge, Tennessee) on the use of carbon-14 to investigate the Wagner–Meerwein rearrangement in the study of 1 : 2 : 2-triphenylethanol and its derivatives. Various aspects of the labelling of ring labelled compounds were dealt with by H. S. Turner (Chemical Research Laboratory, Teddington). The experiments of A. G. Maddock and H. Behrens (Cambridge) on the exchange reaction between iodine and methyl iodide provoked much useful discussion. The kinetics of the process were outlined, and it was shown that there was a chain reaction initiated by radiation which involved the production of free radicals. The branching of vinyl polymers (J. C. Bevington and H. W. Melville, Birmingham), the use of carbon-14 to study the role of oxygenated radicals in the Fischer–Tropsch reaction (E. J. Gibson and A. W. Fletcher, Fuel Research Station, Greenwich), and the poisoning of solid catalysts used in the synthesis of ammonia (C. Bokhoven, Netherlands) illustrated further applications of the radioisotope technique.

A beautiful illustration of the usefulness of tracers combined with radioactivation analysis was given by P. Albert, F. Montariol, R. Reich and G. Chaudron (France) in their investigations of the purification of aluminium from zinc, copper, sodium and silicon by zone melting. Another interesting metallurgical paper was that by M. C. Inman, D. Johnson, W. L. Mercer and R. Shuttleworth (University of Leeds) describing their careful measurements on the self-diffusion coefficients of copper and zinc into alpha- and beta-brass.

In the first of two important practical applications of neutron sources, C. P. Haigh (Barrow Hospital, Bristol) described a measurement of the neutrons generated in the ^{24}Na$(\gamma,n)^{2}$H reaction as a method of assay for heavy hydrogen. In the discussion on the paper by A. H. Knight (Macaulay Institute for Soil Research, Aberdeen) on the measurement of soil moisture by neutron scattering, no satisfactory reason was found why organic matter in the soil did not have a greater practical effect on the measurements reported. Results obtained on archæological specimens with the new carbon-14 dating method developed by A. R. Crathorn and W. R. Loosemore (Royal Institution and Atomic Energy Research Establishment) were presented. The method involves the conversion of the specimen into acetylene which is used as the filling gas in a proportional counter. The supplementary method of B. N. Audric and J. V. P. Long (Chemical Research Laboratory, Teddington), utilizing the acetylene dissolved in a liquid phosphor at − 78° C., has not yet been used for dating specimens.

Of the two new thickness gauges of interest to industry, that developed by J. L. Putman, S. Jefferson and J. F. Cameron (Atomic Energy Research Establishment) was very ingenious. The method was developed for measuring from the outside of pipes the degree of corrosion on the inside of the pipe wall. The gamma-ray source is cobalt-60 and the scintillation counter detector has a gating circuit so that only radiation which has suffered a change of energy by scattering from the pipe wall is measured. One advantage of this system is that no heavy lead shielding is required. Other industrial applications included the use of phosphorus-32 labelled wool fibres to study the very difficult problem of drafting (D. S. Taylor, Leeds), a study of water flow and velocity measurements (A. Montens, Germany) and the wear of carbide-tipped cutting tools (L. G. Erwall, Sweden). Of the papers dealing with new nuclides for use in industrial gamma radiography, that utilizing thulium-170 (gamma energy 84 keV.) was of most immediate practical importance. In the final paper L. E. Brownell and J. V. Nehemias (University of Michigan) illustrated how a ten-thousand curie cobalt-60 gamma-ray source was used for sterilizing foodstuffs by irradiation, and mentioned briefly the very interesting possibilities of initiating chemical reactions by this means. A short closing address was given by Dr. Henry Seligman, head of the Isotope Division, Atomic Energy Research Establishment, who has been primarily responsible for initiating the two Radioisotope Conferences that have been held.

The papers presented at the Conference, together with the discussions, will be published in book form in November 1954 by Butterworths. There will be two volumes: vol. 1 will cover medical and physiological applications, and vol. 2 physical sciences and industrial applications.

In addition to the formal papers, there were films illustrating radioisotope techniques used in hospitals and laboratories. By the courtesy of Lord Cherwell, the Clarendon Laboratory was available for a well-laid-out exhibition covering instruments, laboratory techniques and a representative range of manufacturers' equipment (representing five different countries) of interest to radioisotope users. This was a centre of activity throughout the week.

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CHEMISTRY IN RELATION TO THE DEVELOPMENT OF THE NERVOUS SYSTEM

THE Mental Health Research Fund organized the First International Neurochemical Symposium at Magdalen College, Oxford, during July 13–17. The Symposium was planned as part of a series, and the field selected for the first meeting was "Chemistry in Relation to the Development of the Nervous System". The organizing committee consisted of J. Elkes (Birmingham), L. Flexner (Philadelphia), J. Folch-Pi (Boston), G. W. Harris (London), S. S. Kety (Washington), D. Richter (Cardiff) and H. Waelsch (New York).

The Symposium was attended by approximately seventy scientific workers, forty being from abroad—from Belgium, Canada, Denmark, Germany, Italy, Norway, Sweden, the United States and U.S.S.R. It was arranged in morning and afternoon sessions, and on two days there was also an evening session. Each session started with one or two reviews, followed by communications on recent research; there was always a lively and full discussion, and this was recorded. The transcription of the Symposium will be published in the near future by the Academic Press, New York.

The first morning session, under the chairmanship of Sir Geoffrey Vickers, was characterized by two features: the regrettable absence of Dr. R. Lorente de Nó (New York), and the view expressed by the two anatomists in discussing some aspects of the early development of the nervous system (Prof. J. D. Boyd, of Cambridge) and of the vascular patterns of the nervous system (Dr. Horne Craigie, of Toronto) that chemical inductors are required for explaining the morphological development of the nervous system. Prof. Boyd emphasized the importance of the tissue and the spaces underlying the ectoderm in the development of the dorsal plate and the differentiation of the neural tissue, illustrating his points with a wealth of material from sheep embryos. Dr. Horne Craigie showed the wide range of vascular patterns presented in the development of a variety of species, and posed the question of the extent to which the pattern is determined by underlying changes.

The afternoon session, with Dr. R. W. Gerard (Chicago) in the chair, opened with a review of experimental neuroembryology in the chick by Dr. V. Hamburger (St. Louis), and an account of the functional development of the nervous system in the dogfish by Dr. H. P. Whiting (Bristol). Dr. Hamburger took up the theme of the morning session and reported on the dramatic changes in the growth of spinal and sympathetic ganglia produced by the influence of transplanted limb buds and tumour tissue. Dr. Whiting presented experimental evidence for dividing the developmental steps into the classical divisions of myogenic, neurogenic and reflexogenic, and in general supported the Coghill thesis of segregation of reflexes. There followed a communication by Dr. J. L. Malcolm (London) on his investigations into the appearance of inhibition and facilitation in the developing spinal cord of kittens. He showed that, during the first two post-natal days, an impulse sent in through the dorsal lumbar roots leads only to a single spike in the corresponding ventral root, but that later, with the appearance of after-discharge in the ventral root, facilitation and inhibition can be demonstrated. The session ended with a communication from Dr. D. Hill (London), in which he emphasized the important practical aspects of cerebral maturation as marked by the milestones which can be demonstrated by the electroencephalogram rhythms.

The second day started, under the chairmanship of Dr. S. S. Kety, with a detailed review by Dr. Folch-Pi of the composition of the whole brain of mice during post-natal maturation, with particular reference to phospholipids, a review which was based to a great extent on the extensive work done in his own laboratory. This review was followed by Dr. H. Klüver's (Chicago) careful fluorospectrographic analysis of porphyrins in the central nervous system. They are not present in the central nervous system of reptiles, amphibians and fishes, and are found in warm-blooded animals only after birth—for example, in rats at the age of 20–25 days, a time which is associated with a number of functional advents. Porphyrins occur first in the ventral roots and last in the cerebrum; Dr. Klüver thinks their presence is related to the developing oligodendroglia. These photodynamic substances may be affected by the amount of light known to be transmitted through the skull in some species, and the interesting question arises as to the extent to which light may, by these means, affect nervous system activity and also, perhaps, the sexual cycle. Dr. P. Diezel (Heidelberg) presented histochemical evidence of the distribution of iron throughout the brain substance, and pointed out the considerable amounts which appear in the glial cells during development, while Dr. G. Brante (Eskilstuna) reported on the presence of polysaccharide substances in the nervous tissue of developing mice. Dr. A. F. W. Hughes (Cambridge) described his technique for the refined densitometry measurements of ribonucleic acid in the developing chick embryo, and was able to demonstrate its appearance and distribution in the ventral horn cells and its relationship to the Nissl substance. The morning session finished with an account by Dr.

D. R. Davies and Dr. L. C. Thomas (Salisbury) on their infra-red spectrophotographic method for measuring quantitatively the myelin in the developing nervous tissue. They stressed the point that this method might be applicable to a number of problems associated with myelination.

The afternoon session, under the chairmanship of Prof. H. A. Krebs, started with a carefully worked out review by Dr. D. Richter (Cardiff) on the chemistry, particularly enzymes and substances such as acetylcholine, glutamic acid and glycine, in the developing brain. The material, which was often given in clear tables, will be of great use for subsequent reference when published in the Symposium. Dr. S. S. Kety (Washington) reported on his work, with the nitrous oxide method, on the oxygen consumption of the brain in the human, and made the observation that at birth nearly 80 per cent of the oxygen consumption is accounted for by brain metabolism, that between ten and twenty years the percentage is more than 50, and that later it falls to about 25 per cent. Then Dr. H. McIlwain (London) gave an account of his experiments, together with Dr. P. Greengard, on the oxygen consumption of tissue slices of the cerebral cortex of rats and guinea pigs of varying ages. They showed how the oxygen consumption can be raised to an increasing extent with age by means of electrical potential gradients in the Warburg chamber, the presumption being that such potentials stimulate the cortical tissue to activity comparable to that found *in vivo*. The role of non-nervous tissue was assessed by comparable measurements on gliomas. Dr. R. W. Sperry (Pasadena) followed with an account of the effects of transplanted skin in tadpoles and its effect on subsequent innervation, and, most intriguing, the re-organization of the connexions in the central nervous system.

An evening session was held on the second day, and for this the chair was taken by Dr. L. B. Flexner (Philadelphia). The subject of the geometrical properties of the constituents of the nervous system was ably outlined by Dr. A. Pope (Boston), who discussed, among other problems, the quantitative aspects of inter- and intra-cellular material. The remainder of the evening was devoted to histochemistry of a most refined nature. Dr. O. H. Lowry (St. Louis) gave a fascinating account of his technique for weighing and the subsequent chemical analysis of individual neurones, a feat which won the universal admiration of the audience, as did his apparently casual method of presentation. No less interesting was Dr. H. Hydén's (Gothenburg) description of his methods of measuring the light and X-ray absorption of single nerve cells, from which the lipid protein and ribonucleic acid content can be assessed. How many of his audience envied him a machine which automatically types the results!

On the morning of the third day, with Sir Rudolph Peters in the chair, Dr. H. Waelsch (New York), opened by reviewing the differences in the rate of replacement of substances in the developing and adult brain; the results were obtained with the use of the isotope technique. He showed that in the first week of the developing brain of rats 40 per cent of the fatty acids is replaced, whereas there is a much smaller turnover in the adult rat. With the exception of glutamine, he has obtained no evidence that amino-acids are synthesized into the adult brain; however, from experiments on tissue cells there is some indication that essential amino-acids may be synthesized in immature brain tissue; but the mechanism of the uptake of these amino-acids is not clear. He stressed the point that in the embryonic or immature brain the blood–brain barrier appears to be absent; but so far the number of substances examined is not sufficiently large to allow this general conclusion. He was followed by Dr. H. E. Himwich (Galesburg), who gave an account of the relative rates of uptake of glutamine by adult and young rat brain, concluding that the rate of uptake in the younger age group is relatively greater. The lipid content of the brain was discussed by Dr. W. M. Sperry (New York) as well as by Dr. R. M. C. Dawson (Oxford). Dr. Sperry's results were obtained from human material from 4 to 40 days post natal, and he emphasized the need to correlate the increased lipid content over this period not only with the rate of medullation but also with the changes in the water and nervous tissue space. Dr. Dawson presented evidence of the rate of deposition of phospholipids in the young mouse brain, and presented evidence for a phospholipid metabolic cycle. Prof. A. V. Palladin (Kiev) read a paper on the metabolism of nucleic acids in the developing brain. Investigations in his Institute have shown that the protein content increases during the development of the brain, that despite the concomitant decrease in nucleic acid content the metabolism increases, that the grey matter of the cerebrum has a higher content of nucleic acids, of ribonuclease, and of desoxyribonuclease than the white matter, and that the cerebellum is rich in nucleic acids, especially desoxyribonucleic acid. He stressed the important role of these substances during the morphological and functional development of the brain. Prof. G. E. Vladimirov (Leningrad) in his report dealt with the role of the blood–brain barrier, and presented data collected during the turnover of such substances as adenosine triphosphoric acid, creatine phosphate, etc., using labelled phosphorus. By estimating the iron in blood, in brain tissue free from blood, and brain tissue containing blood, the quantity of blood contaminating the brain tissue was assessed, and errors in estimating the true intracellular content of phosphorus avoided. By such experiments the specific activity of intracellular inorganic phosphates is found to be equal to that of adenosine triphosphate.

The afternoon, with Dr. W. Feldberg (London) in the chair, saw the presentation of a great deal of evidence for the change in enzyme content in relationship to age. Dr. L. B. Flexner (Philadephia) opened with a survey of the growth of various enzyme systems in the guinea pig cortex, and he was able to relate their appearance with that of the cortical electroencephalogram, the presence of strychnine spikes, and the development of the earliest movements evoked by stimulation of the cortex. He presented evidence for a large increase in the chloride and sodium space at a time (forty-sixth day) when recognizable electroencephalogram patterns and strychnine spikes are observed. In the ensuing discussion some scepticism was expressed about the interpretation of the difference between sodium and chloride spaces in terms of Hodgkin's theory of a sodium pump mechanism as a basis for neuronal activity. Both Dr. H. E. Himwich (Galesburg) and Prof. J. Elkes and Dr. A. Todrick (Birmingham) presented figures for the rate of appearance of cholinesterases in the various parts of rat and rabbit brain, while Dr. M. A. Gerebtzoff (Liège) presented histochemical studies of the distribution of cholin esterases in the rat spinal cord. None of these findings could yet be directly tied to actual functional investigations. The session concluded with a paper by Dr. W. K. Jordan (Little Rock) on the increase of adenosine triphosphate in the rat cortex and cerebellum during the first forty days after birth. The increase was correlated with the appearance of spontaneous action potentials which began as short bursts of activity. In the cortex the periods between the bursts greatly decreased between the tenth and twentieth day; in the cerebellum at a somewhat later period.

Prof. L. S. Penrose took the chair on the morning of July 16, when Dr. Salome G. Waelsch (New York) outlined some of the genetic factors involved in the development of the central nervous system, in which she gave a stimulating account of her own work on mutations of mouse central nervous system. Of particular interest were her experiments in the modification of genes by antigen–antibody reactions, and her preliminary findings indicate an extremely interesting future for this method of investigation. The second review, by Prof. E. Klenk (Cologne), was on the possible role of cerebrosides in the pathology of the nervous system. Two short papers presenting original material by Dr. R. W. Gerard and Dr. L. Abood (Chicago) and by Sir Rudolph Peters (Oxford) completed the morning. Drs. Gerard and Abood have investigated the chemistry of the nervous system of the *Dba* strain of mice which between the twenty-eighth and thirty-sixth day post-natal is extremely susceptible to auditory stimulii. Dr. Gerard suggested that the low adenosine triphosphatase activity found at this period could account for the apparent hyper-excitability of the nervous system, if the membrane potential is related to the creatine phosphate content. Sir Rudolph Peters spoke about his interesting experiments on convulsions produced by fluorocitrate and its probable mode of action as a competitive inhibitor of aconitase; he discussed the probable reasons for the inability to reverse the competitor by calcium.

In the afternoon session, under the chairmanship of Prof. R. Gjessing (Oslo), the chemical changes accompanying well-defined mental defects were considered. Prof. L. S. Penrose (London) spoke about the genetic factors involved in the transmission of a number of known metabolic deficiencies, and Dr. H. Bicket (Birmingham) described the control of phenylketonuria by a suitable diet in several cases which he had studied in collaboration with Dr. Gerrard and Dr. Boscott. Finally, Dr. H. Weil-Malherbe (Runwell) presented data on the relationship of blood adrenaline to a large series of mental diseases.

The evening session was devoted to films. Dr. Hughes showed, by means of some extremely good time-lapse photography, the growth processes of chicken neurones, growing in suitable culture media; a fine sequence showing mitosis of a neurone was included in this film. Dr. Feldberg showed a film made by him and Dr. S. Sherwood of the method used for introducing drugs beyond the blood–brain barrier directly into the lateral ventricles of the cat. The action of a series of drugs producing changes of awareness such as stupor, catatonia and anæsthesia, as well as motor effects such as scratching, itching, paralysis and convulsions, were clearly shown with this film. He stressed the fact that from this region of the brain we can easily produce, by the action of small amounts of drugs, conditions which have much in common with mental diseases in man—for example, epilepsy and schizophrenia. Dr. H. Bickel's (Birmingham) short film of the three cases of phenylketonuria, which had been discussed earlier in the day, showed dramatically the recovery which is possible with a diet low in phenylalanine. His film emphasized the difficulties inherent in the control of such cases and the need of hospitalization. Finally, a sound film from Prof. D. Bovet's laboratory in Rome demonstrated skilfully the use of the electroencephalogram in the investigation of drug effect on the central nervous system.

In the closing session on the morning of July 17, with Dr. H. Kluver in the chair, the high standard of the previous days and the intense interest which had been shown in the discussions at all previous sessions were maintained. Prof. G. W. Harris (London) gave a brief but extremely lucid account of the early endocrine–nervous system relationships, with particular reference to the growth of control by the hypothalamus on the pituitary, and indirectly on other endocrine organs. Dr. D. Nachmansohn (New York) gave a short account of his conception of the basic biochemistry associated with the conduction of the nerve impulse, indicating the points in the energy cycles involved at which drug action might be expected to take place. The remaining papers related, in varying degree, to clinical problems, emphasizing their important place beside the highly theoretical discussions which had taken place on the previous days. Dr. J. T. Eayrs (Birmingham) described the relationship of a nerve cell and its background substance in cases of hypothyroidism, with particular reference to the probable inability of dendrites to grow when the background substance is deficient. Dr. M. Reiss (Bristol) presented evidence of the relationship between steroid hormone deficiencies and the incidence of mental states, and Dr. S. P. Hicks (Boston) showed the selective action of a number of agents, such as X-rays, on different parts of the developing nervous system. He gave some interesting data on the selective action of drugs, such as acetylpyridine, on certain parts of the nervous system. Finally, Dr. J. Elkes (Birmingham) spoke of the work done in collaboration with Dr. Eayrs and Dr. Todrick on the effect of inhibition of cholinesterase in the central nervous system during the period of development, pointing out that 80 per cent inhibition of this enzyme has little interference with subsequent development and function.

The closing remarks, presented by Prof. R. Gjessing (Oslo), admirably expressed the opinion and the feelings of all those present. He expressed their gratitude to the organizers for bringing such a comprehensive group of workers together, and felt that, if the symposium had only emphasized the many gaps in our knowledge, that alone would have made it worth while. He expressed the admiration of the meeting for the extreme thoroughness of the organization, which attended not only to their serious discussions but provided a most enjoyable evening in Magdalen College Hall with entertainment from the Oxford Madrigal Society and others. In fact, much of the success of the meeting was no doubt due to the many opportunities for informal discussion in the delightful surroundings of Magdalen College.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Flavour of Porridge

Nowadays, porridge is often insipid and lacking in its traditional flavour and aroma. Possibly one reason for this is that, in England at least, sugar is usually added, and the sweetish taste, while it does not mask any true porridge flavour, is sufficient for most people. In Scotland, on the other hand, the majority add salt—precisely why, despite many inquiries, we have been unable to ascertain—so that the porridge flavour is more important. In any event there is a traditional flavour, often described as 'nutty', associated with Scotch porridge, and it is the view of many that if this flavour were more general the consumption of porridge would increase.

Any flavour in porridge meal or flakes is developed during the initial kilning process. This is not a standard operation. The whole oats are dried down from a moisture content in the range 14–20 per cent (but usually about 17 per cent) to a final moisture content of 4–8 per cent, after which they are shelled and ground into meal. The source of heat may be coke or anthracite, and in the past oat husk was often thrown on the fire presumably with the object of producing some volatile product which then gave the kilned oat its flavour. The conditions of heating are not, however, constant as from one kiln to another, or in one operation within a single kiln. Broadly speaking, if the kilning is carried out at low temperatures (not exceeding about 80° C.) the resulting meal or flakes have no distinctive taste, whereas if the temperature is sufficiently high the meal will have a caramel-like bitterness or even a burnt flavour.

As part of a programme of research for the Oatmeal Millers of England and Scotland, we are investigating the physics of kilning, and inevitably we have also considered the problem of flavour. The full results will be published elsewhere; but meanwhile it is of interest to record that we have consistently produced the desirable porridge flavour by careful control of the conditions of kilning. The furnace gases, despite traditional belief, play no part, and the same flavour is obtained when the air is heated in an electric furnace. The optimum conditions correspond to the gentle drying of the oats down to an intermediate moisture content of about 8 per cent followed by a short toasting for twenty minutes in a current of air at 150° C. These conditions are, of course, not absolutely rigid, and a slight increase in the temperature can be compensated by a corresponding decrease in the time of toasting. The use of high air temperatures at the surface of the partly dried grain to obtain a short but severe heat treatment at the final stage of kilning is the essential feature. On crushing the grain the pleasant aroma is immediately apparent. It soon evaporates from exposed meal; but the flavour is associated with less volatile material and accordingly more persistent.

The work of Baker, Parker and Fortmann[1] has indicated that the aroma and flavour of bread are due largely to numerous organic substances produced in the crust at temperatures around 150° C. The substances thus produced range from the more volatile aldehydes like furfural and pyruvic aldehyde to the melanoidins associated with the browning reactions occurring in the crust. Similar reactions will occur in the kilning of oats, since the outer portions of the grain reach about the same temperature and also undergo slight browning. However, there would appear to be other substances produced which are responsible for the unique flavour of oatmeal. Thus, in laboratory tests we have found that the optimum conditions of heating to produce flavour in oats also apply to groats, albeit there is less tolerance to over-treatment and a tendency for a slight rancid flavour to be produced due to the absence of the protective husk. On the other hand, we have failed to produce the same characteristic nutty oatmeal flavour in wheat when it is submitted to similar treatment.

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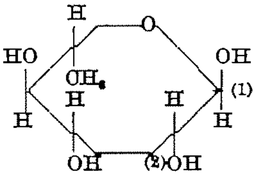
Sweetness and Configuration in Rhamnose

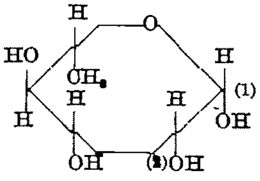
The ordinary form of most reducing sugars, such as α-glucose, β-fructose and α-galactose, becomes gradually less sweet after dissolution, and in the meantime the sweetness reaches a constant value, since the ordinary form is converted in part into the less sweet isomer, and finally an equilibrium is attained between the two isomers : $\alpha \rightleftharpoons \beta$.

Several years ago, one of us[1] pointed out that the sweeter form of these reducing sugars always has *cis*-hydroxyl groups on the carbonyl and adjacent carbon atom, while in the less sweet isomer the hydroxyls on the two carbon atoms are *trans* ; this was confirmed[1,2] by isolating and testing the α- and β-anomers with respect to sweetness.

From this rule it would be expected that in L-rhamnose the ordinary form (I) would be less sweet than the β-form (II), because the hydroxyls on C_1 and C_2 of the latter are *cis*. It has now been found that this is so.



α-L-Rhamnose
(I)



β-L-Rhamnose
(II)

Three tasters compared the sweetness of a 4·29 per cent (calc. as anhydrous) solution of α-L-rhamnose ($[\alpha]_D^{23}$ − 13° → + 8·6°) with that of a 3·86 per cent solution of β-L-rhamnose ($[\alpha]_D^{23}$ + 41° → + 8·8°). Immediately after dissolution the β-rhamnose solution was, in spite of its lower concentration, much sweeter than the α-rhamnose solution ; but with time the sweetness of the two solutions became closer, and after the lapse of fifteen minutes they were found equal in sweetness. After a further interval, the positions were reversed, the latter being distinctly sweeter than the former. From this experiment it is possible to calculate the ratio of the degree of sweetness of the α- and β-form, as in the case of fructose[2].

The content of the α- and β-form in the two solutions at the moment of equal sweetness (15 min. after dissolution) was estimated by measurement of the mutarotation :

	$[\alpha]^{25}_{D}$	α-form	β-form
3·86 per cent β-rhamnose	+ 12°	54 per cent	46 per cent
4 29 per cent α-rhamnose	+ 6°	65 per cent	35 per cent

Representing the ratio of the sweetness of α- and β-rhamnose by x, it was found to be 0·39 from the relation, $(46+54x)/(35+65x) = 4{\cdot}29/3{\cdot}86$; that is, the sweetness of the α-form is less than two-fifths that of the β-form. This ratio is somewhat greater than that for fructose (0·33)[2], but much smaller than that for glucose (0·67)[1], showing that the difference of the sweetness of the α- and β-form of rhamnose is very remarkable. This fact is probably related to the comparatively rapid mutarotation.

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[2] Tsuzuki, Y., and Yamazaki, J., *Biochem. J.*, [illegible], 525 (1953).

Molybdenum in the Growth and Metabolism of *Chlorella*

RECENT papers have shown the need of molybdenum for the growth of *Chlorella*[1] and *Scenedesmus*[2]. Some observations on the effect of molybdenum deficiency on the metabolism of *Chlorella* are recorded here.

Chlorella pyrenoidosa was cultured in purified nutrient solution in 250-ml. Erlenmeyer flasks with continuous shaking and illumination provided by fluorescent lights giving a light-intensity of 1,200 ft. candles at the base of the flasks. In Table 1 the effect of molybdenum on growth as measured by dry weight, chlorophyll content, photosynthesis and respiration of *Chlorella* cultures after five days growth is presented (means of four replicates).

Table 1 EFFECT OF MOLYBDENUM ON GROWTH (DRY WEIGHT), CHLOROPHYLL, PHOTOSYNTHESIS AND RESPIRATION OF *Chlorella*

Added Mo (μgm./l. culture)	Dry wt. (gm./l culture)	Chlorophyll (% dry wt.)	Photo-synthesis*	Respiration†
0	0·87±0 09	1 0±0·2	38±3	16 ±1
10	1·10±0·06	3·4±0·2	139±2	7·9±0 9

* Oxygen evolution expressed as ml. oxygen/gm. dry wt./hr., not corrected for respiration.

† Endogenous oxygen uptake expressed as ml. oxygen/gm. dry wt./hr.

Molybdenum-deficient cultures are characterized by their low chlorophyll content, and expressed on a unit dry-weight basis, low photosynthetic rate and high rate of endogenous respiration. The marked reduction of chlorophyll content of molybdenum-deficient cells has been reported by Arnon *et al.*[2] for *Scenedesmus*, and is perhaps one of the most characteristic features of molybdenum deficiency. The dry weight of molybdenum-deficient *Chlorella* cells was only slightly lower than that of the controls. In this respect, *Chlorella* at first sight behaved differently from *Scenedesmus*, in which molybdenum deficiency was associated with a sharp reduction in growth as measured by dry weight[2]. Recent results obtained by Arnon and Ichioka (unpublished), however, have shown that the dry weight, but not the chlorophyll content, of molybdenum-deficient *Scenedesmus* cells was markedly increased by the addition of vanadium, an element found to be essential for this alga[3]. In this respect the dry weight of the molybdenum-deficient *Chlorella* cells as shown in Table 1 is comparable to the dry weight found by Arnon and Ichioka for molybdenum-deficient *Scenedesmus* cells receiving vanadium.

The depression of photosynthesis in the absence of molybdenum is approximately proportional to the depression in chlorophyll content. Regardless of whether other factors were operative, the observed reduction of photosynthesis in molybdenum-deficient cells could be accounted for solely by their lower chlorophyll content.

Endogenous respiration was remarkably high in molybdenum-deficient *Chlorella*. In homogenized leaves of molybdenum-deficient tomatoes, Nason *et al.*[4] observed a marked lowering of endogenous respiration, a condition which might have been due to preparatory treatment. Spencer (unpublished results) has found increased respiration in molybdenum-deficient tomato leaves.

One of us (J. F. L.) gratefully acknowledges financial assistance from a Hackett studentship and a studentship from the Commonwealth of Australia Scientific and Industrial Research Organization. We wish to thank Dr. Victoria H. Lynch of the Radiation Laboratory for a culture of *Chlorella pyrenoidosa*.

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Incorporation of Acetate-2-^{14}C into Human Erythrocyte Stroma as a Function of Storage

IN an effort to elucidate the changes which may occur in the dynamic state of stroma constituents during storage of human erythrocytes (reported in part at the "Symposium on the Structural and Cellular Dynamics of the Red Blood Cell", June 1953 : National Research Council, Washington, D.C.), we have studied the incorporation of acetate-2-^{14}C into red cell stroma under *in vitro* conditions using a technique previously described[1]. Venous blood from healthy donors was drawn under sterile conditions into cold *ACD* solution (each 100 c.c. of the *ACD* solution contained 2·45 gm. glucose, 1·37 gm. sodium citrate and 0·50 gm. of citric acid ; 0·24 c.c. of *ACD* solution was added to each c.c. of blood) and then distributed as aliquots into an appropriate number of sterile tubes. These tubes were carefully sealed to prevent evaporation and were stored in two groups, one group at 4° C. and the other group at 37° C. At the intervals indicated in Fig. 1, tubes

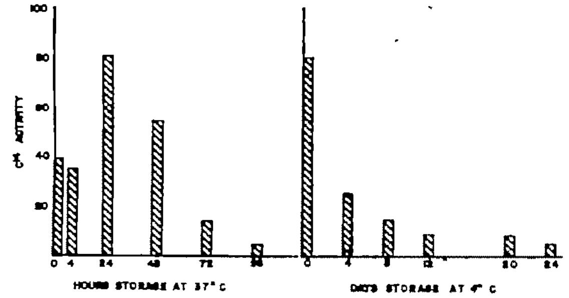

Fig. 1

were removed from the storage conditions and the incorporation of acetate-2-^{14}C into the total stromal fraction of the stored cells was determined. The composition of the incubation mixture for measurement of acetate incorporation was: 12·0 ml. of *ACD*-preserved whole blood, 1·5 ml. isotonic phosphate buffer at *p*H 7·4, 0·6 ml. of 0·3 *M* glucose in 0·9 per cent sodium chloride, and 1·5 ml. of sodium acetate-^{14}C (approximately 80 mgm.) in 0·9 per cent sodium chloride. The total amount of radioactivity added as labelled acetate varied from $4 \cdot 9$ to $6 \cdot 3 \times 10^6$ disintegrations per minute per 12 ml. of whole, preserved blood.

The results of these experiments are shown in Fig. 1. They indicate that upon storage at either temperature there is a progressive loss in the ability of the erythrocyte stroma to incorporate acetate-2-^{14}C. After storage at 4° C. for four days, acetate incorporation decreases to 70 per cent of the initial value. There is a significant rise in incorporation of acetate after storage for 24 hr. at 37° C., followed by a rapid, progressive decrease in incorporation to about 70 per cent of the initial level after 72 hr. of storage at this temperature. After 96 hr. of storage at 37° C., the acetate incorporation exhibits a degree of depression comparable to that seen after twenty-four days of storage at 4° C. A rise in acetate incorporation comparable to that seen after 24 hr. of storage at 37° C. may well have occurred in the experiment where the red cells were stored at 4° C., but may have been undetected, because the first determination was carried out four days after storage was initiated.

These studies indicate that the ability of human red cells to incorporate acetate-2-^{14}C into the stromal fraction is diminished under storage. The diminution of the ability to incorporate acetate is dependent upon the temperature of storage, and may reflect alterations in the dynamic state of the stroma lipids under these storage conditions. Similar conclusions have been reached with respect to lipids and lipoproteins by Lovelock[2] in his studies on thermal shock in red cells. The technique employed here demonstrates an abnormality of erythrocyte stroma metabolism which occurs during storage at 4° C. at a much earlier time than the appearance of significant changes in post-transfusion viability of the red cells.

Upon storage of red cells in *ACD* at 37° C., the time required for these changes in acetate incorporation to occur is much shorter. This suggests that certain *in vitro* studies of red cell metabolic capacity designed to elucidate the abnormalities of red cell metabolism occurring upon storage at lower temperatures might appropriately be carried out at 37° C. The use of these high temperatures of storage might facilitate future studies of some of the abnormalities of red cell metabolism by similarly shortening the time-scale of such experiments.

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A Position Effect of the *Rh* Blood-Group Genes

The opportunity has arisen of comparing the *C* and *E* antigens in the red cells of donors whose genotypes contain the same *Rh* genes, *D*, *C*, *E*, etc., but in different alignments.

Two comparisons have been made: that between red cell samples 1 and 2 in the table, and that between samples 3 and 4. All four samples gave reactions of about equal strength with some anti-*C* and some anti-*E* sera (columns *y* and *z*); but with other sera wide differences were revealed (columns *u*, *v*, *w* and *x*).

Scores representing the Strength of Reaction of Four Samples of Blood against Titrations of Six Selected Antisera

Genotype of donor	Antisera anti-*C* (*u*)	anti-*C* (*v*)	anti-*E* (*w*)	anti-*E* (*x*)	anti-*C* (*y*)	anti-*E* (*z*)
1. *dCE*/*dce*	0	2	73	87	93	34
2. *dCe*/*dcE*	39	55	6	13	93	24
3. *DCE*/*Dce*	0	0	75	71	75	33
4. *DCe*/*DcE*	34	43	29	31	91	33

All four genotypes have been confirmed by family groupings.
Genotype 1 has a frequency in Caucasians of perhaps 1 in 20,000.
" 2 " " " " " " about 1 " 10,000
" 3 " " " " " " " 1 " 10,000.
" 4 " " " " " " " 1 " 10.

The samples were taken on the same day within a few hours and in the same manner. Other examples of genotypes 1, 2 and 4 have been tested with similar results; we know of no other example of genotype 3. Control *dCe*/*dce* and *dcE*/*dce* samples showed that the gene *f* is not playing any detectable part in the *CE* effect.

The words *cis* and *trans*, introduced into genetics by Haldane, are useful here: in terms of *C* and *E*, samples 1 and 3 represent the *cis* arrangement and samples 2 and 4 the *trans*.

The influences of the *Rh* genes on each other are certainly very complicated; nevertheless, by confining ourselves to these two straightforward comparisons it is clear, from rows 1 and 3, that when *C* and *E* are in the *cis* arrangement *C* is inhibited and, from rows 2 and 4, that when *C* and *E* are in the *trans* arrangement *E* is inhibited. (The depression of *E* in genotype 4 though definite is not so extreme as that in genotype 2.)

A difference in phenotype between heterozygotes in *cis* and *trans* is precisely the sort of effect which, in other species, is such a striking characteristic of closely linked genes—genes between which crossing-over is rarely but regularly observed. Two examples may be quoted, namely, the lozenge genes of *Drosophila melanogaster*[1] and the biotin requirement genes of *Aspergillus nidulans*[2,3]. In these examples two genes may appear to behave as allelomorphs in *trans* but not in *cis*, a phenomenon which has been called by Lewis[4] "position pseudo-allelism". However, the reactions of most anti-C and anti-E sera (exemplified by y and z in the table), together with the reactions of anti-c and anti-e, have never allowed C and E to be mistaken for allelomorphs.

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A New Solvent for Silk

It has been shown recently by Schurz[1] that solutions of silk in phosphoric acid undergo a considerable decrease in viscosity on standing, which is probably due to degradation of the silk. Silk is insoluble in formic acid, although the latter is an excellent solvent for many polypeptides and nylon. On the other hand, concentrated aqueous solutions of many inorganic salts, for example, halides[2] and thiocyanates[3] readily dissolve silk, in some cases without degradation of the fibroin[4,5].

We have found that silk is very readily soluble in formic acid containing small quantities of water and certain inorganic salts at room temperature. Up to 20 per cent (w/v) of silk may be dissolved in these solutions, which are then semi-solid. Salts which are effective for rendering silk soluble in formic acid include lithium chloride, bromide, iodide and thiocyanate, magnesium, calcium, strontium, zinc and manganese chlorides, and calcium and barium bromides, whereas the alkali metal halides are almost ineffective. The salt concentration is related to the water-content of the formic acid. Thus, using 90 per cent (w/w) acid 10 per cent (w/v) anhydrous calcium chloride is necessary, whereas with 98 per cent formic acid, only 2 per cent calcium chloride is required.

It is seen from the table of viscosity measurements that formic acid solutions of silk undergo far less degradation on standing than do solutions in phosphoric acid. The raw silk (from Lullingstone Castle Silk Farm, Kent) was first freed from sericin by treatment with a warm dilute solution of soap and ammonia, followed by washing with distilled water and drying at 110° C. Viscosities were determined in an Ostwald viscometer at 25° C., after filtering the solution through glass wool. Intrinsic viscosities $[\eta]$ were obtained by plotting reduced viscosities, η_{sp}/c (c is silk concentration in gm./100 ml. solution), against silk concentration for four values of the latter, over the range 0·2–1·0 per cent, and extrapolating the resulting straight lines to $c = 0$.

Time (hr.)	90% w/w H_3PO_4–H_2O		90% w/w H_3PO_4–H_2O		90% w/w H.COOH–H_2O + 10% (w/v) $CaCl_2$		98% w/w H.COOH–H_2O + 2% (w/v) $CaCl_2$	
	$[\eta]$	% decrease	$[\eta]$	% decrease	$[\eta]$	% decrease	$[\eta]$	% decrease
0·5	1·48	—	1·83	—	1·65	—	2·04	—
2·0	0·85	42·6	1·42	22·4	1·56	5·5	1·98	2·9
5·0	0·44	70·3	0·92	49·7	1·47	10·9	1·88	7·8
25	0·08	94·6	0·15	91·8	1·08	34·6	1·40	31·4

Upon dilution with water, followed by vigorous agitation, the silk is precipitated from formic acid – calcium chloride solutions as a white curd. Alternatively, the silk may be obtained as a film by spreading the solution on a glass plate, allowing the solvent to evaporate in a desiccator over solid sodium hydroxide, followed by washing with ethyl alcohol to remove calcium chloride.

Infra-red absorption curves of the material precipitated by water show it to be in the β-configuration. It is of interest, however, that films cast from formic acid – calcium chloride, without removal of the salt show a carbonyl peak characteristic of the α-form of silk, although other features of the spectrum are rather obscure.

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Inhibition of Vernalization in *Linum usitatissimum* Linn. by Certain Synthetic Hormones

The present communication summarizes the results of eight hours prechilling soaking treatment at room temperature with different concentrations (500, 50, 5, 0·5, 0·05 and 0·005 parts per million in distilled water) of α-naphthaleneacetic acid, indolylbutyric acid and indolylacetic acid on the process of vernalization in *Linum usitatissimum* Linn., strain 477–3/2. Soaked seeds from each treatment were spread over cloth moistened with a solution of the same strength or with water and kept in Petri dishes inside a refrigerator, maintained at a temperature of 4–8° C. Mucilage on the seed-coat retained the solutions during the entire period of chilling (24 days), and this ensured a continuous supply of hormones to the embryo.

Only sprouted seeds of similar stages of development were used for sowings along with water-treated unvernalized seeds. Date of opening of the first flower on each individual plant was recorded, and the average number of days taken from date of sowing

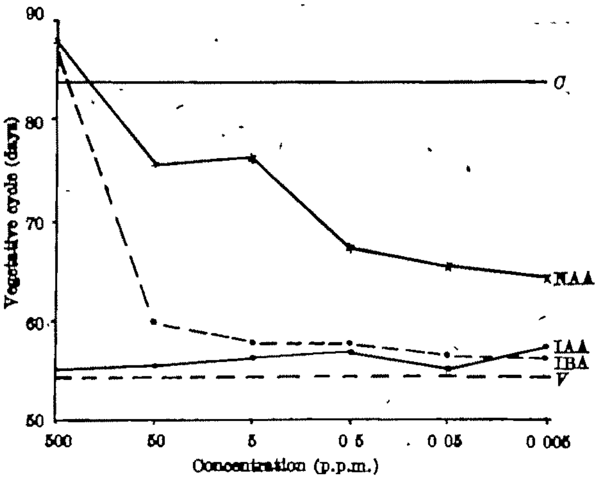

Fig. 1. Vegetative cycles of plants raised from *Linum* seeds treated with different concentrations of hormones before chilling. *C*, control; NAA, α-naphthaleneacetic acid; IAA, indolylacetic acid; IBA, indolylbutyric acid; *V*, vernalized

to anthesis for each treatment was calculated. This has been termed the vegetative cycle. The statistical validity of the experiment was determined by analysis of variance.

Of the three hormones, α-naphthaleneacetic acid was found to be the most effective, at all the concentrations, in reducing the period of earliness in flowering (Fig. 1 and Table 1). This delaying effect is directly proportional to the strength, since it brings down the earliness of 29·9 days, recorded in plants raised from water-soaked vernalized seeds, to 19·6 days at the lowest and to − 3·7 days at the highest concentration. In plants raised from seeds treated with 500 p.p.m. of this hormone, there is not only a complete inhibition of flowering induced by vernalization, but also a delay of 3·7 days, which is significant at the 5 per cent level.

Table 1. EFFECT OF PRECHILLING TREATMENTS OF *Linum* SEEDS WITH DIFFERENT CONCENTRATIONS OF HORMONES ON THE VEGETATIVE CYCLE OF PLANTS RAISED FROM THEM
Date of sowing: October 17, 1953

	α-Naphthaleneacetic acid		Indolylbutyric acid		Indolylacetic acid	
Conc. (p.p.m.)	Veg. cycle in days	Delay over vernalized	Veg. cycle in days	Delay over vernalized	Veg. cycle in days	Delay over vernalized
0 005	64 6 (16)	10 3*	56·6 (27)	2 3	57·5 (18)	3 2
0 05	65·8 (14)	11·5*	56·7 (18)	2 4	55·3 (18)	1 0
0·5	67·6 (7)	13·3*	60·0 (10)	5·7*	57·1 (16)	2 8
5 0	76·5 (6)	22·2*	57 8 (19)	3 5†	56 4 (10)	2·1
50·0	75·7 (7)	21·4*	59 9 (15)	5·6*	55·6 (18)	1·8
500·0	87 9 (20)	33·6*	87·1 (21)	32·8*	54·9 (24)	0 6
Untreated vernalized			54·3 (21)	—		
Control			84 2 (20)	29 9*		

Figures in brackets indicate number of plants.
* Significant at 1 per cent level.
† Significant at 5 per cent level.
Error mean square = 29·5.

Indolylbutyric acid in the highest concentration brings about a complete nullification of the chilling effect. Vegetative cycles of plants raised from seeds treated with 50, 5 and 0·5 p.p.m. of this hormone are slightly higher than that of the normal vernalized plants and these differences are statistically significant. The same cycles do not differ significantly in plants from seeds treated with the lower concentrations (0·05 and 0·005 p.p.m.). Similar results were obtained with all the concentrations of indolylacetic acid.

Destruction of photoperiodic effects, in certain plants, through the application of synthetic hormones, is now established. But with the exception of that of Wittwer[1] and Pillai[2], there are few observations on the effect of growth substances on the process of vernalization. Wittwer[1] recorded that treatment of lettuce seeds with dichlorophenoxyacetic acid (2,4-D) during the process of chilling resulted in an inhibition of flowering induced by vernalization. Pillai[2] observed a significant decrease in earliness in flowering in *Brassica campestris* L. through a pre-vernalization soaking of seeds in 50–0·005 p.p.m. of dichlorophenoxyacetic acid.

I have suggested earlier[3] that the substance or substances formed during chilling are not direct flower-forming ones and thus differ from those synthesized in the leaves during a photoperiodic treatment. Similarity of action of certain hormones on the nullification of photoperiodic and vernalization effects, however, indicates that the above conclusion is true of the final product of vernalization only, and there is every likelihood of the existence of an intermediate step common to both vernalization and photoperiodism in the chain of reactions leading to the ultimate induction of earliness in flowering.

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Relation between Vitamin D and Vitamin B_{12}

IN some experiments on chick growth with wholly vegetable diets[1] supplemented with pure vitamin B_{12}, a relationship became evident between the growth-stimulating effect of this vitamin and the content of calcium, iron and vitamin D of the diet. In an attempt to elucidate the relation between the vitamin D and vitamin B_{12}, the present experiment was started.

Day-old White Leghorn chicks from non-depleted hens were, during their first week, given a wholly vegetable diet (207 in Table 1), without added vitamin D. Then they were weighed and according to their weight grouped in six equal groups, each consisting of four sub-groups with nine chicks. They were fed the same diet with different vitamin D and vitamin B_{12} supplements. The experimental period lasted three weeks, and the results are given together with the experimental plan in Table 2.

Table 1. PERCENTAGE COMPOSITION OF EXPERIMENTAL DIET 207

Barley	22·3
Oats	14·9
Wheat bran	11 0
Corn meal	15·1
Soybean oil meal	16 6
Sunflower seed meal	10 5
Alfalfa meal	4 0
B-vitamin conc.*	1·0
Bone meal	2·0
Ground limestone	1·6
Salt mixture†	1·0
	100·0

* Minimum 200 mgm. riboflavin, 200 mgm. niacin and 20,000 I.U. thiamin per kgm.

† 896 gm. iodized NaCl (5 mgm. KI per kgm.), 50 gm. $MnSO_4.4H_2O$, 50 gm. $FeSO_4.7H_2O$, 4 gm. $CoSO_4.7H_2O$.

Table 2. CHICK GROWTH AND FEED CONSUMED PER UNIT GAIN (UNTIL FOUR WEEKS OF AGE)

Group No.	Vitamin D supplement			Vitamin B_{12} (μgm. per kgm. diet)	Gain‡		Feed per kgm. gain (kgm.)
	Cod liver oil* %	Deltafor D_2—400† %	Approx. I.U. per kgm. diet		abs. (gm.)	rel. %	
1	0	0·05	200	0	128	100	3·06
2	0	0·05	200	30	134	105	3·01
3	0·4	0·1	640	0	110	86	3·45
4	0·4	0·1	640	30	141	110	3·03
5	0·4	0·3	1,400	0	106	83	3·29
6	0·4	0·3	1,400	30	144	112	3·04

* 1,000 I.U. vitamin A, 60 I.U. vitamin D per gm.
† 400 I.U. vitamin D_2 per gm.
‡ Gain between one and four weeks, average males–females.

From this table it is evident that the two higher vitamin D supplements had significant growth-depressing effects in the groups with no vitamin B_{12}. Supplementing the diet with vitamin B_{12}, however, eliminated these effects.

Details of this and other experiments in this series will be published elsewhere.

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Deoxyribonucleoproteins of Cell Nuclei: Sensitivity to X-Rays

STUDIES of aqueous systems of intact deoxyribonucleoproteins[1] showed that they were markedly unstable. Storage at 2°–5° C. for 24–36 hr. produced a substantial depolymerization of the deoxyribonucleic acid component. This is in marked contrast to the stability of dissociated nucleoproteins in 1·0 *M* sodium chloride. It was felt that this instability might be functionally significant in the mechanism of radiation effects on biological systems. Studies were therefore made of the effects of X-radiation on aqueous nucleoprotein gels.

When isolated calf-thymus nuclei are placed in water, there is a rapid gelation, an increase in volume, and lysis of the nuclei. Further additions of water produce a further increase in the volume of the gel, a concomitant decrease in rigidity, and eventually an aqueous nucleoprotein solution. Such gels have a high and anomalous viscosity and are very susceptible to degradation, losing viscosity rapidly at 25°, more slowly at 2°–5° C. When they are exposed to low doses of X-rays no immediate effect is apparent. After 4–6 hr. storage of the irradiated gel at 2°–5° C., there is an acceleration of the spontaneous loss of viscosity. The effect is proportional to dose in the range studied (250–5,000 r.).

The observed effect is a decrease in the structural viscosity of the nucleoprotein gel and relates to the interactions between deoxyribonucleoprotein molecules. In 1·0 *M* sodium chloride, the structural viscosity of the nucleoprotein gel is abolished, and the nucleic acids and proteins are dissociated. Under these conditions it is possible to measure the intrinsic viscosity of the deoxyribonucleic acid. The doses of X-radiation used had no effect on the intrinsic viscosity of the deoxyribonucleic acid, whereas the spontaneous loss of viscosity of non-irradiated gels involves depolymerization and a decrease of intrinsic viscosity.

Exposure of isolated nuclei to 1,000 r. of X-rays markedly decreases the capacity of these nuclei to swell when placed in water. This is in agreement with previous observations[2] that X-rays inhibit trypsin-induced swelling in salivary glands of *Drosophila* larvæ.

With regard to the loss of viscosity observed in the nucleoprotein gels, there are apparently at least two separate factors involved. The lack of any immediate effect of X-radiation on the gel or on its deoxyribonucleic acid component strongly suggests that the observed phenomena involve primarily the interactions of the protein moieties of these systems. Further details of this work will be published in due course.

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Analysis of Unordered Tetrads Segregating for a Lethal or Other Epistatic Factor

Perkins[1] and Whitehouse[2] have shown how chromosome centromeres can be mapped by the analysis of unordered tetrads of spores (or gametes), provided segregation is occurring at three unlinked loci. The basis of the method is the determination of the frequency of tetratype tetrads for the loci considered in pairs. If at one of the three loci there is segregation for a lethal or other epistatic factor, the frequency of tetratype tetrads with respect to the other two loci will be indeterminable. Nevertheless, it is still possible to map the genes in relation to their centromeres.

Consider first the general case of tetrads segregating for three pairs of unlinked genes, *A* and *a*, *B* and *b* and *C* and *c*. Five classes of tetrads can be recognized:

Class	Genotype of tetrad	Ditype (*D*) or tetratype (*T*)		
		A and *B*	*A* and *C*	*B* and *C*
I	*ABC* *abc* *ABC* *abc* *ABc* *abC* *ABc* *abC* *AbC* *aBc* *AbC* *aBc* *Abc* *aBC* *Abc* *aBC*	*D*	*D*	*D*
II	*ABc* *abC* *ABC* *abc* *Abc* *aBC* *AbC* *aBc*	*D*	*T*	*T*
III	*ABC* *abc* *AbC* *aBc* *ABc* *abC* *Abc* *aBC*	*T*	*D*	*T*
IV	*ABC* *abc* *Abc* *aBC* *ABc* *abC* *AbC* *aBc*	*T*	*T*	*D*
V	*ABc* *abc* *AbC* *aBC* *ABC* *abC* *Abc* *aBc*	*T*	*T*	*T*

Tetrads of class I are ditype with respect to all three combinations of the loci in pairs. As indicated, there are four possible constitutions for this type of tetrad, depending on whether the pairs of factors show the parental combination or whether some show recombination. However, if the three loci are unlinked, these four sub-classes are expected with equal frequency. Tetrads of classes II, III and IV are ditype with respect to one pair of loci, tetratype with respect to the other two. In each instance, there are two sub-classes, one with the ditype pair in the parental combination and the other non-parental, and again these are expected with equal frequency. Tetrads of class V are tetratype with respect to all three combinations of the loci in pairs.

Segregation at the first division of meiosis for all three loci will give rise only to class I tetrads. Segregation at the first division at two loci and at the second division at the third locus will give rise to either class II or class III or class IV tetrads, depending on which locus shows second division segregation. Segregation at the first division at one locus and at the second division at the other two will give rise with equal frequency to class V tetrads and to either class II or class III or class IV tetrads, depending on which locus shows first division segregation. Segregation at the second division for all three loci will give rise to classes I, II, III and IV with equal frequency. Expressed algebraically, if the frequencies of segregation at the second division of meiosis for the three loci *A*, *B* and *C* are x, y and z respectively, the frequencies of segregation at the first division being $1-x$, $1-y$ and $1-z$, respectively, then the frequencies of the five classes of tetrads are as follows:

Class	Frequency
I	$(1-x)(1-y)(1-z)+\frac{xyz}{4}$
II	$z(1-x)(1-y)+\frac{xy(1-z)}{2}+\frac{xyz}{4}$
III	$y(1-x)(1-z)+\frac{xz(1-y)}{2}+\frac{xyz}{4}$
IV	$x(1-y)(1-z)+\frac{yz(1-x)}{2}+\frac{xyz}{4}$
V	$\frac{xy(1-z)}{2}+\frac{xz(1-y)}{2}+\frac{yz(1-x)}{2}$

Now, if *A* is a lethal or other epistatic factor, suppressing the difference in phenotype of one or both of the other pairs of factors, then classes IV and V cannot be distinguished from one another; but they can be separated collectively from the other three classes (I, II and III), which can also be distinguished from each other. If p, q and r are the observed frequencies (as fractions of the total tetrads) of classes I, II and III, respectively, then we have three simultaneous equations for x, y and z. The solutions to these equations are as follows:

$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a},$$

where

$$a = 3(p-q-r)+1,$$
$$b = 3[(p+q)(p+r)-2p+q+r]-1,$$
$$c = 4[p-(p+q)(p+r)],$$
$$y = \frac{2(x+p+q-1)}{3x-2},$$
$$z = \frac{2(x+p+r-1)}{3x-2}.$$

As an example of the use of these formulæ, Hartshorne[3] has analysed ninety-two tetrads of *Chlamydomonas reinhardi* segregating for three unlinked factors: 'eyeless' (*ey*), mating-type (*mt*) and 'small colony' (*sc*). The 'small colony' character is suppressed in the presence of the normal allele of 'eyeless'. In the analysis above, *A* is the epistatic locus and must therefore be equated with *ey*. Let *mt* equal *B* and *sc* equal *C*. The frequencies observed by Hartshorne for the different classes of tetrads are then as follows:

Class	I	II	III	IV+V	Total
Frequency	2	9	6	75	92

Hence

$$p = \frac{2}{92}, \quad q = \frac{9}{92}, \quad r = \frac{6}{92},$$

and, applying the formulæ, we obtain either

$$x(ey) = 0{\cdot}979, \quad y(mt) = 0{\cdot}210, \quad z(sc) = 0{\cdot}140,$$

or

$$x(ey) = 0{\cdot}080, \quad y(mt) = 0{\cdot}910, \quad z(sc) = 0{\cdot}947.$$

Further data make it possible to discriminate between these two alternatives. Hartshorne analysed 151 tetrads segregating for *ey* and the unlinked character 'slow growth' (*sg*), and found 9, or 5·96 per cent, were tetratype. This indicates that both these factors are situated close to their centromeres. Hence, the second of the above alternatives is the true one. It is concluded that the second division segregation frequencies for *ey*, *mt* and *sc* are 8·0, 91·0 and 94·7 per cent, respectively, and the genes are located 4·0, 45·5 and 47·3 units from their respective centromeres.

Papazian[4] and Spiegelman[5] have pointed out that the simple procedure of halving the second division segregation frequency to obtain the map distance of a locus from its centromere is inaccurate unless the map distance is short. However, their correcting formula is inapplicable to second division segregation frequencies in excess of 2/3, such as those for *mt* and *sc* above. It appears impossible to correct accurately map distances obtained from second division segregation frequencies, except by the study of intervening loci. Thus, a second division segregation frequency of nearly 100 per cent implies that one cross-over is occurring proximal to the locus in question at nearly every meiosis, that is, that double cross-overs are rare, and hence that the map distance is approximately half this frequency. On the other hand, a second division segregation frequency of about 67 per cent may mean that one cross-over proximal to the locus is occurring in two-thirds of meioses and hence a map distance of 33 units is correct, or it may mean that several cross-overs proximal to the locus are occurring at every meiosis, and hence that the map distance between locus and centromere is perhaps 150 or 200 units. It is convenient to retain the customary procedure of halving the second division segregation frequency to obtain an estimate of the map distance from the centromere, while remembering the limitations of the method.

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A New Antibacterial Principle : Megacine

IN the course of an investigation of the potential lysogenic powers of *B. megaterium* strains isolated recently from faecal and soil samples, one of the strains studied (No. 216) showed a particular effect. When a highly diluted broth culture of this strain was mixed with a heavy suspension of a phage-sensitive *B. megaterium* strain ('mutilate'), and plated on yeast extract agar containing casein hydrolysate, no phage plaques were seen, but the colonies of the strain 216 were surrounded by a small clear halo. To study this effect, young aerated cultures of the strain grown in yeast extract – casein hydrolysate broth were lightly irradiated with ultra-violet light and reincubated. The turbidity of these cultures increased after irradiation up to the end of the second hour; then a lysis of the bacteria set in, which became almost complete in three hours. The bacterial lysate thus obtained does not contain phage particles when tested in the usual way. On the other hand, if one drop of various dilutions (up to a few thousands) of the lysate was put on the surface of a yeast-extract – casein hydrolysate agar plate heavily seeded with *B. megaterium*, it caused a clear spot with no bacterial growth on the site of the drops. There was no reproduction of the antibacterial principle (which we propose to call 'megacine') in the sensitive bacteria, which fact excludes its phage character.

The lysates obtained by irradiation of young growing cultures containing approximately 10^7 cells/ml. were active up to dilutions of 10^{-3}–10^{-4}, depending on the *B. megaterium* strains used as test organism. All the thirty-seven strains of *B. megaterium* investigated, whether lysogenic or not, were sensitive to the antibacterial principle. The most striking was that the producer, the strain 216, was also sensitive to the principle, though to a lesser degree (10^{-2} dilution) than the others. On the other hand, when a considerable number of strains belonging to various other species of bacteria were tested, none of them was found to be sensitive to megacine. The figures in parenthesis show the number of strains investigated: *E. coli* (8), different *Salmonellae* (10), *Shigellae* (4), *Ps. aeruginosa* (3), *Proteus X*-19 (1), *Proteus morgani* (1), *Ae. aerogenes* (1), *Serratia marcescens* (1), *Micrococcus pyogenes*, var. *aureus* (4), var. *albus* (7), *M. tetragenus* (1), *Sarcina flava* (4), *Diplococcus pneumoniae* types 1, 2, 3, 14 (7), *Str. viridans* (1), *Str. faecalis* (3), *Str. haemolyticus A, B, C* (15), *C. diphtheriae* (1), *C. xerosis* (1), *B. anthracis* (8), *B. cereus* (6), *B. subtilis* (7). All the strains of *Sarcina flava* investigated were, however, sensitive to lysozyme, which fact indicates the dissimilarity in the mode of action of lysozyme and megacine. The principle is very slightly diffusible in agar, does not pass through parchment and is moderately thermolabile. Ninety per cent of its activity is destroyed at 80° C. in 30 min., although heating at 60° did not diminish its antibacterial effect. The principle was precipitated by ammonium sulphate at 75 per cent saturation. Trypsin inactivated the active principle.

Megacine is lethal for the cells of *B. megaterium*. If it is added to a light suspension of this bacillus, the organisms are killed within minutes and partly lysed by the fifth to sixth hour. It cannot be classed as an antibiotic, for its characteristics are more closely related to the bacteriocines[1], which are represented so far by colicines[2] and pyocine[3]. There is, however, a striking difference between megacine and these antibacterial principles, namely, both pyocine and colicines are bactericidal only for certain strains of their own or related species, and the strains producing the principles are not sensitive to their own bacteriocine. The unique feature of megacine lies in its effect on the very strain which produces it.

Full details of these observations will be published in the *Acta Microbiologica Hungarica*.

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May 24.

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Sensitive Parallax Detector for Optical Bench

IN accurate measurements of focal-lengths and the like, on an optical bench, it is customary to employ the points of pins mounted on adjustable stands. The lens under test has itself to be so mounted as to enable it and the pin-points to be 'lined up' parallel to the tracks of the optical bench. This is a somewhat troublesome and time-consuming operation, and distracts the students' attention from the basic aim of the experiment. The device herein described eliminates much of this tedious procedure and can indeed yield more accurate settings than the older procedure. As it is easily adaptable to any type of optical bench, I will confine myself to describing the details peculiar to the device itself.

A 'herring bone' pattern, such as that shown in Fig. 1, consists of some two dozen parallel lines which interact an equal number of parallel lines inclined at an angle of 175° to the first set. This is reproduced photographically on lantern slides. As finished, the slides show a pattern of intensely black lines spaced about 3 mm. apart and about 0·1 mm. thick, on a clear background. Of course, the slides are covered with clear glass and bound as usual.

These slides are clamped with spring clips on brackets mounted on the stands which slide on the optical bench. No precise centering is required; all that is necessary is that the plane of the slide shall be normal to the bench axis, and that the middles

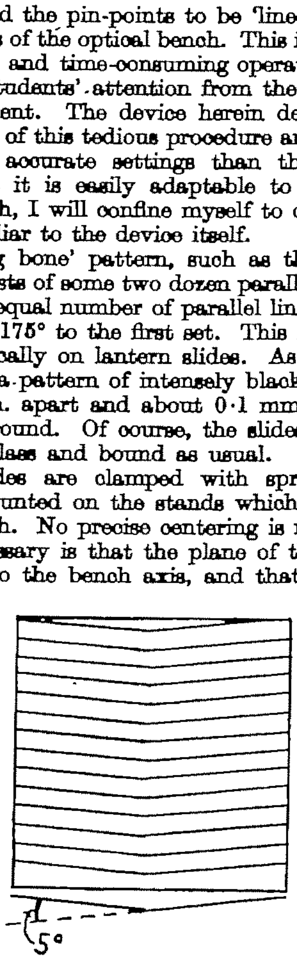

Fig. 1. Graticule pattern. The number of lines is fewer and the angle of inclination exaggerated for reasons of clarity

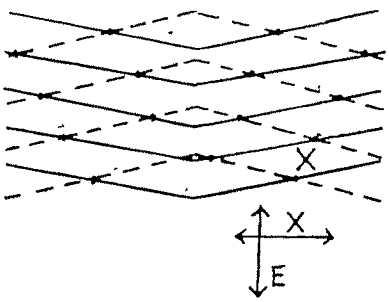

Fig. 2. Part of the pattern presented to the eye. It should be noticed that the points of the two 'herring bone' patterns do not necessarily coincide. E,X indicate the movement of the eye and the consequent sideways displacement of the intersections X

of the slides shall be roughly in line with the centre of the lens. The lens holder need not be adjustable; simple V-blocks are sufficient.

One of these slides is illuminated from behind by diffused light, and a real inverted image of its pattern is found by the lens under test in the vicinity of the other (graticule). On looking at this second graticule in the direction of the lens, the pattern of the image and the graticule appears somewhat like Fig. 2, where the dotted lines represent the image and the full lines the graticule. If the image is not in the same plane as the graticule, slight transverse movements of the eye cause the intersections (X) to shift sideways. The graticule is then moved along the bench towards or away from this position until this shifting effect disappears. The image is now in the plane of the graticule. The lines are inclined at an angle, and it is easy to show that the lateral shift of an intersection X is greater than the lateral 'parallax' displacement observed in the ordinary way in the ratio $1/a$, where a is the acute angle in radians between the two sets of lines. Thus, in our case the ratio is about $57°/5° = 11 : 1$. Thus the sensitivity is about tenfold greater than that of the older method.

When measuring the focal length of a concave mirror, or fixing the focal point of a lens system using a plane mirror behind the lens, one half of the screen is illuminated and the setting made by viewing the (reflected) image on the other half. The pattern viewed is then similar to that described.

The device lends itself to the study of the curvature of the image, to spherical aberration and to other effects. Its main advantages are its sensitivity and ease of adjustment, and that it enables a form of optical bench to be constructed which, although inexpensive, is capable of considerable accuracy.

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Occurrence of *Culex simpsoni* in Mauritius

DURING a survey of breeding sites, a mosquito new to Mauritius has been found. Larvæ of *Culex simpsoni* Theobald were found breeding profusely in rock-pools in the river bed of the Tamarin Gorges. In the same pool, larvæ of *Anopheles gambiae*, *Anopheles maculipalpis* and *Culex tritaeniorhyncus* were also found. The pool was fed by seepage from a spring on the side of the gorge.

MacGregor[1] stated that the larvæ of *C. simpsoni* were pale green in colour during life; this cannot be confirmed. The larvæ and pupæ obtained from the Tamarin Gorges were light blue in colour during life, changing to pale green at death.

C. simpsoni has not previously been reported from Mauritius; but in Rodrigues, another island of the Mascarene Group, it is a common insect. It is a moot point whether Mauritius has been invaded from Rodrigues, or whether *simpsoni* is native to Mauritius, and has remained undetected due to the unfrequented and almost inaccessible siting of its breeding place. Rodrigues is, geologically, the older island; but its limited mosquito fauna (*C. fatigans*, *Ae. aegypti*, *C. simpsoni*), when contrasted with the relative luxuriant mosquito fauna of Mauritius, would suggest that it is native to Mauritius. *C. simpsoni* has not been detected in the French island of Réunion, the third and youngest island of the Mascarene Group.

It is of interest to note that the surface of the breeding pool supported both *Symphypleona* and *Arthropleona* of the order *Collembola*—an order of insects not previously recorded from Mauritius.

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May 17.

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[1] MacGregor, M. E., "Mosquito Surveys" (London, 1927).

Paper Chromatography of Organic Acids

GLYCONIC acids, glycaric acids and glycuronic acids and certain related hydroxy acids show a marked tendency to produce streaked spots on paper chromatograms. This may be eliminated by incorporating in the developing solvent certain organic acids such as formic acid or acetic acid[1] to suppress ionization of the carboxyl group. The developing solvents incorporating formic or acetic acid vary in composition with time, due to slow esterification of the acid when an alcohol is present; for this reason R_F values are variable. Moreover, the number of suitable acidic developing solvents is limited. In order to be able to use any developing solvent for the separation of acids, we have coated the filter paper with alginic acid. Whatman No. 1 filter paper is dipped into a 1 per cent aqueous ammonium alginate solution and after removing the excess of this solution the paper is dipped into N hydrochloric acid which causes precipitation of alginic acid. The paper so treated is washed with water or ethanol to remove excess hydrochloric acid and allowed to dry in the air.

Papers prepared in this way have been used for partition chromatography of D-mannuronic acid, D-glucuronic acid, D-galacturonic acid, citric acid, tartaric acid, succinic acid, malic acid, glycollic acid, malonic acid and various aldobiuronic acids such as O-D-glucopyranosidurono-(1 → 2)-α-D-xylopyranose isolated from chagual gum[2].

Since the papers are acidic in character, the usual acid-base indicators could not be used for detecting the acids. The alginic acid, however, did not interfere with the detection of uronic acids and certain hydroxy acids such as citric, tartaric and malic acids by the ammoniacal silver nitrate reagent. The uronic acids could also be detected on alginic acid papers by the spray reagents containing aromatic amines such as aniline, p-anisidine, etc., usually employed for locating reducing sugars.

The mono- and di-carboxylic acids which could not be detected by the silver nitrate and amine sprays were located by first spraying the papers with a 50 per cent aqueous alcoholic solution containing 5 per cent of an amine (for example, aniline or *p*-anisidine) and 5 per cent sodium nitrite, and then spraying soon afterwards with an alkaline solution of either a phenol (for example, β-naphthol) or an aromatic amine (β-naphthylamine, 6,8-disulphonic acid). The acids are located by the appearance of colours due to azo-dye formation. When these sprayed chromatograms are dry, they exhibit a strong background fluorescence upon which the dark non-fluorescing azo-dye spots could readily be detected; this is particularly noticeable when an amine is used as the coupling agent.

The acids could also be detected by making use of a browning reaction catalysed by acids. When the chromatograms are sprayed with a 50 per cent aqueous alcoholic solution containing 5 per cent of an aromatic amine (for example, aniline or *p*-anisidine) and 5 per cent of a reducing sugar (D-xylose is preferred) and heated for a short time at 125–130° C., brown spots appear wherever acids are present.

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[1] Long, J. W. H., and Overell, B. T., *Aust. J. Sci. Res., Phys. Sci.*, 1, 98 (1948). Buchanan, J. G., Dekker, C. A., and Long, A. G., *J. Chem. Soc.*, 3162 (1950). Howard, G., and Martin, A. J. P., *Biochem. J.*, 46, 532 (1950). Partridge, S. M., *Biochem. J.*, 42, 238 (1948). Bush, M. L., Montgomery, R., and Porter, W. L., *Anal. Chem.*, 24, 489 (1952).

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Estimation of Impurities in Liquid Chlorine by Infra-red Absorption Spectrophotometry

The method of E. R. Wright and R. A. Smith[1] for the determination of moisture in liquid chlorine by infra-red absorption spectrophotometry has been extended to include impurities that give absorption bands as far as 1,180 cm.$^{-1}$ (8·5 μ). In the range 4,000–1,180 cm.$^{-1}$, liquid chlorine is, for practical purposes, completely transparent in the infra-red. This enables the use of path-lengths a thousand times greater than normal. Certain impurities can thus be estimated to a few parts per million by this method. 1

A 5·25-cm. tantalum-clad steel pressure cel (200 lb./sq. in.) was fitted with calcium fluoride windows and 'Teflon' gaskets. This cell was designed and made by the Perkin Elmer Corporation (Norwalk, Connecticut). It was fitted with stainless-steel needle valves and a stainless-steel reservoir which enabled the cell to be filled under pressure directly from an inverted chlorine cylinder, or placed in a Dewar flask and surrounded by solid carbon dioxide for filling at atmospheric pressure. Spectra were recorded on a Perkin Elmer Model 12C single-beam instrument fitted with a calcium fluoride prism to give adequate resolution.

The concentration of impurity is given by the Beer's law relationship which (adopting the usual symbols) is as follows:

$$c = \frac{1}{El}\log\left(\frac{I_0}{I}\right)\max.$$

Using standardized conditions, the concentration in parts per million can be expressed as a constant times the optical density, which is read directly from the absorption curve.

The method has been evaluated by adding weighed amounts of the following compounds to liquid chlorine (wave numbers of absorption bands in cm.$^{-1}$ given in parentheses): chloroform (1,213), methylene chloride (1,259), hexachlorobenzene (1,348). For these compounds, and at the path-length used, this method is sensitive to approximately 5 p.p.m. with an accuracy at 50 p.p.m. of ± 10 per cent.

The method has been used for the estimation of moisture in liquid chlorine using the absorption band at 1,640 cm.$^{-1}$ which is free from interference by carbon dioxide.

This work is being submitted for publication more fully elsewhere. So far as we know, this is the first account of infra-red absorption spectrophotometry of liquid chlorine from 2,860 cm.$^{-1}$ to 1,180 cm.$^{-1}$ (3·5–8 5 μ).

The constant help and advice of F. W. Matthews of this laboratory is gratefully acknowledged, and the Perkin Elmer Corporation is thanked for the loan of the cell.

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Production of Individual, Sized, Droplets by High-Voltage 'Firing' from a Micropipette

There are several satisfactory methods for the continuous production of uniform droplets. The range below 10 microns may be covered in the La Mer vapour condensation apparatus, 10 μ–1,000 μ, by the spinning disk principle, 100 μ to several millimetres by the vibrating tip, interrupted jet and micro-burette principles and 800 μ to 6–7 mm. by liquid falling by gravity from the tip of a vertical tube.

In experiments on the evaporation-rates of various airborne droplets, we wished to produce individual droplets and place them with accuracy in the field of the microscope, for example, on a 1-μ diameter wire. Of the above methods, only the last is suitable for producing individual drops; but these are much too large for our purpose. The size of drops falling by gravity from a fine tip is given with reasonable accuracy by equating the upward force of surface tension acting round the circumference of the tip to the gravitational pull at the moment of breakaway: $\pi d.T = \pi D^3 \rho g/6$, where d and D are the diameters of the tip and droplet respectively. For a 20-μ tip, the diameter of the drop which falls is still as large as 0·95 mm. The cubic relationship between d and D prohibits any further worth-while reduction in D as d is reduced to the smallest practical size.

We have found that droplets of any desired size down to about 10 μ may be 'fired' off from the tip of a micropipette by applying a momentary high voltage to the liquid. Suitable micropipettes in thin-walled glass tubing may be drawn by hand; but much greater precision, particularly in the finer sizes, is given by a 'microforge' such as Powell's microscope attachment[1]. The micropipette needle is fitted to a small glass holder which has (i) a sealed-in wire electrode passing up inside the needle to make contact with the liquid, and (ii) a small side arm for supplying pneumatic pressure to the needle from a hand-operated hypodermic syringe via a length of fine rubber tubing. A source of d.c. voltage variable between 0 and 5 kV. is required, and it is convenient to apply this to the micropipette by means of a bell-push operated relay. For mounting the micropipette in its operating position, Goldacre's arrangement[2] is convenient because of its simplicity, universal adjustment and high insulation.

When forming droplets, the procedure is to apply pneumatic pressure to the micropipette, observing the drop in a microscope fitted with a calibrated scale in the eyepiece. As the drop is formed, it tends to run back up the shaft of the pipette so that the liquid usually cannot be sucked back if the required size is exceeded; however, evaporation will quickly reduce the drop to the required diameter, with most liquids. When the drop is exactly the required size, the bell-push is operated, the drop flies off and, by trial and error setting of the micropipette, may be aimed with considerable accuracy over a distance of several centimetres. The trajectory of the charged droplet is of course strongly influenced by electrostatic fields. A 100-megohm leak to earth from the electrode ensures discharge of the holder before the next drop is formed.

A study was made of the minimum firing voltage, tip diameter and drop size for various liquids with the view of establishing a relationship between the relevant parameters; but there was too much unexplained variability in the results for this to be done. It is possible that such factors as the cleanliness of the outside of the pipette and the shape and taper of the tip may have an overriding effect. The results showed a general correlation between a slow increase in minimum firing voltage and increasing tip diameter, the former being practically independent of size of drop from a given tip. In practice, it is convenient to work at a voltage of about twice the minimum firing voltage to ensure immediate firing of the drop. There is a considerable range above the minimum firing voltage which can be used; but at too high a figure the drop is disrupted and spraying commences. Observed minimum firing voltages for various tips are: $< 10\,\mu$, 0·6–1·3 kV.; 10–20 μ, 0·8–1·4 kV.; 20–50 μ, 1·0–1·8 kV.; 50–100 μ, 1·5–3·0 kV. These figures cover all liquids, from conductors such as aqueous salt solutions to insulators such as paraffin oil. The minimum firing voltages for water may be reduced considerably below these values by coating the outer surface of the pipette with a thin film of paraffin wax.

The rule-of-thumb for pipette size is that the tip should not exceed one-third of the required droplet diameter. Micropipettes down to 1–2 μ are easily made, though blockage from foreign substances in the liquid naturally becomes a problem with such fine tubes. To minimize the tendency of the droplet to run back up the micropipette, the taper on the latter should be as small as possible. With a little practice in the control of heating, traction and position of the tube when forming the pipette in the microforge, almost parallel-sided tubes can be made.

Apart from our own requirements, other uses for individually produced droplets may be found in, for example, fuel combustion studies, applying minute quantities of toxic substances such as insecticides to specific areas on insects, the calibration of droplet detectors, etc.

It should be possible to produce droplets continuously by means of a steady liquid flow and controlled frequency voltage pulse.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this letter, and we are grateful to Mr. W. R. Lane for advice.

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May 28.

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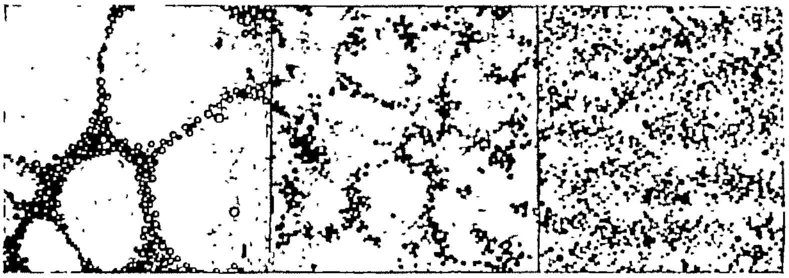
[1] Powell, H. O., *J. Roy. Micr. Soc.*, 72, 214 (1953).

[2] Goldacre, R. J., *Nature*, 173, 45 (1954).

Structure of Breath Deposits on Dielectric Oils

It is possible, by low-power microscopic observation of water droplets deposited by breathing upon the surface of dielectric oils, to detect their degree of alteration by ageing.



With unused oil, the breath figures are identical with those obtained with a neutral paraffin oil containing some foreign molecules with hydrophilic groups[1]: moisture condenses on their surface as very small, randomly disposed droplets (about 10 μ in diameter). After some seconds these droplets join up, forming chains, and finally coalesce as bigger droplets located at the intersection points of former chains (Fig. 1).

With dielectric oils artificially aged (by heating for 10 hr. in contact with copper, at 120° C. or higher) droplets deposited by breathing join up as more-or-less elongated groups (Fig. 2); but they do not readily coalesce to form bigger drops.

With dielectric oil aged by being in use for a long time, the droplets do not join up at all and have the appearance shown in Fig. 3.

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[1] Mérigoux, I-R., *C.R. Acad. Sci., Paris*, 207, 47 (1938); 208, 1382 (1939); *Bull. Sté Fr. de Physique*, [illegible], 70 (1944).

Determination of the Absolute Concentration of Deuterium in Thames River Water

The deuterium content of natural waters has hitherto been determined either by accurate density measurements or by a mass spectrometer, absolute values being obtained by intercomparison with standard samples of known absolute deuterium concentration prepared from deuterium-free water. However, density measurements are complicated by variations in the concentrations of the more abundant oxygen-17 and oxygen-18 isotopes, and the preparation of deuterium-free water is a long procedure. These complications can be eliminated by the following simple method, using only a mass spectrometer.

A number of standard water samples are first prepared from mixtures of the natural water and pure heavy water, giving different known excess concentrations, ΔC, above the unknown absolute concentration, C_0, of deuterium in the natural water. The values of $\Delta C/C_0$ are then directly determined by the mass spectrometer, since

$$\frac{(\mathrm{HD/H_2})\mathrm{std.}}{(\mathrm{HD/H_2})\mathrm{nat.}} = 1 + (\Delta C/C_0),$$

where both C_0 and $\Delta C \ll 1$. Hence, by plotting $\Delta C/C_0$ against ΔC, a straight line passing through the origin should be obtained, the reciprocal of the slope giving the value of C_0.

This method was used for determining the absolute concentration of deuterium in Thames water, sampled in August 1953, no previous mass spectrometer determinations having been made for any British fresh waters. Three standard water samples were prepared by weighing, using heavy water containing 99·73 ± 0·01 per cent deuterium and only 0·02 per cent oxygen-18 in excess of its natural concentration of 0·20 per cent. Gas samples were prepared from these and from natural water by reduction[1] of 25-mgm. quantities over uranium metal turnings at 500° C. The molecular isotope abundance ratio, $\mathrm{HD/H_2}$, for each of the standard samples was compared with that of the natural sample using a mass spectrometer of high stability developed from a design of Nier's[2]. The results and mean deviations are shown in Table 1 and Fig. 1.

Table 1

$C_0 = 0·0152 \pm 0·0003$ per cent deuterium

Sample	1	2	3
ΔC (per cent)	0·005800	0·01160	0·01740
$(\Delta C/C_0)$	0·384 ± 0·004	0·761 ± 0·002	1·140 ± 0·006

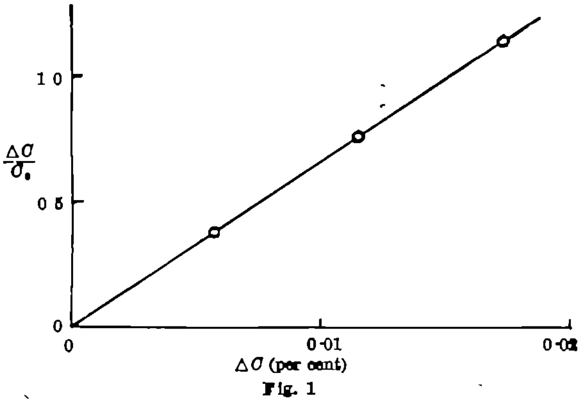

Fig. 1

The error quoted for C_0 includes the maximum possible systematic error which could have been introduced if the resistors used to measure the ion beams had not obeyed Ohm's law. Separate measurements showed that this error could not have exceeded ± 1 per cent of $\Delta C/C_0$. The normal procedure for correcting for the formation of tritium ions was used in which the effect, noted by Friedman[3], of a departure from the assumed linear relationship between the $\mathrm{HD/H_2}$ ratios and the $\mathrm{H_2}$ beam intensity at low values of the latter did not occur and was not therefore a source of error. The total measured memory effect between samples was − 1 per cent of $\Delta C/C_0$, for which the above results have been corrected.

Friedman's[3] recent survey of absolute deuterium concentrations, with a precision of ± 0·00002 per cent and absolute to within ± 0·0002 per cent, included values ranging from 0·0133–0·0154 per cent for a wide variety of American fresh waters, and 0·0153–0·0156 per cent for various ocean waters. Thus our absolute value for Thames water lies at the high end of the American freshwater range and near the less variable ocean values. This may be attributed to the fact that the bulk of the rainfall entering the Thames is only an initial condensed fraction of the water vapour carried inland by the prevailing Atlantic winds. The resulting deuterium enrichment on condensation then approximately cancels the original depletion (about 9 per cent at 10° C.) occurring on evaporation from the Atlantic, although there may be some further depletion before being carried inland. In contrast, for a large land mass like the United States, where a much higher proportion of the water vapour carried inland is ultimately condensed, freshwater concentrations extend well below the ocean values.

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Harwell, Berks. June 15.

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[3] Friedman, L., *Geochimica et Cosmochimica Acta*, 4, Nos. 1/2, 89 (1953).

A Deep Sounding from the Southern Hemisphere

It is well known that the great trenches of the Western Pacific represent larger vertical departures from the level surface of the geoid than even the Himalayas. But our knowledge of the shape of the ocean floor is still so fragmentary that the question as to which trench is the deepest has received several different answers within the past two decades. The Mindanao Trench east of the Philippines was long believed to contain the greatest oceanic depth; but for a few years prior to 1950 many authorities considered that the U.S.S. *Ramapo* soundings in the Japan Trench were the deepest yet recorded. In that year Hess and Buell[1] re-examined the data and concluded that the sounding of 5,740 ± 50 fathoms obtained in the Mindanao Trench by the U.S.S. *Cape Johnson* during the Second World War represented the greatest depth. H.M.S. *Challenger* in 1951 made still deeper soundings in the Marianas Trench east of Guam. These were reported by Carruthers and Lawford[2], and later Gaskell, Swallow and Ritchie[3] stated that the maximum depth lay between 5,882 and 5,940 fathoms.

In December–January 1952–53, during the Capricorn Expedition of the Scripps Institution of Oceanography, the research vessels *Horizon* and *Spencer F. Baird* made twenty-four echo-sounding lines across the Tonga Trench between lat. 14° 30′ S. and 26° 15′ S. *Horizon* found the area of greatest depth more than 5,500 fathoms near the abrupt change in trend of the trench axis 180 miles south of the island of Tonga Tabu. In this "Horizon Deep"[4], soundings were taken by recording the echoes from explosions in order to eliminate some of the sources of absolute error inherent in the echo-sounding apparatus. Positions were determined by dead reckoning between morning and evening star sights supplemented by meridian altitudes of the sun at noon.

As the ship proceeded at about 7·5 knots, half-pound demolition blocks with 14-in. fuses were dropped overboard at 3–10 min. intervals. The charges exploded 10–13 fathoms below the surface; the firing mark and echo-train were received on the echo-sounder hydrophone and were recorded by a pen oscillograph. Timing marks were placed on the record at 1-sec. intervals using a break-circuit chronograph. The longest time of travel for the first echo was measured at lat. 23° 15·5′ S. and long. 174° 36·5′ W.

Assuming that this echo came from directly beneath the ship, and using velocities of sound at different depths computed with the aid of Kuwahara's tables[5] from temperature and salinity measurements by *Spencer F. Baird*, 200 miles north of *Horizon's* position, the time of travel corresponds to a depth of 5,814 fathoms (10,633 m.). If this were accepted as the time value, it would be the deepest sounding yet recorded from the southern hemisphere; it would exceed the Galathea Depth in the Mindanao Trench[6] by 50 fathoms and would be second only to the soundings obtained by H.M.S. *Challenger* in the Marianas Trench.

An investigation of the uncertainties involved in the depth of explosion of the charges, in reading and correcting the records, in the timing circuit of the oscillograph, and in the computed velocities of sound, indicates that the combined error from these causes is less than ± 15 fathoms. The consistency of the travel times recorded from successive explosions shows that true sea-floor echoes were obtained. But careful comparisons of the first and subsequent echoes from each shot on the line of soundings show that the first echo at the above stated position came from the relatively gentle eastern slope of the trench, and that the actual depth directly under the ship was somewhat greater. Because of the V-shaped cross-section of the trench, a 'masked' zone extended for a distance of two miles west of the position. Here the first echoes to arrive came from the steeply sloping west wall rather than from the bottom beneath. Graphical analysis of the travel times of the second echoes indicates that the deepest point actually lies near the centre of this masked zone at about 5,900 fathoms but with a rather large uncertainty. Thus the Tonga Trench may be deeper than even the Marianas Trench; measurements with a narrow beam echo-sounder are needed to resolve the question. A detailed discussion will be published shortly by one of us in the *Journal of Deep Sea Research*.

It is remarkable that all three of the greatest measured ocean depths, though recorded from widely separated areas, lie within 200 fathoms of each other in the V-shaped portions of deep trenches. This close agreement may reflect both the nature of the trench-producing forces and the strength of the earth's crust.

ROBERT L. FISHER
ROGER REVELLE

Scripps Institution of Oceanography,
University of California.

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[1] Hess, H. H., and Buell, jun., M. W., *Trans. Amer. Geophys. Union* 31, 401 (1950).

[2] Carruthers, J. N., and Lawford, A. L., *Nature*, 169, 601 (1952).

[3] Gaskell, T. F., Swallow, J. C., and Ritchie, G. S., *Deep Sea Research*, 1, 60 (1953).

[4] This term is used in accordance with the rules of nomenclature stated by Wiseman, J. D. H., and Ovey, C. D., *Deep Sea Research*, 1, 11 (1953).

[5] Kuwahara, S., *Hydrographic Rev.*, 16, No. 2, 127 (1939).

[6] Wüst, G., *Die Erde, Z. Gesell. Erdkunde, Berlin*, 3/4, 203 (1950/51).

Bursting of Air Bubbles at the Surface of Sea Water

In recent communications, Woodcock *et al.*[1] and Knelman *et al.*[2] have described experiments in which they have studied the fragments produced by the bursting of bubbles at an air–water interface. Both groups of workers have obtained high-speed photographs of the later stages of bubble bursting which show a small jet of water being projected vertically into the air and breaking up to form a few drops. The main differences between the results of the two sets of experiments lie in the fact that whereas Knelman *et al.* used bubbles of a few millimetres diameter, Woodcock *et al.* used much smaller ones (0·2–0·02 cm. diameter) which produced much finer jets and correspondingly smaller drops. But, besides the drops produced by the jet, Knelman *et al.* also found some much smaller droplets which, they suggested, may have been produced by break-up of the bubble film. The American workers[1] report that the formation of such a group of smaller droplets was not associated with the bursting of their very small bubbles and suggest that this second mechanism occurs only in larger bubbles. It may be, of course, that the droplets produced by the disruption of very thin films are too small to be detected by normal methods, particularly as they will evaporate very quickly.

Some recent experiments I have carried out appear to throw some light on the problem. The bursting of bubbles of 0·3–4·3 mm. diameter at the surface of sea water has been studied. The mean diameter of the drops produced by a breaking jet was roughly 15 per cent of the diameter of the parent bubble. In addition to these large drops projected vertically into the air, a second group of droplets having diameters between 5 μ and 30 μ, and containing between 2×10^{-12} gm. and 5×10^{-10} gm. of salt were found several centimetres from the bursting bubble and very close to the water surface, which suggested that they were ejected at a low angle to the horizon. The numbers of these droplets were always small, a bubble of 2 mm. diameter producing, on average, only about one droplet in this size range. Similar results have been obtained by Knelman *et al.* and will soon be published.

To determine whether the disruption of the bubble film produces much larger numbers of particles too small to be detected by conventional methods, the bursting of bubbles has been studied in a cloud chamber. Clean filtered air is passed through identical jets into two chambers, one containing sea water and the other distilled water. After an equal number of bubbles has burst in each chamber an expansion is made; a dense cloud of tiny droplets is then observed in the space above the sea water but not above the distilled water. It appears that the bursting bubbles produce very small salt particles which can act afterwards as condensation nuclei during the expansion.

Bubbles of 3-mm. diameter produce 100–200 of these nuclei, the majority of which are estimated to have salt contents between 10^{-15} gm. and 2×10^{-14} gm., while smaller bubbles of only 0·5 mm. diameter burst much more violently and produce comparable numbers of nuclei. It seems entirely reasonable that these nuclei, representing the residues of droplets with diameters 0·4–1·0 μ, should be produced by the break-up of the bubble film into filaments in the manner suggested by Knelman *et al.*

The cloud chamber experiments suggest that if foam patches are largely composed of bubbles greater than 0·5 mm. diameter, disintegration of the bubble films will be a much more important mechanism for the production of salt nuclei than break-up of the jets, since the latter produce only small numbers of relatively large drops which will quickly fall back into the sea.

B. J. Mason

Department of Meteorology,
Imperial College of Science and Technology,
London, S.W.7. Aug. 1.

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[1] Woodcock, A. H., Kientzler, C. F., Arons, A. B., and Blanchard, D. C., *Nature*, 172, 1144 (1953).

[2] Knelman, F., Dombrowski, N., and Newitt, D. M., *Nature*, 173, 261 (1954).

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Linguistic Studies in Polynesia

In an article entitled "Comparative Philology and Polynesian Studies", published in *Nature* of October 10, 1953, Prof. Alan S. C. Ross points to the need of a scientific study of the Polynesian family of languages, and suggests a plan for such studies. Our purpose in commenting on Prof. Ross's article is two-fold: (1) to show that structural linguistics, the recent development of which Prof. Ross disparages, may be of help in Polynesian studies; and (2) to express a somewhat different picture of the present status of Polynesian and Malayo–Polynesian studies.

The development of structural linguistics in the past few decades may be considered a natural growth of a new science from preoccupation with purely technical collection of data, to an analysis of those data on a higher level of abstraction. Such a growth would seem to hold true of disciplines as diverse as astronomy, physics and grammar. Accurate amassing of detail no longer suffices. The desideratum is now analysis and synthesis of the data.

A good many languages have been studied by the new descriptive techniques, both of the 'exotic' variety and the well-known European ones. Each language, however, is approached with fresh eyes, with awareness of methods used elsewhere, but with realization that other descriptions cannot serve as exact models for the next language to be described.

Yet in his discussion of a method for Polynesian studies, Prof. Ross first suggests that Polynesian grammars be written on the model of ancient Indonesian, such as Old Javanese. He then rejects this idea, but without stating any reasons for his rejection. (A good reason is that only fragments of Old Javanese grammar are found in modern Hawaiian, for example). Then he proposes to eliminate grammars altogether, and "to relegate all that would be in them to the dictionaries". There seems to be a danger, however, that such a procedure would eliminate a unified approach and synthesis of the disparate phonetic and morphemic data into wholes.

Prof. Ross suggests that most structuralists are uninterested in comparative studies; yet Isidore Dyen of Yale University, who is probably the most productive Malayo–Polynesianist alive to-day, is both a descriptivist and a comparativist. At least two linguists (Robert A. Hall, jun., and George L. Trager) have insisted that the only acceptable comparative work is that which utilizes descriptive techniques at every stage, on both phonemic and morphological levels. Far from "despising" comparativism, most structuralists thus feel that with their techniques they can immeasurably advance comparative studies, or conversely, that comparative studies without revivification on each time-stage by structural analysis and synthesis are of doubtful validity.

As to the present status of Polynesian studies, we would point out that Polynesia itself is far more complex than Prof. Ross indicates. By our count there are at least twenty-three languages or dialects in Polynesia (not just five "principal" ones). For some of these there are fairly complete dictionaries; but for others the data are nearly non-existent, particularly for the 'outliers' in Melanesia, which are in particular need of study. Samuel H. Elbert has recently published a paper[1] that establishes a tentative system of sound shifts for twenty Polynesian languages or dialects, draws up a tentative family tree for sixteen of them, and suggests time dates for their separations from the central stock.

At the present time a joint research programme in the Oceanic field is being conducted by Yale University, the University of Hawaii, and the Bernice P. Bishop Museum. This programme, supported by a grant from the Carnegie Corporation, is directed toward understanding the processes of culture change that have been and still are operating in this island area, with particular reference to the Malayo–Polynesian-speaking peoples. Prof. Ross states in his article that "anthropologists rather naturally tend to regard linguistics as a subordinate subject". It is interesting to note that, although this programme is indeed anthropological, one of its initial, major efforts involves library and field research conducted by professional linguists with the aim of gaining a fuller knowledge of the historical relationships among the Malayo–Polynesian languages. Polynesian is an important concern in this effort.

Prof. Ross's suggestion of a New Zealand centre for the study of the comparative philology of Polynesian merits serious consideration. However, in view of the severe financial limitations under which universities supporting linguistic research are at present working, perhaps a more feasible approach is the furthering of co-operative endeavour among scholars and institutions everywhere with a current interest in the Pacific. There is much to be done in the Polynesian area, and all workers are welcome.

S. H. Elbert

University of Hawaii.

Alexander Spoehr

Bernice P. Bishop Museum,
Honolulu 17, Hawaii. May 5.

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[1] Elbert, S. H., *Southwestern J. Anthrop.*, 9, 147 (1953).

FORTHCOMING EVENTS

Sunday, September 5—Wednesday, September 8

British Association for the Advancement of Science (at Oxford).—Continuation of Annual Meeting.

Sunday, September 5

At 8 p.m.—Prof. C. A. Coulson, F.R.S.: "Science and Religion".

Monday, September 6

At 10 a.m.—Dr. C. J. Stubblefield, F.R.S.: "The Relationship of Palæontology to Stratigraphy" (Presidential Address, Section C).

At 10 a.m.—Prof. A. D. Macdonald: "The Relief of Pain" (Presidential Address, Section I).

At 8 p.m.—Dr. F. P. Bowden, F.R.S.: "Friction".

Monday, September 6—Thursday, September 9

Physical Society (at the Cavendish Laboratory, Cambridge). Conference on "The Physics of the Ionosphere".

Monday, September 6—Tuesday, September 14

Institute of Metals (in Switzerland).—Forty-sixth Annual Autumn Meeting.

Tuesday, September 7—Tuesday, September 14

British Mycological Society (centred on the University of Southampton).—Autumn Foray, 1954—New Forest, Hampshire.

Thursday, September 9—Monday, September 13

Textile Institute (at Ghent).—Conference on "Fibre Friction".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Physicist (with a good honours degree in physics, and at least two or three years research experience, and preferably some practical acquaintance with electronics), to work under the Professor of Laryngology and Otology in the field of psycho- and physio-acoustics—The Secretary, Institute of Laryngology and Otology, 330–332 Grays Inn Road, London, W.C.1 (September 10).

Scientific Officer (with a first- or second-class honours degree in physics or mathematics, and an interest in applying mathematics to practical problems), to carry out theoretical work in connexion with the design of nuclear reactors—The Establishments Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/108/189 (September 10).

Assistant Biochemist (with a degree or equivalent qualification in chemistry, and wishing to take up clinical biochemistry)—The Secretary, Welsh National School of Medicine, 34, Newport Road, Cardiff (September 11).

Lecturer (with teaching experience, and a special knowledge of the theory and operation of electrical machinery) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (September 11)

Lecturer (graduate in medicine) in Physiology—The Assistant Registrar, The Medical School, The University, Birmingham 15 (September 17).

Assistant Sylviculturist (with a degree in forestry, and preferably with practical experience in sylvicultural research and biometry) in the Wattle Research Institute of the University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

Lecturer or Assistant Lecturer in Histology and Embryology in the Department of Veterinary Anatomy—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (September 30).

Lecturer or Junior Lecturer in Sociology at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, September 30).

Lecturer (with a degree in electrical engineering, preferably with honours, and a knowledge of the theory of automatic control) in Electrical Engineering, at the New South Wales University of Technology, Sydney—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2 (October 15).

Chair of Mechanical Engineering in the New South Wales University of Technology, Sydney—The Agent-General for New South Wales, 56–57 Strand, London, W.C.2.

Chemist (with a first- or second-class honours degree in chemistry, and preferably with some experience of plant biochemistry), to work on nutritional disorders of glasshouse crops—The Secretary, Experimental and Research Station, Cheshunt, Herts.

Chemist (with an honours degree of a British university in chemistry, and/or Associate or Fellow of the R.I.C., and with three years postgraduate experience) in the Medical Department, Hong Kong, to assist the Government Chemist in analytical and consulting work concerned with public health; control of narcotic drugs; strategic materials; dangerous cargoes; commercial analytical work; toxicology, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD/117/51/108.

Microbiologist (with biochemical training) for research on the anaerobic fermentation of cellulose-rich materials; a Biochemist (with training in plant physiology and microbiology) for research on the biochemistry of nitrogen fixation in nodules on leguminous plants; and a Microbiologist (preferably with mycological training), for research on the effects of antiseptics on the soil microflora—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Mining Geologist (with a B.Sc. degree with honours in mining geology) in the Colonial Geological Survey Service, Sierra Leone, for duties which include search for new mineral deposits, mapping, petrology and mineralogy of known mineral deposits, geological mapping, and geophysical prospecting by resistivity and magnetometry—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD 105/15/02

Physical Chemist (with a good honours degree, and preferably with research experience) in the Colloid Chemistry Section—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

Physicist (Ph.D. or equivalent status, with experience in vacuum technique), for development and control of freeze-drying of biological subjects—The Director, Wellcome Research Laboratories, Langley Court, Beckenham, Kent.

Research Assistant (graduate in physics or electrical engineering, and interested in the technical problems of nuclear particle accelerations) in Physics—The Registrar, The University, Birmingham 15.

Research Physicists and Electronic Engineers (with first-class qualifications and experience), with the European Council for Nuclear Research, Geneva, to assist in the design and construction of high-energy accelerating machines for nuclear research—The Secretary, Ministry of Labour and National Service, Almack House, 26 King Street, London, S.W.1, quoting AS.12/CERN

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Forestry Commission. Thirty-Fourth Annual Report of the Forestry Commissioners for the year ended September 30th, 1953. Pp. 84. (London: H.M. Stationery Office, 1954.) 3s. net. [17

Association of Principals of Technical Institutions and Association of Technical Institutions. Report on the Development of Higher Technological Education. (Summer Meeting—Southport, 10th–12th June, 1954.) Pp. 7. (London: Association of Technical Institutions. (The Polytechnic, London, W.1), 1954.) [57

Calendar Reform and the Seven-Day Week: a Clarification. By Elisabeth Achelis, James Avery Joyce and Daniel Sher. Pp. 30. (London: World Calendar Association, 1954.) 1s. [57

Ordnance Survey. Professional Papers. New Series No. 19: The Geodimeter Measurement of the Ridge Way and Caithness Bases, 1953. By Major L. C. C. Mackenzie, R.E. Pp. iii+48 (14 plates). (London: H.M. Stationery Office, 1954.) 5s. net. [57

Institution of Gas Engineers. Publication No. 440: 91st Annual Report and Accounts. Pp. 42. Publication No. 441: Presidential Address. By John T. Haynes. (91st Annual General Meeting, Bournemouth, 31st May to 3rd June, 1954.) Pp. 9. Publication No. 442: The Organization of the Gas Industry in the South West. By C. H. Chester. Pp. 55. Publication No. 443: Civil Defence and the Gas Industry. By W. N. Marshall. Pp. 30. Publication No. 444: Natural Gas and the Italian Gas Industry. By Dott. Ing. A. Bohn. Pp. 15. Publication No. 445: Centralized Control of a Gas Grid. By F. G. Symon. Pp. 25. Publication No. 446: The Appreciation of Factors Affecting Cost in the Gas Industry. By Dr. J. M. S. Risk. Pp. 23. Publication No. 447: Human Relations in the Gas Industry. By Henry Lesser. Pp. 20. Publication No. 448: Official Programme. 91st Annual General Meeting, Bournemouth, 31st May to 3rd June, 1954. Pp. 15. (London: Institution of Gas Engineers, 1954.) [57

Other Countries

Comptes Rendus des travaux du Laboratoire Carlsberg. Série Physiologique. Vol. 25, No. 10: Some Studies on the Genus *Saccharomycodes* Hansen. By Aase Hjort. Pp. 259–284+3 plates. 2 kronor, 50 øre. Série Chimique. Vol. 29, No. 2: Studies on Pinocytosis in the Amoeba *Chaos Chaos*. Pp. 7–26+1 plate. 1 kronor, 75 øre. Vol. 29, Nos. 3–4: A Method for the Production of the Plakalbumin-Forming Proteinase from *Bacillus Subtilis*. By A. V. Guntelberg. Purification of the Proteolytic Enzyme from *Bacillus Subtilis*. By A. V. Guntelberg and M. Ottesen. Pp. 27–48. 1 kronor. 75 øre. Vol. 29, No. 5: Partition Chromatography of the A and B Chains of Insulin. By William Anderson. Pp. 49–56. 65 øre. (Copenhague: En Commission Chez H. Hagerup, 1954.) [57

Bulletin of the American Museum of Natural History. Vol. 104, Article 1: Bees of Panama. By Charles D. Michener. Pp. 1–176. 3 dollars. Vol. 104, Article 2: A Revision of the Genus *Tornos* Morrison (Lepidoptera, Geometridae). By Frederick H. Rindge. Pp. 177–236. 1 dollar. (New York: American Museum of Natural History, 1954.) [57

Scientific Research of Mellon Institute, 1953–54. (Annual Report Series, No. 41.) Pp. iv+56. (Pittsburgh: Mellon Institute of Industrial Research, 1954.) [57

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DEVELOPMENT OF ATOMIC ENERGY IN BRITAIN

THE transfer to the Atomic Energy Authority on August 1 of the ownership of Britain's atomic factories is something more than a formal change of name and responsibilities. The powers and functions of the new Authority differ from those of the Ministry of Supply under the Atomic Energy Act of 1946, and although the public authority set up under the Atomic Energy Authority Act, which received the Royal assent on June 4, takes over all the atomic plants of the country, a nationalized atomic energy industry was not thereby created. The money to operate the plants will be voted annually by Parliament—the revised estimate for the current year is £53·7 million, of which nearly £27 million is for new plant and buildings—and there is every intention of encouraging industry to play as large a part as possible in the development of atomic resources. Moreover, the far-reaching powers for the control of the production and use of atomic materials formerly possessed by the Ministry of Supply have been transferred to the Lord President of the Council and not to the new Authority, nor is it assumed that the latter should possess a *de facto* monopoly of new knowledge in this field.

The significance of the transfer is well put in a recent article in *The Economist* (July 31). The important clauses in the Act from this point of view are those which open the way to what it is hoped will become increasingly close co-operation with industry and permit any nuclear process—such as the generation of power for electricity or transport, the production of plutonium (with electric power as a probable by-product) or chemical processes based on nuclear reactions—to be undertaken legally by private industry, unless expressly forbidden by the Lord President of the Council. Still more is it to be seen in the light of the prospects to which Sir Francis Simon referred in a lecture early this year (see *Nature*, 173, 573; 1954) and on which Sir John Cockcroft touched in addressing the scientific committee of the French Chamber of Deputies in Paris on July 1. Mr. Geoffrey Lloyd's remarks in the House of Commons on July 9, in moving the second reading of the Gas and Electricity (Borrowing Powers) Bill, and the creation by the British Electricity Authority of the new post of nuclear power engineer, are also significant.

The Atomic Energy Authority is empowered by the Act to provide technical training and distribute information, to sub-contract research to university or industrial laboratories, and to make grants to assist the independent production or use of atomic energy, as well as to aid atomic research. Such industrial co-operation will obviously take time to develop, and this greater freedom for the exchange of knowledge and technique should enable the atomic scientists of the Authority, on one hand, to consider how atomic energy could be applied in different industrial fields, and to acquire specialized knowledge of engineering design and operating technique, while industry, on the other, will be enabled to acquire first-hand knowledge of the physical problems of making and handling fissile materials. Such contact and discussions may, in the first instance, be limited to the design of plant for specific problems, but should lead ultimately to the design and construction of nuclear equipment by industry itself. In particular, an impetus should be given to the fuller investigation of nuclear chemistry where, as Lord Cherwell emphasized in his Messel Memorial Lecture on July 14, our knowledge is at present so rudimentary.

The development of the most satisfactory way of establishing effective liaison with industry and of resolving the many practical problems, of which security is only one, will take time, however urgently and sympathetically it may be fostered by the Board of the Authority. Moreover, the field in which it is likely to be developed first, that of power production for the British Electricity Authority, is now visualized as much nearer than was generally anticipated a few years ago. Sir John Cockcroft said in Paris that, at present prices of raw materials and on present estimates of capital costs, the atomic power plants now being built in Britain would be able to supply electricity at about a penny a unit, compared with about three farthings a unit from the most modern coal- or oil-burning stations. These power stations, such as that at Calder Hill, Cumberland, which is expected to come into operation in 1956, are essentially experimental. By the time the scientists and engineers are ready to hand over the building or operating of such power plants to the British Electricity Authority, as contemplated under the Act, improvements in production methods or design, and particularly the efficiency with which uranium is used, should have reduced costs still further.

Sir John Cockcroft emphasized that this provisional cost of one penny a unit is only possible because the by-product, plutonium, is used. That is a reminder that the use of atomic power cannot be sharply divided between specifically military and specifically civilian use; but for Great Britain this nearer prospect of the industrial application of nuclear power is important in another connexion. The six-year plan for the development of fuel and power which, in effect, the Minister of Fuel and Power outlined in his speech on July 9 and, in part, was earlier described by the British Electricity Authority in a pamphlet, "Power and Prosperity", published last February, contemplates the design and construction of nuclear power stations of an advanced type by 1960, in preparation for which the British Electricity Authority was establishing a nuclear power branch of its engineering department. Sir John Cockcroft had outlined a programme in which the detailed planning and construction of two experimental nuclear power stations to supply electricity to the grid on a commercial basis would occupy eight years, until 1962. After trial operation for three years, the large-scale construction of nuclear stations to supply the major part of our power requirements would follow during 1965–70.

The important consideration, however, is not simply that Mr. Lloyd's proposals visualize an earlier contribution from nuclear power, but rather the extent to which his plan involves demands on our resources of coal and other materials as well as man-power. Besides its attention to nuclear power developments, the British Electricity Authority is pushing ahead with a programme for the expenditure of £750 millions on the construction of conventional power stations, some of which will experiment with oil in order to save coal. Nevertheless, in spite of improvements in efficiency which are estimated to save six million tons of coal a year, these plans envisage the consumption of an additional fourteen million tons of coal a year for the generation of electricity and a further two millions for the production of gas. The total investment of coal, gas and electricity between now and 1960 will amount to £2,250 millions.

In considering the economics of the distribution of the nation's resources in this way, there is a further factor which both Sir John Cockcroft's estimate and Mr. Lloyd's proposals neglect. The price of coal to-day does not represent its scarcity to the nation, and in assessing the national advantage of coal-saving investment, a higher price for coal should be assumed. Indeed, it has been computed that if nuclear power could be produced to-day, it would be cheaper to the nation by a factor of ten or twenty per cent than that produced from coal. Disregarding the economic value of the plutonium by-product, to which Sir John Cockcroft referred, and the security or defence implications, it seems probable that although the initial capital cost of a nuclear power station is very much higher than that of an equivalent conventional station, by the time such a station could be brought into operation, technical and economic developments would give nuclear power very considerable economic advantages.

In assessing the claims upon the nation's resources—for investment, materials or man-power—of nuclear power development and of the plans outlined by the Minister of Fuel and Power, there is a further consideration. Nuclear power developments must not be pressed too hard, because of the risk of expensive technical mistakes. Even on Mr. Lloyd's more optimistic estimate, however, it seems probable that economically the new power plants contemplated by the British Electricity Authority may be obsolescent almost as soon as they are built. The decision as to the apportionment of capital resources cannot be easy; but some more comprehensive statement of the Government's plans seems desirable.

Hitherto, the recommendations of the Ridley Committee have been virtually ignored; but in the position now disclosed, it seems essential that between now and 1960 a main objective of policy should be to reduce the consumption of coal to the minimum possible. Alternatives such as water-power and natural gas should be exploited as far as possible where available; but Sir Cyril Hinshelwood's words in the annual report of the Fuel Research Board for 1953 go to the root of the matter: "On the basis of existing knowledge, and with no undue capital expenditure, the same amount of useful heat and power as is now obtained could be achieved with a saving over the country as a whole of several million tons of coal a year. Better still, for the same total fuel consumption there could be greater industrial productivity and improved conditions of comfort. With further intensification of fundamental and applied research, ways and means could be found for obtaining even greater fuel and power efficiency at an economic cost justified by the potential savings". No plan for the development of fuel and power which ignores this aspect can be regarded as realistic, and support for the programme outlined by the Minister for Fuel and Power must wait on evidence that it represents the minimum demands which can reasonably be made on Britain's resources of coal, manpower, capital and other raw materials.

GOVERNMENT AND SCIENCE

Government and Science

Their Dynamic Relation in American Democracy. By Don K. Price. (James Stokes Lectureship on Politics. New York University–Stokes Foundation.) Pp. ix+203. (New York: New York University Press, 1954.) 3·75 dollars.

In the first four chapters of this book Mr. Price traces the development of science in the United States and the way in which the form taken by its organization was shaped, inevitably, by the pattern of American institutions and democratic ideas. In them he epitomizes also much to be found in those earlier reports, "Research, a National Resource", in Dr. Vannevar Bush's "Science, the Endless Frontier", and the Steelman Report, "Science and Public Policy", and he gives the gist of the debate which ultimately issued in the establishment of the National Science Foundation. His shrewd comments and penetrating analysis of the real issues contribute to a clear understanding of the difficulties which the latter Foundation has hitherto encountered. They will also help those outside the United States to appreciate more fully what lies behind the security problem in that country, and the way in which it has affected scientists. Although Mr. Price writes with his eyes on the American scene and reader and his comments on the British practice and organization are sometimes uncertain and not always entirely accurate, these chapters will be read with interest by all who to-day are concerned with the problem of securing the adequate endowment of scientific research without external control, or with the other main problem of the relations between Government and science, namely, that of determining how best the findings of science can be integrated into public policy where required.

It is, however, the chapters on the "Machinery of Advice" and the "Structure of Policy" that give the book its widest appeal. As an exposition of the issues involved in the place and use of the expert in government, be that expert administrator or scientist, they can scarcely be bettered. Mr. Price goes right to the heart of the problem, and the principles he lays bare are as valid and relevant in Great Britain and elsewhere as in the United States. What he has to say on the vulnerability of science to political attack, or on the consequences that follow when scientists best able to exercise discriminating judgment on matters of secrecy and security are by temperament and tradition so impatient that they leave this too much to people who know too little abo applies on both sides of the Atlantic. The c between scientific freedom on one hand and security considerations on the other, as he points out, may really be due not to a fundamental conflict, but simply to political irresponsibility or sheer incompetence. Mr. Price reveals the complexities of the situation and the dangers which promptly follow failure to recognize where the boundaries of knowledge end and the realm of responsible judgment begins. Nor does he suggest that we are likely to find an easy solution. The lines of advance that he indicates can be as usefully pursued in the context of conditions in Great Britain as in the United States. Though the particular solution found will vary, certainly in detail, and quite possibly considerably in structure, it will doubtless be found that in both countries success will depend more and more on our administrators and perhaps some of our political leaders beginning their careers as scientists, or at least with some training in science.

The book can be whole-heartedly commended to all who are concerned with the problems which the advancement of science involves for society, and the way in which public policy could be based on knowledge as far as is possible. Even for its last chapter alone it is worth reading, and the pity is that so outstanding a book should have been produced without either index or bibliography. R. Brightman

THE CAMBRIDGE PLATONISTS

The Platonic Renaissance in England

By Prof. Ernst Cassirer. Translated by James P. Pettegrove. Pp. vii+207. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1953.) 15s. net.

The British genius for understatement is well illustrated in this very able translation of the late Prof. Ernst Cassirer's book, originally published in German in 1932. For not only has it been left to a distinguished Continental scholar (an expert in Neo-Kantianism) to portray the Cambridge Platonists as they should be portrayed, but even among professionals in Britain they have been put on one side. There are reasons for this neglect, which will appear in the sequel; meanwhile, a little more enterprise over—say—the past two centuries would have given weight to these scholars' limitations, while extracting the essence of their thought. Nevertheless, in the pages before us, there is now a good 'yield'. But the remarkable thing is how relevant to our present intellectual position these essays are: they could scarcely be more appropriate if they had been contributed *ad hoc* instead of as a commentary upon a group of seventeenth-century thinkers, themselves not always lucid in analysis, and deplorably prolix in expression. Yet, they had a 'message' for mankind.

To see what this was, it is necessary to appreciate the philosophical climate in which these Cambridge men, Henry More, Ralph Cudworth, Benjamin Whichcote and John Smith, laboured. It was the age of empiricism and of Puritanism. At first sight, these somewhat chilling winds would appear to blow in opposite directions (and so perhaps to cancel out); but on closer reflexion they are seen largely to reinforce one another, and thus to produce a mighty blast against which these Platonists struggled man-fully, ill-equipped as they were in some respects for so stiff an encounter.

Stripped of all its frills, Francis Bacon, Thomas Hobbes and John Calvin had evolved between them a theory of knowledge which said in effect, "Power is what matters; power over Nature and power over men". Acts of cognition not directed specifically to these ends were classified as futile, if not worse. Investigation, on this view, was not justified if it produced mere understanding; its proper purpose was almost judicial, to force a witness to depose, and to use the information to gain the mastery. In brief, empiricism and pre-destination were birds of a feather. Against all this, with such imperfect weapons as they possessed, the men of Cambridge waged unending warfare. They wished to contemplate rather than to impose, to enjoy the secrets of Nature rather than to debase them by making them but tools in the service of a particular type of political philosophy. In effect, they were gentle, antiquarian and basically opposed to the prevailing spirit of progress. When one recollects the characteristic self-confidence of the age, there emerges a deep respect for these lonely savants, paddling about in a little backwater, but at the same time keeping afloat a liberty, a magnanimity and a humility, all in danger of becoming submerged in a lust for power.

But they did more than that. As later generations have discovered, there is no sure sense of the beautiful without contemplation. From seventeenth-century Cambridge, therefore, emerged the bare bones of æsthetics as we now know it, though it was not to be called by such a name until the following century had run half its course; and in between, the Society of Antiquaries was founded, to study the past, rather than to obliterate all traces of it.

Thus, much of what Prof. Cassirer has to say redounds to the credit of that post-Reformation foundation, Emmanuel College, Cambridge, to which the majority of these writers belonged. (Incidentally, there is a sizeable corpus of Cudworth's scripts still not printed.) Brought up, for the most part, in surroundings of ecclesiastical rigour, they cast off many of its more unlovely fetters, and managed to combine the Puritan ideal of service with a fair zest for life. Above all, they knew what they wanted, and, as Prof. Cassirer points out, never was the adjective 'latitudinarian' more inappropriate than when applied to Cambridge Platonism.

We now come to a peculiar feature of the movement, and of the niche which it must always occupy in the history of thought. This is the way in which it regarded the natural sciences. Strange to say, Henry More in particular was very keen on experimental philosophy as it was in his day. His distrust of the empiric did not inhibit this activity in the least. But unfortunately his critical faculty deserted him. He would assemble fact after fact, with no attempt to discover any unifying principle. Added to which, a somewhat facile regard for miracles and the like brought confusion and negation just when clarity was most needed. Ill-equipped in mathematics, and deficient in epistemological judgment, the Cambridge School presented to a hostile world the paradox of a nexus of men zealous for the enthronement of reason in matters of religion, while abandoning it entirely in the sphere of science.

On more than one occasion, pioneers have been known to work in a vacuum, with the result that no contact with the outside world could occur until, by chance, an interpreter appeared, ready and willing to be their spokesman, and so to save them from public oblivion; and so it turned out to be for the Cambridge Platonists, when their labours attracted the attention of the third Earl of Shaftesbury (1671–1713). He identified himself with their doctrines and introduced them to a far wider circle than they would otherwise ever have reached. At the same time, he made secure their system of ethics, and of æsthetics, by supporting the essential liberty of mankind both against 'sanctions' and spurious rewards. It must have needed some courage to achieve this, for one who had been a pupil of John Locke, and was afterwards his patron.

Prof. Cassirer has done the cause of the Cambridge Platonists a distinct service by writing his book in the first instance. By producing this translation, however, Dr. J. P. Pettegrove and the publishers have performed a valuable auxiliary task, which should enable students of English-speaking countries to judge for themselves how deeply our present-day outlook has been influenced by the unfashionable efforts of these seventeenth-century scholars.

F. I. G. RAWLINS

THE NUCLEIC ACIDS

The Biochemistry of the Nucleic Acids

By Prof. J. N. Davidson. Second edition, revised. (Methuen's Monographs on Biochemical Subjects.) Pp. viii+200+4 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1954.) 10*s*. 6*d*. net.

ALTHOUGH the nucleic acids have been investigated for more than eighty years, it is only comparatively recently that their true biological importance has been appreciated. Early work in the old tradition of organic chemistry appeared to have established that the nucleic acids were simple in structure and probably only two in number, and, as a consequence of this, there was little incentive to study the nucleic acids from the point of view of their possible biological specificity. This is the state of relative stagnation which is reflected in the classical monograph of Levene and Bass, published in 1931. For years following this, work on the nucleic acids was largely confined to observation of the quantities present in various tissues, both from a macroscopic and a microscopic point of view.

In 1944, however, the phenomenon of pneumococcal transformation was discovered by Avery, McLeod and McCarty to be due to a deoxyribonucleic acid, an observation suggesting that, in fact, the nucleic acids did have biological specificity of a high order. A structural basis for this followed a few years later, when chromatographic analysis revealed that the nucleic acids are not only very complex in structure, but are also very numerous and varied in composition according to their source. Since that time many instances of nucleic acids possessing biological specificity have been discovered, and this has revolutionized the whole approach to the subject.

Progress in the field is at the moment extremely rapid, and it is inevitable that any book covering the subject will be out of date in some respects. The second edition of Prof. J. N. Davidson's monograph, however, covers most of the recent developments, much of the text having been rewritten, and a number of errors and omissions in the first edition have been rectified. It is remarkable how many of the references are to papers published since the first edition of this book, and the author is to be congratulated on the wide field which he has covered. There are, perhaps, places where the old has not given due place to the new. For example, although the recent structures, based upon the X-ray work done in King's College, London, are mentioned, considerable space is devoted to a minute examination of work which these investigations have made obsolete. Again, Fig. 6.3 may convey little to those unfamiliar with the theory underlying microspectrophotometry, while to students of instrumentation it will appear delightfully old-fashioned.

A minor criticism is that the space devoted to the work being done on the nucleic acids of micro-organisms is rather restricted, because it is in this field that the most exciting recent developments have appeared. The work of Hershey and his colleagues is of such fundamental importance that it deserves to be dealt with at length, while the related and most exciting subject of bacterial transduction is not mentioned. In fairness it should be stated that this is one of the few omissions in an excellent and inexpensive text-book, and it will, no doubt, be remedied in the next edition, for there will certainly be a next edition.

The references are now grouped at the end of each chapter, an alteration which is a great improvement on the arrangement in the first edition, because this book, while covering the subject adequately for the general reader, will also be found to be an excellent guide to further reading. ROY MARKHAM

SUPERCONDUCTIVITY

Superconductivity

By Dr. D. Shoenberg. Second edition. Pp. x+256. (Cambridge Monographs on Physics.) (Cambridge: At the University Press, 1952.) 30*s*. net.

MORE than forty years have now elapsed since Kamerlingh Onnes discovered superconductivity; but in spite of the large volume of experimental material which has since come to hand, the phenomenon remains as enigmatic as ever. Indeed, all recent attempts at theoretical explanation have served to emphasize the difficulties which stand in the way of a satisfactory explanation. Of late, and particularly since the War, the number of cryogenic laboratories has greatly increased and a new generation of low-temperature physicists has grown up. To them much of the experimental work on superconductivity is historical fact rather than personal experience. The new edition of Dr. Shoenberg's book is therefore a most welcome aid for all working in the field and in particular for those students who wish to specialize in low-temperature research.

The first edition of the book, published in 1938, had become the standard work of reference on the subject of superconductivity; but the rapid growth of the subject has necessitated re-writing rather than a revision. This is best shown by the increase to more than twice the volume of the first edition. The lay-out of the book, too, has been somewhat changed to allow a better grouping of the subject-matter.

The introduction, which briefly lists the essential facts of superconductivity, is followed by a chapter on the magnetic properties of macroscopic superconductors. These and the subsequent chapter on the thermal properties roughly follow the lines of the first edition with the inclusion, however, of many new results and with some more detailed treatment of the old material. The new survey of the work on heat conductivity and thermo-electric effects will be especially noted. The separate chapter on alloys at the end of the first edition has now been incorporated in the general discussion of macroscopic magnetic effects, with a short mention of their thermal properties under the respective headings.

The next two chapters on the intermediate state and on the penetration of a magnetic field into the surface of a superconductor are quite new. These researches had only just been started at the time of the first edition, and it is here where most of the experimental progress has been made. A good deal of this progress is due to Dr. Shoenberg's own work. Writing with this unique qualification, he has produced a well-balanced and extremely clear account of a difficult and somewhat involved subject. Also new is the final chapter, on the theoretical aspects. The main emphasis is placed on the phenomenological theories of F. and H. London and on the two-fluid model of Gorter and Casimir, while the 'fundamental' theories of Heisenberg and of Fröhlich and Bardeen are briefly discussed in the closing paragraph. Considering the rudimentary state of these latter attempts and the success of the phenomenological models, this choice of emphasis must appear, at the present state of affairs at least, fully justified. Where one may perhaps not follow the author quite so whole-heartedly is in his optimism regarding a speedy solution of the fundamental problems and in his enthusiasm for the latest refinements of the phenomenological treatment. However, this should be regarded as a difference in temperament rather than as a serious criticism of the book.

It is rare for a reviewer to find so little fault with a book and to be able to recommend it so fully as in the present case. Whether one wishes a student to familiarize himself with the subject, or whether one wants to refer to a particular point in the discussion of research, Dr. Shoenberg's book will prove equally useful. Whether one looks at the text, or the data in the appendix, or the references to original work, the same care and competence is everywhere apparent. It will be indispensable to anyone dealing with the subject of superconductivity.

K. MENDELSSOHN

PHYSIOLOGY OR META-PHYSIOLOGY?

Chemical Physiology of Contraction in Body and Heart Muscle

By A. Szent-Györgyi. Pp. xx+135+3 plates. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 4.80 dollars.

PROF. A. SZENT-GYÖRGYI, in the foreword to his latest book on muscle, says that he will "try to tie the facts together" and "talk in a language understandable to the average biologist, stressing outlines more than details". The average biologist, however, will need to be extremely alert to distinguish "facts" from "outlines" and vice versa; for the author is prolific in speculations which are built very skilfully, one upon the other. This discursive way of writing has the virtue of stimulating the reader acquainted with the fundamental data; but it is liable to lead others less knowledgeable into a veritable no-man's-land of hypotheses which William of Occam says should not be multiplied beyond necessity.

The book is divided into three parts. Part 1 opens with a discussion of the structure of myosin in terms of the sub-units, L- and H-meromyosin, obtained by short digestion of myosin with trypsin. The heavier of the two (H) possesses the adenosine triphosphatase activity and actin-combining ability of the parent molecule, where the lighter (L) is held to be responsible for the contractile properties of the actin–myosin system. On the basis of these findings, it is deduced that the intact myosin molecule is made up of two terminal H-units linked covalently to four L's in series; but, although the arithmetic by which this conclusion is reached is sound in itself, it cannot be considered proved in the absence of accurate data on the degree of hydration and the relative proportions of the two components. Nevertheless, this structure is used as the cornerstone in erecting the far more elaborate edifice of the protofibril. Again, the arithmetic is without blemish.

The structure of the protofibril established, the author proceeds to dilate on its contractile properties in terms of 'autones', hypothetical subunits of actomyosin which react with one molecule of adenosine triphosphate only. Relaxation is treated first, in terms of the recent finding that muscle-fibre models will relax in the presence of adenosine triphosphate, creatine phosphate, magnesium ions and an enzyme capable of transferring phosphate from creatine phosphate to adenosine diphosphate. In this system relaxation occurs only if the *p*H is below 6·5; above this *p*H the fibres contract, and this also occurs on addition of calcium ions. Without more ado it is assumed that this system operates *in vivo*, although the necessary changes in *p*H in the buffered system of intact muscle would require an amount of acid or base very much larger than that suggested by the author. Moreover, an alternative has already been proposed by Marsh, who discovered a factor which induced relaxation in the presence of adenosine triphosphate only, without the intervention of a large change of *p*H or of creatine phosphate. The properties of this factor have lately been confirmed by Weber and by the present reviewer.

It is implicit in Szent-Gyorgyi's scheme of relaxation that adenosine triphosphate should be split to adenosine diphosphate during contraction, since otherwise creatine phosphate would be without effect. However, in a later chapter, splitting is considered to occur only in the phase of relaxation, whereas the energy for contraction is imparted as free energy by the adenosine triphosphate molecule without change in its structure. The meaning of this concept is not clear and, moreover, appears to conflict with Weber's findings that splitting and contraction go hand in hand, whereas relaxation occurs only when splitting is inhibited—for example, by salyrgan or by the Marsh factor. Again, it is evidently considered that this transfer of free energy is an endothermic process, whereas Hill has shown conclusively that contraction is entirely exothermic, as would also be expected from Weber's findings.

Part 2, a study of heart muscle, mainly describes the 'staircase' effect and the action of various substances upon it. Many of the findings are well known. As intact heart muscle is used, the added substances must exert their effect primarily on the cell membrane and not directly on the contractile proteins, as is the case with glycerinated psoas-muscle fibres. For this reason, it does not seem possible or profitable to compare the two systems directly.

Part 3 is entitled "Interpretations" and includes some new speculations on the nature of the conduction of the nervous impulse. It is noteworthy that the 'continuum theory' of muscle, which was a prominent feature of the author's earlier books, has been omitted entirely here.

The book contains several typographical errors, of which the most glaring is the use of the words 'isometric shortening' when 'isotonic' is clearly intended (pp. 55–56). In conclusion, the student and the 'average biologist' should again be warned that, although the book is fascinating and forthright in its statements, it 'ties together' only a limited number of facts and fails to take into account much important work by other schools; as the author himself says, it is certainly not a comprehensive and exhaustive review.

J. R. BENDALL

AN ITALIAN TEXT-BOOK OF ZOOLOGY

Trattato di Zoologia

Da Umberto D'Ancona. Pp. xxiv+1102+1191 Figs. (Torino: Unione Typografico-Editrice Torinese, 1953.) 10,500 lire.

THIS text-book is intended to meet the requirements of a two-year university course in zoology for students in natural science. It is divided into two quite separate parts. The first part (pp. 1–438), subdivided into five sections, is a general introduction to animal function in its widest sense. It starts with a short definition of the science and its main branches and then gives an epitome of its history from classical to modern times. The second section treats of living matter and vital functions, and while, in a way, this is based on cytology, it must be understood that it includes the physical, chemical and physiological activities of protoplasm. The third section deals with the functional organization of the animal body, and here again, while histology and early embryology play an essential part, the functional and comparative aspects are stressed. Thus, under light perception, we find discussed the eyes of Turbellaria, a gastropod, *Nautilus* and a "higher cephalopod", an insect and a teleost. Section 4 is concerned with genetics and evolution, the various aspects of which are dealt with adequately for the non-specialist. The last section discusses the relationships of animals to the world and to one another, ecology, zoogeography, applied zoology, migration and human industries based on animals, etc.

The second part (pp. 441–1019) is a survey of the classification of the animal kingdom in a formal, group-by-group manner. Then follow a full bibliography, author index and subject index (pp. 1049–1102). Possibly the first thing that would strike a reader in Great Britain familiar with the traditional text-book is the almost entire absence of comparative anatomy. Under mammals, for example, there is the diagram of the alimentary canal of a herbivore (with no buccal cavity), a diagram of the heart of a mammal, and again another of the male reproductive organs. Nowhere does the student get an overall picture of any one of the higher animals, and the diagrams just mentioned are not based on any particular animal but are purely schematic. There are some curious omissions; for example, while *Latimeria* is illustrated, there is no reference to the work of Stensio and his school, so essential to an understanding of the early fishes, and there is no mention of the pre- and exo-erythrocytic stages of the malarial parasite necessary to the comprehension of the disease.

It is possible to find slips and errors; but for one author to have accomplished so exacting a task is a matter for congratulation, and any reader will be struck by the large amount of information it contains. The illustrations are all good, but some deserve special notice; these are a number of original figures of fishes and a number of very pleasing sketches of living marine animals made in the Naples aquarium.

TEXT-BOOK OF BIOCHEMISTRY

Textbook of Biochemistry

By Prof. Edward Staunton West and Prof. Wilbert R. Todd. Pp. x+1,345. (New York: The Macmillan Company, 1951.) 90*s.* net.

THIS text-book will be welcomed by many teachers who have sought a comprehensive modern treatise suited to the needs of students taking an advanced course in biochemistry. Its most outstanding feature is the amount of detailed experimental evidence which the authors give throughout the book. This is particularly well done in the chapters on intermediary metabolism, which provide a very adequate and balanced account of this intricate subject. It is apparent that the authors have made every effort to bring this section up to date, even to the extent of inserting several pages on coenzyme A after the rest of the book had been printed. In a few of the earlier chapters, the information is obviously of less recent origin; but this will no doubt be put right in a second edition. Most of the detailed information given in the book is fully documented by numerous references to original papers and, wherever possible, the existence of recent reviews is also indicated. In addition, the introductory chapter of the book encourages the student to do his own exploration of biochemical literature by providing an excellent guide to the main journals, reviews and books (dates of publication and editions are omitted from the books) in which articles of biochemical interest are to be found.

In dealing with text-books of this scope, there are bound to be differences of opinion about what should be included. The inclusion of a good deal of physical chemistry at the beginning is fully justified, but it seems a pity that such a comprehensive book should not devote at least one chapter exclusively to plant biochemistry (there is a section on photosynthesis under carbohydrate metabolism), and another to the biochemistry of bacteria and fungi. No doubt limitations of space and the anthropocentric interests of medical readers dictate these omissions, but the type of reader to whom this text-book will prove most useful needs as broad an outlook as possible. There are also fewer figures and drawings than one might expect in a book of this size; this is particularly noticeable in the case of those illustrations which have been found perennially useful in the teaching of students, such as diagrams of the apparatus used in determinations of energy metabolism. A curious feature of the section of protein chemistry is the omission of any reference to paper partition chromatography, although six pages are devoted to other methods of separating amino-acids.

In general, however, this book represents a remarkable assimilation of biochemical knowledge on the part of the two authors, and they are to be congratulated on producing an advanced text-book of such quality without resorting to the technique of multiple authorship with its attendant loss of continuity.

H. N. MUNRO

A. W. CONWAY: SELECTED PAPERS

Selected Papers of Arthur William Conway

Edited by Prof. James McConnell. Pp. viii+222. (Dublin: Dublin Institute for Advanced Studies, 1953.) 21*s.* net.

IRELAND has been the birthplace of several great mathematical physicists—above all, Sir William Rowan Hamilton. For a long time they were mostly at Trinity College, Dublin; but towards the end of the nineteenth century the torch passed to University College, Dublin, the staff of which included A. W. Conway and J. A. McClelland. This selection of the most important of Conway's papers has been edited by Prof. J. McConnell and published by the Dublin Institute for Advanced Studies, which was founded on the advice of Conway by his former pupil, Mr. de Valera. It is preceded by the twelve-page obituary notice written for the Royal Society by Sir Edmund Whittaker, which contains a detailed analysis of Conway's researches.

The first paper reproduced and several later ones concern the classical electromagnetic equations and the point electron, which is regarded as a moving singularity of the differential equations. The use of contour integration to calculate the field is particularly striking. This work on moving electrons led on naturally to the study of the origin of spectra. Conway's paper of 1907 was the first to break away from the old idea that the spectra corresponded to the natural periods of oscillation of the atom, though it fell short of the much greater advance made by Bohr six years later. In 1913 Conway returned to the problem. He had not yet accepted the point of view of Bohr's paper, published a few months earlier, and tried to utilize J. J. Thomson's suggested model of the atom. However, in later years Conway finally accepted the Rutherford model of the atom, as used by Bohr, and published papers on these lines dealing with non-central forces and with some discrepancies between experiment and theory in the helium spectrum. He also treated the helium problem by Schrödinger's wave mechanics.

The heavy task of editing (in collaboration with Profs. J. L. Synge and A. J. McConnell) Hamilton's collected papers on optics and dynamics, many from previously unpublished manuscripts, led Conway to extend some of Hamilton's work. He showed that the Hamiltonian principal function can be obtained immediately from a complete integral of Hamilton's partial differential equation. The last four papers in this selection apply Hamilton's quaternions, for which Conway had long cherished a great admiration, to relativity and quantum mechanics. In particular, he used quaternions to replace matrices in the study of Dirac's relativistic wave equation. Thus his last paper, in 1948, may be considered as the natural development of his first work, the essay on quaternions written for a junior fellowship in 1900.

H. T. H. PIAGGIO

Thermionic Valves

Their Theory and Design. By A. H. W. Beck. Pp. xviii+570. (Cambridge: At the University Press, 1953.) 60*s*. net.

One of the dangers besetting the competent mind has been well put in the "Hippolytus" of Seneca: "He who is able to do too much wants to be able to do more . . .". This is the impression gained on reading this book. The author presents the theoretical basis of valve studies by dividing the subject-matter into three parts: (1) thermionic emission; (2) electrons in fields of charged conductors; and (3) valve properties, with a bias towards microwave tubes, including travelling-wave tubes and magnetrons.

There is admirable logic in this arrangement. Unfortunately, the author has not reached the high stage he has set himself, mainly through failure in adequate presentation at a uniform level. For example, in Part 1 the treatment of the Fröhlich–Wooldridge theory is not easy to follow; in Part 2, the chapters on 'electron optics' should be directed mainly to showing its relevance in valve design. In Part 3 the author shines best in dealing with the principles and theory of velocity modulation, bunching effects of space charge, klystrons, frequency pulling and noise; there is a good critical discussion on the usefulness of the Llewellyn theory, and also on the Brillouin steady-state conditions in magnetrons. Other topics dealt with include space-charge oscillations and the radio-frequency field in the interaction space; however, in many cases the diagrams require much fuller explanation. The final chapter on "Storage Tubes" seems out of place and could well have been omitted.

On the whole, readers will gain most from discussions on practical applications and limitations, in various parts of the text. These are generally good. One cannot help feeling that a more appropriate title would be "Source Book on Thermionic Devices", for the text requires to be supplemented by considerable outside reading for full advantage. The bibliography given is ample and helpful for this purpose. L. Jacob

Bakterien unter Hemmstoffwirkung

Elektronenmikroskopischer Bildatlas. Von Dozent Dr. G. Bringmann. Pp. 16+Tafel 1–101. (Berlin-Wilmersdorf: Transmare-Photo, G.m.b.H., 1954.) n.p.

This electron-microscopic study of the action of inhibitors on bacteria is presented as a collection of a hundred and one unbound electron micrographs with a fifteen-page descriptive booklet. The booklet briefly outlines factors to be considered in interpreting alterations of cellular appearance, techniques used in this study and the changes that cytological structures of bacteria undergo when acted upon by various antibiotics, chemical disinfectants and chemotherapeutic agents.

A large proportion of electron micrographs is devoted to the effects of penicillin on *Bacterium proteus* (*Proteus vulgaris*); some interesting micrographs of long filamentous cells and L-forms arising in the penicillin-containing cultures are included in this part. Unfortunately, most of the electron micrographs of bacteria treated with the various agents have been taken at the stages culminating in extensive autolysis and degeneration of the cells. Thus little can be seen of the more immediate effects of the drugs, etc., on the cellular organization. It is a pity, too, that there are no shadowed preparations, as these would have shown more clearly any changes in the surface structures.

However, this collection does show the gross cytological alterations that many organisms undergo on exposure to antibacterial substances, and as such it has some value for illustration purposes. The collection would have little appeal to the experienced research worker in this field. M. R. J. Salton

Nature, Mind and Modern Science

By Prof. Errol E. Harris. (The Muirhead Library of Philosophy.) Pp. xvi+456. (London: George Allen and Unwin, Ltd.; New York: The Macmillan Company, 1954.) 35*s*. net.

In this well-written and attractive book, Prof. Errol E. Harris asks his readers to reconsider the almost nihilistic position assumed by many present-day philosophers. He rejects firmly but courteously the positivism of Wittgenstein and of Carnap, and—for different reasons—the historical views of Collingwood. There are, for the author, certain basic philosophical problems which man can, in a finite sense, solve. The particular one most in question is the relation of mind to nature, and the inquirer is well conducted through the development of Greek thought and Renaissance *Methodik* to the general outlook demanded by contemporary physics.

What perhaps is the most intriguing remark in the whole volume occurs on p. 14, where suspended judgment in the face of uncertainty is postulated. This is indeed nothing but a very practical—and welcome—application of Husserl's 'reduction' or 'bracketing'. In almost the next sentence comes the confirmation that this supplies the place of the universal doubt of Descartes. There could be no clearer example than this of the *epoché* of phenomenology going into action.

Whether one agrees with Prof. Harris's main contention—namely, the existence of perennial philosophical problems—or not, this is assuredly a book to be recommended. F. I. G. Rawlins

The Observer's Book of British Birds' Eggs

Compiled by G. Evans. (The Observer's Pocket Series.) Pp. 217. (London: Frederick Warne and Co., Ltd., 1954.) 5*s*. net.

Another book has been added to the famous little Observer's Series. The eggs of 180 species are described with the utmost accuracy. Mr. H. D. Swain's 154 coloured illustrations are excellent and will be a considerable help in field identification. Each egg is drawn to its natural size and accompanied by a very useful text on the nest, nesting period and notes on the bird concerned. A foreword has been written by Philip Brown, secretary of the Royal Society for the Protection of Birds. He explains that a book about birds' nests and eggs might be dangerous, for it might encourage people to interfere with nests and generally do more harm than good. But he goes on to say that everyone interested in birds likes to find a nest and that a book of this kind should help them, so that the good it will do will undoubtedly outweigh the harm.

The eggs are classified in the Witherby order and not in the Wetmore order, which is now internationally accepted.

This book should be in every naturalist's pocket when on his field excursions. Bruce Coleman

THE HISTORY OF SCIENCE IN MODERN EDUCATION*

By Dr H. HAMSHAW THOMAS, M.B.E., F.R.S.

FORTY years ago, or more, students of the natural sciences formed a comparatively small part of the student population of universities of Britain; to-day a very different picture is presented. Men and women studying science, medicine, engineering, technology and agriculture are in the majority; students of the arts faculties form only about 43 per cent of the total number of undergraduates. This means that a very large number of people with the best potential intellectual capacity devote themselves each year to scientific or technological studies. Many of them should become leaders in thought and culture; they should play a leading part in society and in politics, and they will have to help in guiding Britain in the difficult times ahead.

A few years ago the University Grants Committee said in one of its reports, "A University would, in our view, fail of its essential purpose if it did not, by some means or other, contrive to combine its vocational functions with the provision of a broad humanistic culture and a suitably tough intellectual discipline". It seems to me to be a matter of considerable national importance that science students should be given that humanistic culture so that they may become effective and enlightened citizens in the days to come.

Many of those who are in close touch with students are becoming increasingly uneasy about the results of modern specialization, especially in science. Does the study of natural science in our universities include any real education which will help pupils to understand their fellow men? Does it train them to form sound judgments about the things of everyday life? Does it help them to live more happily in society?

Present-day science students have been specialists since the age of sixteen or earlier: they have a very limited knowledge of the world and of the behaviour of man, derived mainly from newspapers and the cinema screen: they know little real history, and are scarcely sensible of their debt to the past. Too often the student has a poor understanding of the meaning of words and of the implications which words can convey; hence he is unable to appreciate poetry and good prose. He is quite at home with formulæ and equations—the shorthand of science—but is seldom able to write fluent unabbreviated prose and to express his thoughts in a way that is easily intelligible to others. Even his ability to think logically and to understand the philosophical foundations of his own studies is often weak.

But we must not blame our students for these cultural deficiencies. They all must work extremely hard in endeavouring to learn and remember the vast body of information which is now presented to them, and which they are expected to understand and remember. Every branch of science has progressed enormously during the past fifty years, and the schoolboy of to-day is taught about subjects which, in my time as an undergraduate, were recent discoveries on the confines of knowledge. Moreover, while the field of study has been steadily increasing, very little of the older material has been omitted. Our universities seem to take little heed of the fact that the load placed on the science students is becoming, or has become, unbearable, and that this in its turn means a demand for more intensive study at school.

The training now given to students of the natural sciences is generally planned, consciously or unconsciously, with a view to the production of professional scientists who will spend their lives at research or teaching. But in fact a considerable number of people do not reach the necessary standard and have to look for other posts. Many men and women in this class have undoubted ability; they might become good administrators, works managers, journalists or business men, if their training were broader and less specialized. While the training of students is so detached from human affairs, they are seldom able or willing to embark on a career outside the limits of their own special subjects. For the same reason they are often unsuited to become really effective teachers in schools. The provision of some broad humanistic culture for the majority of university students is thus of importance both to the individual and to the community as a whole.

We must consider what can be done to remedy the situation which I have outlined. What modifications can be introduced into the teaching in the universities and schools to give the science students a broader intellectual training? One suggested remedy is the postponement of specialization until the pupils' minds are more mature, and the continuation of a study of a wide range of subjects up to or after entry into a university. I do not think this is a satisfactory solution of the problem. Some specialized study at school is valuable, even for those who will not go to a university; it can bring a wonderful zest into the intellectual life of many students. It is also necessary for those who look forward to a career in science, or in other subjects, to have the opportunity of showing that they have the capacity to begin advanced education with good prospects of ultimate success. But when a boy or girl has decided to embark on a particular course of study, all intellectual work which does not seem to be directly connected with the chosen field is regarded as a waste of time. The same consideration applies to students at the university, where the first-year undergraduate finds much new work to interest him and occupy his attention. The best method is not to impose a compulsory study of subsidiary cultural subjects but to widen our science teaching, so that it not only imparts information about the phenomena of Nature but also deals with the humanistic aspect of natural knowledge. If we can lead students to appreciate the way in which man's concepts of Nature have been built up, telling them of past failures as well as of successes, and revealing the personal characters of some of those who have worked in the search for knowledge, we should make them better scientists and at the same time illustrate the social and human aspects of their studies. All this can be done by the institution of well-planned courses in the history of science.

In speaking of the history of science I do not mean a mere knowledge of the names and dates associated with discoveries that have stood the test of time. In the first place, I should draw no hard and fast line between the history and the philosophy of science. Science is still in essentials 'natural philosophy', though the old name is now seldom used. The present-day search for the principles of things can scarcely be understood without reference to its history. Most young scientists need some philosophical training, and we have evidence at Cambridge that many of them find their introduction to philosophy most fascinating. This is an age when few specialists have had a philosophical training, and when non-specialists are unable to understand the language or details of many scientific subjects.

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* From the presidential address to the British Society for the History of Science, delivered on May 3.

Some tentative suggestions may be made as to the kind of teaching which might lead to a broader humanistic outlook. First, we might hope that a general survey of the history of scientific effort would give the student some idea of his own position in the world by reference to the past. The story of the empirical quest for knowledge, extending far back before our era, should not be passed over lightly. The discovery of the methods of extracting metals, of curing hides, of making pottery and raising crops and stock, represent substantial scientific achievements by primitive peoples. Still more remarkable were the abilities shown by the ancient Egyptians in fashioning and using stone on a scale that has never since been equalled, as well as in the construction of buildings, in mechanical problems, in dyeing, weaving, wood and metal working.

A concise account of Greek thought and culture and of the civilization of the Hellenistic age seems essential. The world owes so much to the Greeks that one who is ignorant of the main facts about Greek civilization and thought can scarcely claim to be educated. Some teaching about the philosophers, scientists and medical men of classical times would provide a means of introducing students to the life and thought of the ancients, and of showing how mathematics, mechanics, astronomy, medicine and systematic scientific thought found their early expression.

The organization of society in Greece and Rome, which is so closely linked with early scientific progress, is a topic through which an outline of the political history of Europe can be approached. I do not suggest the study of more political history than is necessary as a background for the consideration of the progress of civilization and the movements of thought. Of course, at many points after the sixteenth century the history of science becomes much linked with political events, and can scarcely be understood without reference to them. But battles and treaties, the struggle of men for the domination of governments, and much of the detail usually taught in ordinary courses on history need little attention. The history of science is essentially the study of the growth of ideas. The successive views on the nature of things, both living and non-living, should be followed. The factors which led to the formulation of these views should be examined, and especially the relation between experiments or observations and the opinions current at the time when these were made.

Some historians of science pay little attention to the erroneous hypotheses widely held at certain periods. But for the more mature students the study of theories like that of phlogiston or of the imponderable fluids may, I think, be very instructive. I often wonder what I should have thought about phlogiston had I been living at the end of the eighteenth century.

Of the general educational value of history there can be no doubt. The modern biological study of organisms in Nature shows clearly how present-day populations owe their existence to events and changes in the past. Scientific thinking should make us more and more conscious of the fact that we cannot understand man, his societies and his social systems without reference to history. Most boys and girls are taught some English history at school; but it seldom includes enough social history or references to changes in thought and technical skill. Some knowledge of the past and of the ways in which men have acted under different situations is also, I think, of the greatest value to all of us to-day when we have to face the complex problems that arise in both public and private affairs.

This reflexion leads to a consideration of what is probably the greatest deficiency in the education of the young scientist. How much does he know of human beings, their motives and desires, their hopes and fears, their affections and hates? Students of the classics, of literature, history and law become well aware of the complex nature of human personality and of its wide variety; but the scientist often seems to think that all men in the world have minds that work like his own. He does not realize the power of the more primitive human instincts, of racial and social background, and of early training. He is thus surprised or disappointed when other people do not act in the way in which he thinks they should behave. Some people appear to regard men as they would substances or organisms in an experiment, where an alteration of environmental conditions is expected to produce a predictable response. Human beings, however, seldom react in that way.

We may not be able to give our students very much insight into human personality; but through the history of science we may, at least, make him aware of the different ways in which some people have thought and acted in the past. The story of the lives of well-known scientists provides a considerable fund of material from which the development of character and the influence of personality can be illustrated. I think that writers and teachers might well pay more attention to the selection of biographical details to bring out the character, good or bad, strong or weak, of the people they describe. We can find among our records plenty of interesting human stories, showing love and affection, jealousy and hate, perseverance in the face of adversity, triumph and tragedy.

An entirely different aspect of our problem concerns the training of the young scientist in the use of his native language. So much of his written work is done in the form of tables and diagrams, graphs and formulæ, and so little in the form of connected prose, that one hears constant complaints about the inability of the young graduate to express his thoughts in a way that is readily intelligible to others. It may be that similar criticism may be made of the abilities of some arts students; but to-day, more than ever, the scientist should be able to express himself in language that can be generally understood.

While I do not think that a gulf exists between the scientists and the non-scientific public in Britain to-day, as is said to exist in the United States of America, there is considerable risk that one may develop in the future. Although we have some first-rate scientific journalists and broadcasters, there is also a tendency, not without foundation, to regard the scientist as the 'back-room boy' who knows little of the world around him. This may become more pronounced if our young scientists are unable to tell about their work and ideas in a way that the ordinary man can understand. To remedy this, I can only suggest that our pupils should be encouraged to read more books in good connected prose, like those on history and philosophy, together with some selected works by scientists well known for their prose style, and that they should be encouraged to try to imitate that style.

There is also much to be said for the study of some complete book or paper of outstanding importance, with special reference to the way in which the subject is presented, the evidence is brought forward, and the conclusion reached.

Many school and university teachers will have a short reply to what I have been saying. They will point out that young scientists have already more than enough to learn, and that they have no time to spare for the kind of instruction I have suggested. This, without doubt, is perfectly true at the present time; but the day must soon come when every British university is forced by the accumulation of knowledge to revise its science-teaching and to make radical changes. Those responsible must face the problem of whether teaching or education is to be the first consideration. When this revision comes I hope that it will enable science students to devote some time throughout their education to the history and philosophy of science, so that they may obtain a good measure of humanistic culture, and will not tend to become cut off from the intellectual interests of their fellow students.

This brings me to another aspect of my subject, the value of the history of science to those who are not science specialists. In the past, a knowledge of the phenomena of Nature was considered quite unnecessary in the education of those who would not become medical men or science specialists. For a long time the part played by the scientific revolution of the seventeenth century in altering the currents of man's thought and in improving his material environment was clear to those who cared to think about it. But it received little attention, and the practical results which followed and which led to great improvements in our health, food, housing, transport and communications were taken as matters of course. To-day, most educated people have suddenly awakened to the fact that the discoveries of science have brought about the most profound change in human affairs that the world has yet seen, at least since the discovery of metals. No longer can young people be brought up in complete ignorance of modern science. But this does not mean that they can or should be taught chemistry and physics to enable them to understand the process of atomic disintegration, or learn physiology and genetics for the explanation of blood transfusion. What I think is needed is a general picture of how man's knowledge of Nature has come about, and what have been the results of this knowledge. In several schools a successful attempt is being made to inform pupils, by teaching the history of science, of the ways in which discoveries have affected men's lives. The historical approach enables the more important contributions to knowledge to be linked into a connected story. At the same time, it enables many inventions and principles to be understood by reference to the way in which they have developed from simple beginnings. Thus the early experiments of Faraday on electromagnetic induction are not difficult to understand, and when these are known the principle of the modern dynamo can be explained. By this mode of study much can be done to show the way in which biological and medical knowledge has altered the lives of the people of the world, and, may I add, to direct attention to the unacknowledged debt of the inhabitants of Asia and Africa to the labours of European and American scientists. This study will also stress the importance in our lives of vaccination and inoculation, the dangers of bacterial and virus infection, and the value of hygiene. In these days when so many people are terrified by reports of atomic weapons, there is in some minds a feeling that the progress of discovery in the world of Nature is to be regretted; scientists are only regarded as the authors of horrible contrivances. How important it is to show the manifold ways in which everyone has benefited from the labours of the investigators of Nature.

INTERNATIONAL PEAT SYMPOSIUM 1954

THE first International Peat Symposium was held in Dublin during July 12–17 under the auspices of Bord na Mona—the statutory corporation set up in Ireland to develop the peat resources of that country. It was attended by more than two hundred delegates from nineteen countries, and sixty-nine papers by delegates from thirteen countries were discussed. Nations as far apart as the United States and Malaya were represented; but one large peat producer—the U.S.S.R.—was absent. However, its near neighbour, Finland, was well represented, as were the Scandinavian countries and Austria.

The reason for this widespread interest in peat varies. In Ireland it is its immediate use as a fuel, followed by the reclamation of the bog for agriculture and afforestation. Elsewhere it may be the conservation of native fuel for use in an emergency, or even the employment of evacuees. Whatever the reason, there is no doubt that interest in peat is more intense now than formerly. In the past it was stimulated by war-time conditions, when other fuels were difficult to obtain, and tended to flag in peacetime. At the present time, economic conditions are such that in some regions peat can compete with other fuels on a calorific basis, particularly when modern methods of production and utilization are used. This has led to more research and development, which in their turn have resulted in further improvements in methods and still greater incentives to use peat.

The scope of the conference covered a wide field, including the initial survey and classification of resources, the winning and preparation of the raw material, its utilization in all types and sizes of equipment and, finally, land reclamation.

It was noteworthy that at every stage the discussion was dominated by the same characteristic properties of the material, particularly the large weight and volume of raw material required to produce a given quantity of dry peat substance, its variable composition, and, above all, its high moisture content. Their importance was made strikingly apparent during a visit by the delegates to typical peat bogs and power plants to observe various methods of winning and utilizing peat.

This left the general impression of a long-drawn-out struggle against natural conditions requiring a series of huge machines systematically to traverse many miles of desolate open country and to handle vast quantities of difficult material only to produce in the end a disproportionately small output of useful heat or power. Taking actual figures, it is hoped that by 1960 it will be possible to remove about 90 million tons of material each year from the Irish bogs to generate about one and a half million megawatt-hours of electricity. In comparison with this, Battersea Power Station generates slightly more power from about three-quarters of a million tons of coal per annum.

To estimate peat resources on a national scale is a formidable task in view of the large areas involved (one-third of Finland and one-seventh of Ireland consist of peat bogs), and the need to take into account variations in bog depth and in the quality of peat in different areas and at different depths. Nevertheless, several countries have made comprehensive surveys, the results of which were made available. One interesting suggestion which may reduce the cost and labour involved in future surveys was that surface vegetation can be correlated with the nature of the peat beneath it, and this will enable useful information to be obtained by relatively inexpensive aerial surveys.

Although peat has many uses, for example, as moss litter and for horticultural purposes, its main value is as a fuel, and it was mainly discussed as such. In passing, it is interesting to note that peat is still won by hand and used for household purposes by the same methods as were described by Pliny nineteen centuries ago. On a larger scale, its winning and utilization are extensively mechanized; but the conference made it abundantly clear that even now the methods employed have by no means reached finality. Thus the two power stations already burning peat in Ireland both use it in the form of machine-cut sods or turves; but Bord na Mona has now pinned its faith to granular peat won by a completely different method—the milled peat process—and it is its present intention to produce one million tons per annum of sod peat, about half of which will be used for domestic and industrial purposes and about half for power production, plus 2½ million tons of milled peat, most of which will be used for power production.

Since this decision was made, new machinery has been developed which will reduce very considerably the amount of labour required in the preparation of sod peat, and this must materially affect the relative economies of the two processes, although not necessarily to the extent of reversing their former order of merit.

Although mechanically very different, the fundamental difference between the two principal methods of winning peat is in the provision made for partially drying the fuel. An undrained peat bog usually contains about 93 per cent of moisture, that is, more than 13 lb. of water per pound of dry peat substance. Part of this moisture can be removed by drainage; but even then the remaining moisture, say 90 per cent, is far too much to be removed by waste heat, and the nature of the peat is such that it cannot be removed by ordinary mechanical means. Recourse is therefore made to air drying, and the basic difference between the two processes lies in the methods used to bring the fuel into contact with the air. In the sod peat process a strip about six feet wide and nine feet deep is cut from the previously drained bog and, after maceration, spread on the field to dry in the form of sods about 12 in. long and 4 in. wide It is then subjected to periodic turning and stacking and is eventually formed into a long pile in which it is stored until required for use. In the milled peat process, a thin layer about half an inch thick is removed in granular form from the top surface of the previously drained bog by means of a toothed roller and is repeatedly brought into contact with air by harrowing and similar means. Both processes depend upon weather conditions, and on the average during the summer months there will be two harvests of sod peat and fifteen to twenty-five of milled peat

The seasonal nature of peat winning and its dependence on day-to-day weather conditions, combined with the remoteness of peat bogs from towns and their amenities, involve many labour and sociological problems which, though not discussed in detail, were obviously in the minds of the delegates. Some of these problems would be at least partially solved if some continuous method of drying could be evolved which would be independent of weather conditions and yet economic.

Of the many methods which have been tried, osmosis has been found to be possible but not economic, and 'wet carbonizing' followed by pressing, though found wanting in the past, is still the subject of experiment. Another alternative is to use the Madruck process in which peat powder, previously dried down to about 12 per cent moisture, is mixed with wet peat and the mixture subjected to high sustained pressure; the suggestion being that the dried powder provides channels through which the water escapes while the peat is still under pressure. The moisture content of the final product is about 80 per cent, that is, more than half the moisture is removed in the press. Experimental work with the Madruck process using specially designed presses is now being carried out in Britain by the Ministry of Fuel and Power. If this is successful and enables peat winning to proceed continuously throughout the year, it should greatly ease the future economic position with regard to both capital costs and labour.

In the past, when peat was considered only as an alternative to other fuels, it was almost invariably burned in appliances designed primarily for those other fuels and modified as little as possible to burn peat. There is now a greater tendency to develop special apparatus which takes advantage of the favourable properties of peat, such as its high reactivity, and minimizes the effect of adverse properties such as high moisture content and low bulk density. Modern apparatus also takes account of the high volatile content of peat and the high percentage of carbon dioxide in its distillation products.

The two Irish power stations burning sod peat use more or less conventional chain grates with special pre-drying of the fuel by means of hot air; but the equipment to burn milled peat in the new stations will require further development work. Powdered peat has already been used for large-scale power production in the U.S.S.R.; but apart from this, experience is not available, unless it be assumed that peat can be burned efficiently by methods similar to those already used extensively on the Continent to burn brown coal. With this in mind, three German manufacturers were commissioned to design and construct three different boilers which will be used for gaining experience of burning milled peat in the new Ferbane power station. In these boilers either finely divided fuel will be burned in suspension after being dried by hot gases while passing through a Krämer mill of the type used for brown coal, or, alternatively, the spreader-stoker system will be employed in which the original milled fuel is projected into the boiler furnace in such a manner that the finer particles are burned in suspension and the coarser particles fall on to a form of chain grate where their combustion is completed.

The combustion of peat in small-scale equipment is equally the subject of experiment. Taking domestic heating as an extreme case, more economical methods of burning peat in the open fireplace have been devised; but Bord na Mona recommends the use of closed stoves of special design, and ultimately completely automatic mechanical operation. At the other extreme, large heating boilers are said to give good results when fitted with a furnace of Dutch design which consists essentially of a low-velocity cross-draught gas producer delivering gas into a combustion chamber, where it is burned with carefully controlled secondary air. The most promising device, however, would appear to be a modification of the downjet burner to burn broken sod peat in both domestic and small-scale industrial appliances. Its essential feature is that all the air for combustion is directed as a high-velocity jet upon the top surface of the fuel bed and it can be used over an exceptionally wide range of loads, giving a very high output per unit volume and per unit grate area, and complete combustion with very little excess air.

The high moisture content of peat makes its possible use as a gas turbine fuel of special interest, first because the gas supplied to the turbine is necessarily at a low temperature in order to avoid overheating the blades, and secondly a large quantity of exhaust gas is available at a temperature which permits it to be used for drying. In experiments with the open-cycle gas turbine carried out under the ægis of the Ministry of Fuel and Power, the problem of feeding pulverized peat under pressure has been solved by the use of a fluid-bed feed in conjunction with a 'coal pump', and combustion does not appear to be too difficult. Problems of blade abrasion, corrosion and ash deposition in the turbine are, however, still unsolved, though under active investigation. In the closed-cycle gas turbine these particular difficulties are avoided by using indirect heating and a clean working fluid, but the system involves more elaborate heat exchangers, including a large 'air boiler'. A contract has been given for a 2,000-kW. peat-fired closed-cycle set to generate power in the north of Scotland and an experimental 750-kW. open-cycle set will be erected on the same site.

Apart from its present uses, more or less in its raw state, serious consideration has been given to peat as a potential source of high-grade manufactured products. It has, for example, been found possible to extract from it a wax which may itself be converted into new plastics. Attention has also been given to the gasification of peat to make either water gas or synthesis gas, and Bord na Mona has examined a number of complete gasification processes as possible starting points for the manufacture of synthetic ammonia for conversion to fertilizers.

Whatever the method by which peat is utilized, the final stage of exploiting peat resources must be the reclamation of the land, and most of the last two sessions of the Conference were devoted to this subject. In them it was evident that the best use which can be made of the land, whether for grassland, arable land, or forestry, is a complex question, the answer to which depends upon many factors, such as drainage, acidity and existing vegetation. Much information is now available on this subject, but active research into its many aspects still continues.

T. F. Hurley

OBITUARIES

Prof. T. F. Dreyer

Thomas Frederick Dreyer passed away suddenly on July 13, while discussing problems concerning Florisbad with his colleagues. For the past few years, in spite of severe set-backs to his failing health, his main interest was in trying to elucidate the many puzzling features which had been uncovered at the now world-famous site where in 1932 he had discovered the remarkable Florisbad human skull. The amazing wealth of archæological and palæontological material from this site had been increased by the 1952 expedition of the National Museum, Bloemfontein, and Prof. Dreyer was working against time in order to give his findings to the scientific world. Unfortunately, his death prevented him completing this research work.

Dreyer was born in the Cape Province on May 7, 1885, took his M.A. degree in the University of the Cape of Good Hope and the degree of D.Phil. *cum maxima lauda* at the University of Halle. After periods of study at Naples and in the United States and Australia, he served for a few years as entomological officer in the South African Agricultural Department. In 1912, at the youthful age of twenty-seven, he became professor of zoology, and in addition for a short period professor of geology, at the Grey University College (later the University of the Orange Free State), a post which he filled with distinction up to his retirement in 1950. He had also been responsible for courses in archæology and bacteriology. He continued his research work at the National Museum, Bloemfontein, up to the time of his death.

In addition to his brilliant career as professor of zoology in the University of the Orange Free State, he devoted much of his spare time—and money—to investigating, uncovering and describing some remarkable sites, three of which are of extreme scientific importance, namely, the Matjes River Shelter, the Kakamas area of prehistoric Hottentot graves, and Florisbad. These sites have contributed much, archæologically, anthropologically, and palæontologically, towards clearing up the prehistory of South Africa. There are very few regions in South Africa which Prof. Dreyer did not investigate, and his remarkable and rich collection was presented to the National Museum, Bloemfontein, where it is now housed in the T. F. Dreyer Hall for Anthropology and Archæology.

Those who passed through his hands as students or were fortunate enough to be associated with him in his research work bear only the kindest memories of a big soul. A great worker with boundless energy, he infected his associates with his enthusiasm and gave loyalty for loyalty. A doughty fighter, he could hit out hard during constructive arguments; but never allowed varying points of view to cloud his personal contacts.

His interests extended beyond just his work and research. This is amply demonstrated in the variety of positions held during his career, including member of the Bloemfontein Town Council, chairman of the Governing Council of the National Museum, chairman of the Senate of the Grey University College, of the Senate of the University College of the Orange Free State, and chairman of the Senate of the University of South Africa. His interests extended to locust control, and he was also asked by the Provincial Authorities of the State, to direct the investigation of freshwater fisheries in this province.

As time goes on, the important contributions Prof. Dreyer has made to the archæological story of South Africa and to the study of prehistoric man in this region will be more clearly seen in their true perspective and recognized for their importance. His collections have been on too great a scale for his personal complete description and publication, and will still be an important source for future research. Without them no true picture of South African prehistory is possible.

We, who were privileged to be closely associated with Prof. Dreyer, know how severely he suffered during the past two years and daily were witness to mind triumphing over body. In spite of the physical drawback, his clear memory, fast-working brain and keen interest never flagged for a moment nor deserted him. He thoroughly deserved that much-desired end —to die in harness. A. J. D. Meiring

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The passing of Prof. T. F. Dreyer has deprived the study of early man in South Africa of one of its acknowledged leaders, and his place will not be easily filled.

Outside South Africa, Prof. Dreyer will be most widely remembered as the discoverer of the Florisbad skull, the most remarkable human fossil to be found in Africa since the Broken Hill skull. This discovery was a well-deserved reward for his intuition in selecting for thorough investigation the Florisbad mineral spring deposits with their wealth of archæological and fossil mammalian remains. But his explorations in the Matjes River Cave and elsewhere also constitute notable contributions to our knowledge of man in South Africa from prehistoric to historic times.

With a characteristic scorn for the compartmenting of knowledge, Prof. Dreyer pursued his studies simultaneously in the field of physical anthropology, Quaternary mammalian palæontology, archæology and even Quaternary geology and climatology. Such a broad approach, allied to the natural vigour and freshness of his mind, gave birth to original and challenging interpretations of his discoveries. However these may fare in the light of future increases in our knowledge, there can be no doubt that to the present generation of investigators in South Africa they have been a most valuable stimulus.

Prof. Dreyer was not only distinguished in the field of research; he was also an inspiring teacher. Moreover, as a senior professor his wide-ranging and lively intelligence did valuable service both within his own University and over the whole field of university and professional education in South Africa.

The vigour with which Prof. Dreyer maintained his opinions might lead a casual reader of his writings to misconceive him as an acrimonious controversialist. To encounter him personally was to find him quite otherwise: courteous, kindly and charming. As human being as well as scholar, he will be remembered with honour and with affection.

L. H. Wells

Prof. H. G. A. Hickling, F.R.S.

Henry George Albert Hickling, emeritus professor of geology in King's College, Newcastle upon Tyne, died on July 26 in his seventy-second year. He was born on April 5, 1883, in Nottingham. His school education in that town was followed by three years private study in Scotland, where the rugged cliffs of Angus were to inspire him with the love of geology. He learned the fundamentals of this science from Prof. W. Boyd Dawkins in the University of Manchester. He graduated in 1905, and after two years further study and research he became in turn lecturer in palæontology and geology in 1907 and reader in geology in 1917 in Manchester. Owing to the absence in India of Prof. T. H. (later Sir Thomas) Holland during the First World War, Hickling was acting head of the Department. In 1920 he became professor of geology in Armstrong College (now King's College), University of Durham, Newcastle upon Tyne, a post which he held until his retirement in 1948.

In 1934 he received the Murchison Medal from the Geological Society of London and in 1936 he was elected a Fellow of the Royal Society. In 1935 he presided over Section C (Geology) of the British Association. He also served on the Council of the Geological Society, on the Geological Survey Board and on the Fuel Research Board.

His research was mainly in the fields of palæobotany, coal-measures tectonics and coal petrology. During his Manchester period he published papers on palæontology, and on the stratigraphy of the Old Red Sandstone of Angus, and a paper on the nature and origin of the Cornish china-clay, in which he advanced a new and original theory of its genesis. During the same period he made a detailed study of the tectonic structure of the Lancashire coalfield, a work published in 1924 as a coloured map of the underground contours of a single coal seam—the Trencherbone seam—supplemented in 1927 by a book, "Sections of Strata". At a later date he applied the same method of mapping to the coal seams of the Northumberland and Durham coalfield (1950).

Hickling's most striking contribution to science, and the work for which he was best known, was in the field of the study of coal. Following on the pioneering work in Great Britain of James Lomax on the micro-petrology of coal, Hickling's first paper on this subject (*Trans. Inst. Min. Eng.*, 1917), followed by a paper on the chemical relations of the principal varieties of coal (*ibid.*, 1927), opened up a series of publications by him and by his pupils on the microstructure and on the chemistry of coal—a new and very important contribution to coal science, and one which received world-wide recognition.

Hickling was very keen on local geology, and he was responsible for the preparation of accounts of the geology of Northumberland and Durham for the meeting of the Geologists' Association in 1931 and for the meeting of the British Association in 1949. His interest in geology as a subject of popular education was already shown in his younger days when he published his book "Geology: Chapters of Earth History", and right through his academic career he was very much appreciated as a popular lecturer. He was also interested in water supplies, a subject on which he was an acknowledged authority.

This stark enumeration of facts will not convey to the generations of students, who revered and loved him, the Prof. Hickling they knew in the lecture room, laboratory and field and whose home was always open to them. His clear logical exposition and the slow tempo of his speech, whether in lecture or conversation, made misunderstanding impossible, and will be as well remembered as his rapid pace as a leader of field expeditions and his speed when driving. Despite his undoubtedly important original contributions to science, it will probably be as a teacher that most people will think of him. His teaching career, covering some forty years, belonged in the main to a period when mechanical aids were few and buildings and general equipment inadequate. In such circumstances the personality of the teacher was all in all and Prof. Hickling's innumerable past students, many of them now famous themselves, will bear witness to his pre-eminence in this respect.

His first wife (Gertrude Hermine Geiler), whom he married in 1910 and who died in 1952, was herself a medical doctor of distinction and a pioneer in the nursery-school movement, and she co-operated loyally with him. Together they built up a tradition of friendliness, with which, as with that of disinterested scholarship, the name of Hickling will always be associated. S. I. TOMKEIEFF

Dr. W. C. F. Shepherd

WILFRED CHARLES FURNESS SHEPHERD, deputy director of the Safety in Mines Research Establishment, Sheffield, died suddenly at his home on July 19, in his fifty-second year. He had just returned from Germany after attending an International Conference of Directors of Safety in Mines Research at Dortmund.

From Manchester Grammar School, in 1919, Shepherd joined the staff of the late Prof. R. V. Wheeler at the Home Office Experimental Station, Eskmeals, Cumberland, in research on means of minimizing risks of ignition or propagation of explosions of firedamp or coal dust in mines, and devoted the whole of his working life to this purpose. He became well known in all the mining countries of the world for his research on explosives; the much greater safety of mining explosives in use in coal mining to-day in comparison with thirty years ago is an achievement of research teams of which Shepherd became a leading figure.

In his early years he was occupied with the ignition of methane by hot wires and the photographic study of movement of flame in gaseous mixtures in tubes, work related to the safety of electric and flame safety-lamps; but he soon joined the section, directed by the late W. Payman, engaged in investigations of the ignition of firedamp by mining explosives. Payman was applying schlieren photography to the study of the part played by pressure and shock waves in the ignition process and, in 1929, Shepherd was asked, under an arrangement for the exchange of staff, to work in the laboratories of the United States Bureau of Mines. Here he made his first friends among overseas research workers, with whom he maintained an active correspondence for the rest of his life. His year and a half's study of the ignition of firedamp by explosives, by the schlieren method, was published in a Bureau Bulletin in 1932. On his return, he continued work on this subject; many of his findings were of fundamental interest. He published two papers in the *Proceedings of the Royal Society*. A notable contribution was the demonstration of quasi-detonation in methane–air mixtures under the influence of projected hot particles. He studied the ignition of gaseous mixtures by impulsive pressures produced by the bursting of diaphragms in shock tubes. He showed that surprisingly low pressures were sufficient to ignite mixtures of certain inflammable gases and oxygen and that ignition could even ensue from rapid expansion, that is when, for example, a methane–oxygen mixture under pressure in a tube was released into open air by the bursting of a restraining diaphragm at one end. This novel expansion–ignition phenomenon was the subject of a paper written shortly before his death. It was during this pre-war period that, with D. W. Woodhead, also in Payman's group, he developed the instrument which became known as the Buxton rotating-mirror camera.

During the war years Payman and his colleagues turned to work, under the Ministry of Supply, with military explosives, on problems relating to the detonation of shaped charges and the fragmentation of projectiles. The years 1940–45 were a period of intense activity and provided valuable experience in the development and application of new techniques. Shepherd's inventive and organizing ability assisted the team in making important contributions to armament design. Most of the work necessarily remains unpublished. The work for the Ministry of Supply continued after the War, and at Payman's death in 1946 Shepherd took over the direction of the team, and, at the same time, guided the re-establishment of the team devoted to research on coal-mining explosives. He initiated a long-term research programme and, as a more immediate practical contribution, in close collaboration with the explosives industry, he fostered the development of 'equivalent to sheathed' mining explosives in place of the sheathed explosives which were falling short of the hoped-for standard of safety. He published with H. C. Grimshaw a number of papers on these new explosives that, before his death, were meeting a third of the United Kingdom requirements.

From 1947 the responsibility for mine safety research was assumed by the Ministry of Fuel and Power, and the research of the Safety in Mines Research Establishment was expanded. Shepherd was promoted first senior principal scientific officer and then deputy chief scientific officer and became deputy director of the Establishment. He retained his interest in explosives research, and in recent years assisted in initiating research on quite new methods of blasting, convinced that the problems of mining would not be solved by research directed solely to the study of the explosives. Prompted by the disastrous fire at Creswell Colliery, he directed the formation of a new team for fire research to work on mining problems in collaboration with the Joint Fire Research Organization of the Department of Scientific and Industrial Research, and he published two authoritative papers on fire prevention. At the time of his death he was engaged in planning an important new programme of research on flame propagation and explosion prevention for the Factory Department of the Ministry of Labour and the Department of Scientific and Industrial Research.

His sudden death at the height of his powers is a serious loss to British mining research. Shepherd, though always modest and unassuming, was a man of much strength of character, who never spared himself throughout his working life. Many men in the world of mining both in the United Kingdom and in laboratories abroad will mourn his death. He leaves a widow and one daughter. H. C. GRIMSHAW

NEWS and VIEWS

New President of the British Association: Sir Robert Robinson, O.M., F.R.S.

General satisfaction will be felt at the announcement that Sir Robert Robinson is to be next year's president of the British Association for the Advancement of Science. Since 1930 Sir Robert has been Waynflete professor of organic chemistry in the University of Oxford, having previously served as professor of either chemistry or organic chemistry in the Universities of Sydney, St. Andrews, Manchester and London. He was awarded the Order of Merit in 1949 and holds the Longstaff Medal of the Chemical Society, and the Davy, Royal, and Copley Medals of the Royal Society, besides many foreign honours. He has already had a very notable experience of presiding over learned bodies, having been for two years president of the Chemical Society and for five years president of the Royal Society. Sir Robert's extensive scientific work lies in the field of organic chemistry. His investigation of the constitution, by degradation and by synthesis, of the anthocyanin group of plant pigments is already classical, as is that on the constitution of several groups of alkaloids. He has made notable contributions to the synthesis of steroids. He was one of the first to apply the electronic theory of valency to problems of organic chemical reactions, and has offered an attractive picture of the biogenetic relations of naturally occurring plant substances.

Research on Humane Vivisection: Dr. W. M. S. Russell

UFAW (The Universities Federation for Animal Welfare), in association with the Animal Welfare Institute of New York, has appointed Dr. W. M. S. Russell as research fellow to study the history and progress of the introduction of humane techniques into experimentation on animals, with the view of assisting further progress. Examples of progress already achieved are the use of anæsthetics in experiments involving operations, the reduction in the requisite number of animals by means of modern small-sample statistical theory, and in the assay of drugs the substitution of painless (for example, chemical) criteria for various criteria entailing discomfort. Dr. Russell, who will have the assistance of a consultative committee, has had a brilliant career at Oxford and is the son of Dr. F. S. Russell, director of the Marine Biological Laboratory at Plymouth. At present he holds a fellowship from the Agricultural Research Council. As an undergraduate he abandoned a Greek scholarship in order to study zoology, and he has written a number of papers on the behaviour of vertebrates, together with a forthcoming book on comparative physiology.

British Standards Institution, Chemical Divisional Council: Dr. G. H. Beeby

Dr. G. H. Beeby has been appointed chairman of the Chemical Divisional Council of the British Standards Institution and has, therefore, at the same time become a member of the General Council and the Executive Committee. Dr. Beeby, who is the well-known chairman of Imperial Chemical Industries Salt Division at Winsford in Cheshire, has spent all his working life in that organization. Born in Leicestershire, and educated at Loughborough College and the University of London, he joined the Billingham Division of I.C.I. as a chemist in 1928. Afterwards he spent thirteen years in I.C.I. sales offices before taking up his present duties in 1952. He first joined the Heavy Chemicals Industry Committee of the British Standards Institution in 1945, and has been its chairman, as well as chairman of the Institution's Sub-Committee for International Work on Chemistry, since 1948.

John Gould, F.R.S. (1804–81)

John Gould, who has an honoured place in the ranks of ornithology, was born at Lyme Regis in Dorsetshire a hundred and fifty years ago on September 14, 1804. At the age of fourteen he began working under his father, who had been appointed foreman gardener at Windsor Castle, and acquired an intimate knowledge of birds in their wild state and considerable skill in the art of taxidermy. In 1827 he became taxidermist to the newly founded Zoological Society of London. His first attempt at authorship was his description of bird skins received in 1830 from the Himalayas, "A Century of Birds from the Himalayan Mountains" (1832), and his own sketches, artistically transferred to stone by his wife, made this the most accurately illustrated book on foreign ornithology up to that time. A two-year expedition to Australasia (1838–40) was responsible for "The Birds of Australia", which took seven years to complete. He was elected to the Royal Society in 1843. Gould published forty-one folios on birds, illustrated with 2,999 plates, his best-known works being "A Monograph of the Trochilidae, or Family of Humming-Birds" (this collection was exhibited at the Great Exhibition of 1851), "The Birds of Europe", "The Birds of Asia" and "The Birds of Great Britain". Gould also contributed some three hundred memoirs and papers to the *Proceedings of the Zoological Society* and to other scientific journals. He died on February 3, 1881, aged seventy-seven, at Charlotte Street, near the British Museum.

Calendar Reform and the Seven-day Week

A pamphlet entitled "Calendar Reform and the Seven-Day Week: a Clarification", by Elizabeth Achelis, James Avery Joyce and Daniel Sher, is No. 5 of the World Calendar Pamphlets series, and is published by the Calendar Reform Association (pp. 30; 1954; 1*s*.). It is unfortunate that there is opposition to calendar reform from a few religious sects—Christian and non-Christian—the foremost critics being the Jews, chiefly because the Sabbath is fixed for the seventh day of the week and the proposed alterations would disturb this. The main disturbing factor is the use of a 'Worldsday' which, in the suggested scheme, is the 365th day, now dated December 31, and which would be a world holiday, dedicated to the brotherhood of man and a non-working day. Every year would thus begin on a Sunday, January 1. The objections are fully and fairly dealt with by Mr. Joyce, a British Methodist; and Mr. Sher, an Israeli Jew, shows the error of the points raised by the late Chief Rabbi Hertz on the spiritual and human rights of the minority, which were largely responsible for the somewhat hasty and erroneous action taken by Jewish organizations. A few examples show the faulty conceptions of such terms as 'day' and 'week'. Thus a person crossing the International Date Line may experience two successive Sabbaths or may miss one, passing directly from Friday to Sunday. Again, according to Jewish Law, the Sabbath lasts from sunset until sunset on the following day, but how could such a regulation be observed in polar regions where the sun neither rises nor sets for months ? These and other arguments show conclusively that the Sabbath is not absolute, but a function of physical and political geography. In addition, there are many precedents in Jewish history for the concept of the year undergoing changes, as, for example, making the month of Tishri the first month of the calendar year instead of Nisan, in flagrant defiance of the command mentioned in Exodus xii, 2. Except for a small body of Christian Sabbatarians, Judaism seems to be the only opponent of the reformed calendar on religious grounds, and if world opinion should show a substantial majority in favour of reform, it would be unreasonable to postpone the change in deference to the wishes of a race that represents only about 0·5 per cent of the world's population.

Directory of International Scientific Organizations

In accordance with a decision of the General Conference of the United Nations Educational, Scientific and Cultural Organization in November–December 1952, the second edition of the Organization's "Directory of International Scientific Organizations" (pp. 312. Paris: Unesco; London: H.M.S.O., 1953. 2.50 dollars, 13*s.* 6*d.* or 650 francs) has been published only in English, the language which commanded the larger sales of the first edition. It is arranged on similar lines to the first edition, and although certain bodies included in the first edition are now omitted in the absence of up-to-date information and other defunct ones are no longer listed, 264 organizations, as against 202 in the first edition, are described, though a few of those given in the "Miscellaneous" section appear to have somewhat slender claims to be regarded as scientific organizations in the usual sense of the term. As previously noted, the contents pages, with their interpretation of the initials and symbols so commonly inflicted on the reader in place of names and titles, and the adequate subject index make the volume a most useful reference work to men of science generally as well as to the librarian.

New Education Scheme of the Institute of Fuel

In the July issue of the *Journal of the Institute of Fuel* is an informative account of the new education scheme of the Institute of Fuel, contributed by the chairman of the Institute's Education Committee, Dr. D. T. A. Townend. Among the activities of such a professional body, the development of its educational aims must always be a matter of prime importance; for to a chartered body the professional competence and corresponding status of its members must be factors in which the highest standards must progressively be assured. One needs to recall the background against which the first education scheme was framed following the report of the Sibly Committee made more than a decade ago. That Committee, set up by the Advisory Council of the Department of Scientific and Industrial Research to inquire into the supply of trained fuel technologists, reviewed both the urgent short-term and the long-term problems involved; the educational activities of the Institute had in some measure contributed towards the progress envisaged. Some weaknesses in the early scheme were revealed by practical experience of its working, and these have been remedied in the new scheme now coming into operation. A professional body must always gather much of its strength from members educated in the universities and technological institutions. There are, however, in these days of part-time release from industry for further education, a large number of potential technologists, much needed in industry. The new scheme is particularly directed towards their welfare if their livelihood is concerned with the many-sided aspects of fuel technology. A grouped course of study is prescribed in which five years is intended to be occupied on part-time study of the scientific background and the technological essentials. For those who are fortunate enough to be able to profit by full-time educational facilities, a valuable detailed account is given of the resources of Britain in a collective statement which has not previously been made available to the intending student. The discussion of the scheme by the members of the Institute is appended to the paper.

Brotherton Library and Collection of the University of Leeds

The annual report of the Librarian, University of Leeds, for the session 1952–53 (pp. 12; from the University), records holdings of 365,912 volumes and 159,090 pamphlets at June 30, 1953, of which 266,053 volumes and 109,171 pamphlets are in the Brotherton Library. Special reference is made to the use of aluminium and plastic in the new mezzanine floor of the Brotherton Library in which radiating lines of bookcases converge on the centre of a circle 104 ft. in diameter, and the new floor and shelving are supported at basement-level by aluminium stanchions spaced at a uniform distance of 3 ft. 6 in. Horizontal supporting members are fixed at the top of the stanchions, which in turn support parallel beams, between which are inserted standard 'Holoplast' sheets. Each stanchion accommodates four perforated steel channels, the centres of the perforations being 1¼ in. apart, and this is the only use of steel in an otherwise entirely aluminium structure which is believed to mark a new departure in library planning. The new floor is covered with a cork linoleum specially treated to preserve its sound-absorbent quality.

The eighteenth annual report of the Brotherton Collection Committee of the University (pp. 10; University of Leeds, 1954) covers the session 1952–53, during which three main exhibitions were arranged. The first of these related to the Poets Laureate of England, the second to three Queens of England—Elizabeth I, Anne and Victoria—and the third was an exhibition of items from the collection of atlases, maps and road-books presented to the University by the late Dr. Harold Whitaker. The Collection was also open, usually with special exhibitions, to learned societies which were guests of the University; these included the Thirteenth British Congress of Gynæcologists and Obstetricians (July 1952), the Royal Astronomical Society (July 1952) and the British Association of Urological Surgeons (June 1953). Dr. E. E. Willoughby gave a series of four lectures on "The Uses of Bibliography to the Student of Literature and History" in the Brotherton Room during November. The contents of the Collection on June 30, 1953, were estimated at 24,220 books; 16,287 pamphlets; 608 manuscripts; 4,106 deeds; 32,269 letters; and 25 maps.

Fitzwilliam Museum, Cambridge: Report for 1953

The restrictions on new museum buildings are so severe in Great Britain at the present time that it is pleasing to note in the annual report for 1953 of the

Fitzwilliam Museum, Cambridge, that a building licence was granted for the Graham Robertson Room. This extension will provide a much-needed exhibition gallery and students' room, with storage accommodation, for water-colours and drawings. The work is due to be completed by October 1954. The Friends of the Museum have again been generous in their support, and purchases to the extent of more than £1,200 were made during the year. These included a porcelain dish of the Ming dynasty (Yung Period) decorated in blue, and a porcelain stem-cup decorated in red and green enamels and dated sixteenth century (Ming Dynasty).

Records of the Dominion Museum, Wellington, New Zealand

The "Records" of the Dominion Museum, Wellington, New Zealand (Vol. 2, Part 1; 1953), includes papers on ichthyological notes, with special reference to sexual dimorphism in some New Zealand fishes; the ecology of the vegetation of sand dunes at Piha; and a molluscan fauna from the Chatham Rise. Part 2 of the same volume consists of papers on Acantocephoba from Auckland and Campbell Islands, parasitic nematodes and trematodes from Campbell and Auckland Islands. Vol. 1 of this "Record" was published in 1942–44. Since that date, various publications have been issued; but it is now stated that, commencing with the present parts, the series of "Records" will continue.

Cross-Sections of Paints

An important article in the July issue of the *Museums Journal* by Joyce Plesters, of the National Gallery, London, details some experimental work on the preparation and study of layers of paint on pictures. For a proper microscopical study of the layer structure the paint fragment must be mounted and its surface prepared by sectioning. The embedding medium used is 'Maroo Resin S.B. 26 C', and full details of the process are given in the paper. The information about the physical structure of paintings that can be gleaned from a study of paint cross-sections is varied and a few specific and illustrated examples are recorded. Such matters as overpainting are quickly detected, and a clear distinction can be drawn between the original and subsequent additions. Facts of art-historical interest sometimes emerge from a study of paint cross-sections, and information regarding the technical methods used by the artists can generally be deduced. A collection of paint cross-sections is being made and with the corresponding chemical analyses form an interesting record of artists' techniques and palettes, and may indeed prove of definite diagnostic value in providing additional evidence for attributions.

Heat Transfer by Radiation

The Department of Scientific and Industrial Research and Fire Offices' Committee has produced Fire Research Special Report No. 2, "Heat Transfer by Radiation", by J. H. McGuire (pp. 29. London: H.M.S.O., 1953; 1*s.* 6*d.*), which deals with the configuration factor, and heat transfer between extended surfaces and between reflecting surfaces. The configuration factor, or geometrical factor, takes account of the geometrical relationship between a radiator of uniform temperature and emissivity, and a receiving element, and may be defined as the ratio of the intensity of radiation at the receiving element to the intensity near to the radiator. In the pamphlet the configuration factor integral, the additive property of configuration factors and the configuration cosine law are first derived, and then the geometrical and optical methods of determination of the configuration factor are briefly described. The various mathematical expressions for the configuration factors of the simple well-known surfaces—for example, plane, sphere, circular disk, cylinder, etc.—are listed and the use of the configuration factor tables relating to the various expressions is illustrated by the worked solution of a particular problem concerning a cylindrical flue pipe. The remainder of the report is devoted to radiative heat transfer when multiple reflexions can take place. Expressions are derived relating to infinite plane surfaces, two finite non-concave surfaces, concentric spheres and concentric cylindrical surfaces. The report is a useful collection of available information expressed in a form which facilitates numerical calculation, and with the increasing use of radiative heat transfer in industry and with the application of its geometrical principles to the illumination of buildings it should prove valuable to engineers working in these fields.

Solar Furnaces for High-Temperature Research

A brief but interesting account of recent progress in the design of solar furnaces for high-temperature research and development work, written by one who is actively engaged in this field of investigation, is given by W. M. Conn in the January number of the *Journal of the Franklin Institute* (257, 1; 1954). The principal advantages and disadvantages of solar furnaces in comparison with other means of obtaining high temperatures are discussed, and the various fields of study in which solar furnaces have been utilized or are expected to be of particular value are briefly outlined. A useful table is included in which data are given concerning recently erected solar furnaces at Jena, Germany, by the Zeiss Company; at Meudon and Mont Louis, France, by F. Trombe and co-workers; and at Kansas City, United States, by Mr. Conn and co-workers. The first large solar furnace units were used for qualitative work only; but recently solar furnaces for quantitative work have been developed, and various accessory equipment for heating and cooling a specimen according to a predetermined schedule, for maintaining it at a desired temperature and for air quenching is described. The development of solar furnaces for semi-industrial use is also discussed, and in one type mentioned the usual one-piece mirror is replaced by a collector consisting of a large number of small curved mirrors.

Work Study

The Association of British Chemical Manufacturers organized a two-day conference on works study at Buxton during October 9–10 for senior executives engaged in the chemical industry. The conference was arranged in order to implement one of the recommendations of the Heavy Chemicals Productivity Team, which visited the United States in the spring of 1952. The proceedings of the conference have now been brought together and cover all the addresses given, together with a summary of the main points which emerged at the meetings of the thirteen discussion groups. Among the addresses were descriptions of the techniques of method study and work measurement, the application of work study to financial incentive schemes, the effect of work study on labour relations and the introduction of work study into a factory. All these were contributed by members of the staff of Imperial Chemical Industries, Ltd., an organization which has probably had greater experience in the use of work study than any other in Great Britain. The whole volume has been well put together and will be of practical value not only to those who are introducing work study techniques into factories and offices but also to those who wish to familiarize themselves with its methods and jargon. Copies of the proceedings can be obtained from the Association of British Chemical Manufacturers, Cecil Chambers, 86 Strand, London, W.C.2.

Occupational Medicine in Finland

The Finnish Institute of Occupational Health has recently published its annual report for 1953, which shows how its work is rapidly expanding. In the past two years its staff has increased from 84 to 121 and now comprises the following departments: general, medical, physiological, psychological and industrial hygiene. In the physiological department particularly, a good deal of work has been carried out—some of it with the aid of money from State-controlled football pools—on such topics as the mineral composition of thermal sweat, age and athletic performance in ball games, ski-ing and in wood-cutting, factor analysis of hæmatological changes in heavy manual work and the effects of a ski-ing season on physical fitness. In the psychological section the following subjects have been investigated: job analysis in the metal industry, selection tests for miners, statistical analyses of accident proneness with especial regard to the relationship between age and accident proneness, fitness tests for drivers, method of selecting X-ray assistants for hospitals, studies of the condition of intoxication and so-called "hang-over studies". The report also contains a list of publications of the Institute during the year, which was marked by twenty generous donations amounting to a total of 1,350,000 Finnish marks. The donors came from industry, insurance companies and workers' organizations.

Pest Infestation Laboratory: Report for 1953

The annual report for 1953 of the Pest Infestation Laboratory, Slough, of the Department of Scientific and Industrial Research (pp. iv+46+4 plates. London: H.M.S.O., 1954; 2s. net), shows that the range of activities of this centre of entomological research continues to enlarge. During the year the new biochemical laboratories were opened, and this will greatly facilitate the more fundamental work in which the metabolism of various insecticides is being studied, with the object of discovering their mode of action and the nature of the resistance which many insects are developing to certain types of insecticides. But the greater part of the work reported is of immediate practical importance. The ability of a wide range of pests and potential pests to survive under winter conditions in unheated buildings has been studied. In preliminary trials it has been found that sacks impregnated with a mixture of pyrethrins and piperoxyl butoxide retain their insecticidal properties from six to nine months. A simple electrical device, depending upon changes in conductivity, has been developed for rapid estimation of the water-content of bagged grain. Although not so accurate as the usual methods, this procedure is extremely simple and rapid and should prove of much practical value. One of the most important changes in policy which is apparent in this report is a great increase in the amount of work which the Pest Infestation Laboratory is doing for the British Colonies. Most of these investigations concern storage problems, such as the underground storage of grain in pits, the susceptibility of rice to attack by mites, and the contamination of African maize by insect remains and much other filth since the adoption of hammer mills in place of the old method of winnowing the grain and grinding between stones or by pestle and mortar. It is a recommendation of the Pest Infestation Research Board that the Colonial side of the Laboratory's work should be still further strengthened.

Cytology of *Puccinia coronata*

Studies of chromosomes in germinating sporidia of *Puccinia coronata* f. *secalis*, by R. C. McGinnis (*Canad. J. Bot.*, 32, 213; 1954), show that three are present in the haploid nucleus. Hitherto, the very minute size of the chromosomes in the rust fungi has tended to deter cytologists from tackling these organisms. In an earlier paper (*ibid.*, 31, 522; 1953) the same author has reviewed the literature and also recorded a haploid chromosome number of six for *P. graminis* and presented evidence of polyploidy. For if this species is an auto- or allotetraploid, then species with a lower chromosome number must have contributed to its origin. The present study contributes part of the relevant evidence: one of the illustrations shows a nucleus at anaphase with six daughter chromosomes migrating to the poles. It is suggested that three is probably the basic number for the genus and that *P. coronata* may be a constituent species of *P. graminis*.

Forestry in New Zealand

The New Zealand Forest Service has started a new "Information Series" of pamphlets, the first number of which is entitled "Forestry in New Zealand" and is an extract from the "New Zealand Official Year-Book" (pp. 27. Wellington: Government Printer, 1953). The pamphlet is written for the public and deals with the present position of forestry in New Zealand under the headings of national forest policy, forest resources, forest authority, forest management, fire protection, soil conservation, public and private forestry, reclamation of sand dunes, finance of State activity, forest utilization, overseas trade research, principal forest trees, and strength properties of New Zealand timbers. The annual reports of the Service deal with those aspects of forestry work in the routine fashion. But, as the director of forestry complained in his annual report for 1950–51, the public does not read these reports—a fact scarcely to be wondered at in any country where government routine reports are in question. The pamphlet here considered is the director's answer. A periodical brief review for the public of the forestry position in every country owning forests drawn up on these lines would prove of interest to many public men apart from the general reader. The opening statement on national forest policy displays both the object and method of the pamphlet. Forest policy is essentially one of conservation of all existing forests and expansion in bringing on to the ground additional forest areas where they are obviously required, whether of indigenous or exotic species, both on uplands and plains. Not only productivity, but also protective scenic and recreational facilities, should be considered in the objectives. In short, a national forest policy should be drawn for the maximum understanding and enjoyment by the public of those economic and social benefits which forests alone can confer.

Courtaulds' Scientific and Educational Trust Fund: Postgraduate Research Scholarships for 1954

The Courtaulds' Scientific and Educational Trust Fund has recently announced the award of its postgraduate scholarships for 1954, these being the sixth such awards to be made since the formation of the Fund in April 1948. The Fund provides for the establishment and maintenance of scholarships to encourage study and research in those branches of natural science which may be thought likely to assist the textile, plastics or other allied industries. Postgraduate research scholarships in a branch of science related to the textile, plastics and allied industries (maximum of £400 for one year only, but renewable for further periods) have been awarded to the following for research at the places indicated: C. S. Chadwick (Manchester College of Technology), K. H. Garrett (Imperial College of Science and Technology, London), J. H. M. Hill (The Queen's University, Belfast), R. M. Hochestrasser (University of Edinburgh), R. Johnston (University of Liverpool), G. R. Kotten-Kaye (Royal College of Science, Imperial College of Science and Technology, London), J. H. Oxley (University College, London), P. R. Sewell and R. Worrall (University of Birmingham), and T. C. Stening (King's College, London). Postgraduate research scholarships in textile technology (£320 for the first year and £360 for the second year) have been awarded as follows: E. Attle, S. L. Fitton, K. Jarnell and A. Powell (Manchester College of Technology), D. Hardisty, W. G. Kaye, J. A. Leathley and A. Selwood (University of Leeds), and C. D. Ward (Nottingham and District Technical College).

Royal Technical College, Glasgow: Report for 1952–53

This report on research for the session 1952–53 carried out at the Royal Technical College, Glasgow (pp. 40; 1954), gives a brief indication of the range of research in progress in the Departments of Mathematics, Natural Philosophy, Chemistry, Technical Chemistry, Metallurgy, Civil and Mechanical Engineering, Electrical Engineering, Mining Engineering, Architecture, Town Planning and Building, Pharmacy and Bakery, Textile Technology and of Industrial Administration. To most of these departmental summaries a list is appended of the most important publications during the year, with abstracts, and the titles of theses approved for higher degrees are also listed separately under departments. The report replaces the former *Journal* of the Royal Technical College, the publication of which has now ceased.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: P. S. Castle and L. F. Derraugh (agricultural officers, Gold Coast), senior agricultural officers, Gold Coast; W. E. M. Logan (regional assistant conservator of forests, Tanganyika), deputy chief conservator of forests, Tanganyika; R. G. Sangster (deputy chief conservator of forests, Tanganyika), chief conservator of forests, Tanganyika; W. J. Gray (veterinary officer, Nyasaland), veterinary officer, Northern Rhodesia; J. McCulloch (principal veterinary officer, Eastern Region, Nigeria), deputy director of veterinary services, Northern Region, Nigeria; R. I. McQuistan, agricultural officer, Sierra Leone; J. B. Taylor and B. Woodhead, agricultural officers, Nigeria; R. K. Claydon, veterinary officer, Nyasaland; M. R. E. Durand, veterinary officer, Kenya; D. Bleackley, geologist, British Guiana; D. I. Nicholson, ecologist, North Borneo; D. Slater, veterinary officer, Nigeria.

Announcements

To mark the bicentenary of the birth of William Murdoch, pioneer of the gas industry, a Murdoch Memorial Lecture has been arranged by the Institution of Gas Engineers, which will be delivered by Dr. Alexander Fleck, chairman of Imperial Chemical Industries, Ltd., in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1, on October 5, at 6 p.m. Admission to the Lecture will be by ticket. Further information can be obtained from the Secretary of the Institution at 17 Grosvenor Crescent, London, S.W.1.

The Scottish Group of the Nutrition Society is holding a symposium at Dundee on October 23 dealing with "Disorders of the Alimentary Tract and their Nutritional Effects". Papers will be read that deal with the absorption of vitamins, minerals and fat, and also on the subject of food allergies. Further information can be obtained from Prof. R. B. Hunter, Department of Pharmacology and Therapeutics, The Medical School, Queen's College, Dundee.

The Sciences Committee of the Scientific Film Association is arranging a meeting to take place in the theatre of the Shell Film Unit, Shell-Mex House, Strand, W.C.2, on October 14, at 6.30 p.m., for the introduction and exhibition of films made to record or illustrate advances in chemical research—pure, physical or applied. The meeting is to demonstrate how film-making can implement investigational work. The meeting is open to the public.

The sixth Canadian High Polymer Forum, which is devoted to all aspects of high polymer chemistry, will be held at Ridley College, St. Catherines, Ontario, during April 14–15, 1955. Contributions to the Forum should be sent as soon as possible to the programme chairman, Dr. H. L. Williams, Research and Development Division, Polymer Corporation, Ltd., Sarnia, Ontario, and confirmed with a two-hundred word abstract not later than February 15. Inquiries regarding accommodation should be directed to Mr. D. S. Fensom, of Ridley College. General information on the Forum can be obtained from the secretary-treasurer, Dr. D. G. Ivey, Department of Physics, University, Toronto, Ontario.

An official Catalogue of the National Collection of Yeast Cultures is now available from the Brewing Industry Research Foundation, Nutfield, Redhill, Surrey, where the Collection is maintained.

Erratum. The report of the Royal Meteorological Society's symposium on "The Upper Atmosphere" (*Nature*, August 21, p. 334) contains an incorrect statement about the directions of *F*-region movements observed from the Jodrell Bank Experimental Station. In the auroral zone the drift movements are predominantly towards the west during the period 09–21 hr. and towards the south-east or south-west thereafter. In the zenith the movements are towards the west during 18–01 hr. and towards the east during 01–05 hr. A detailed account of these observations is given by Maxwell and Dagg (*Phil. Mag.*, 45, 551; 1954).

SOCIETY FOR THE STUDY OF FERTILITY

ANNUAL CONFERENCE

THE annual conference of the Society for the Study of Fertility was held in the Meeting House of the Zoological Society of London during July 22–23, when the opportunity was also taken to celebrate the fifth anniversary of the Society's existence. The proceedings opened with a paper by R. Irving-Bell on the routine clinical examinations carried out at the Male Subfertility Clinic at Bristol, followed by a group of three papers from the Department of Anatomy, Liverpool, by Prof. R. G. Harrison and his colleagues, on some fundamental aspects of the structure and function of the rat testis and the male accessory organs. In the first paper, concerned with the influence of freezing temperatures on the rat testis, Prof. Harrison and Miss Jean Macdonald elaborated in detail their thesis that the adverse effects of low temperatures on spermatogenesis are due directly to ischæmia. Next, E. W. Macmillan gave an account of his experiments on the anatomical factors in the male which determine the normal rate of disposal and dissolution of epididymal spermatozoa, and which predispose to the formation of spermatocoele. E. J. Clegg described the response of rat accessory glands to the interruption of arterial blood supply. His finding that, when deprived of the normal blood supply, the coagulating glands cease to secrete fructose is a good indication that the blood-flow in the accessory reproductive organs is of decisive significance for composition of the seminal plasma.

Dr. Cecilia Lutwak-Mann (Cambridge) spoke next on the physiology and biochemistry of the near-implantation stages of pregnancy in the rabbit. She has found that very little glucose is present in the young unattached blastocyst (six days after fertilization), but that the content of this sugar begins to increase markedly as implantation progresses. This is in contrast to the content of bicarbonate ions, which in the unimplanted blastocyst are almost three times more concentrated than in the maternal blood but which decrease to maternal serum-level after the implantation. The remarkably high content of bicarbonate in the free-lying blastocyst coincides with the appearance in the mucosa of the pregnant uterus of carbonic anhydrase, the zinc-protein enzyme which is well known to be concerned with bicarbonate metabolism in the animal body. From Dr. Lutwak-Mann's experiments concerning the passage of a variety of substances from the maternal blood stream into the blastocyst, it appears that, so long as the blastocyst remains free in the uterus, it is largely independent of major changes in the maternal blood composition. Once implantation is completed, several substances, including certain drugs, are capable of passing freely from the maternal blood into the blastocyst cavity.

This paper was followed by a group of three reports, all of them concerned with different clinical aspects of human infertility: D. M. Shotton (Birmingham) spoke on the obstetric management of infertile women, M. C. N. Jackson (Exeter) presented her records on the follow-up of infertility cases, extending over many years of observation, and Dr. J. Loewenstein (London) described in detail the use of mechanotherapy in subfertile men.

The session on the next day opened with a paper by Dr. E. J. Farris (Philadelphia) on the value of ovulation timing in the sterile couple, followed by two other guest-speakers from abroad: Dr. G. E. Seegar Jones (Baltimore), who discussed the relationship between adrenal hyperplasia and fertility, and Dr. Raoul Palmer (Paris), describing the use of cœliscopy in the diagnosis of reproductive disorders in women. The remaining papers centred largely on the problem of male sterility and sperm physiology and biochemistry. Dr. G. I. M. Swyer (London) commented critically on the value of testicular biopsy as a clinical procedure. Dr. A. S. Parkes and Dr. P. Spensley, from the National Institute for Medical Research, Mill Hill, reported on their experiments with 'Rehibin', a condensation product of gentisic acid, and on certain other new macromolecular polyacids in relation to their action on hyaluronidase and the fertilizing capacity of rabbit spermatozoa. An interesting fact brought to light by these researches was that, in spite of the marked inhibitory effect on sperm-hyaluronidase which coincided with a decrease in fertilizing capacity, 'Rehibin' and similar polyhydroxybenzoic acid condensation products are not necessarily spermicidal agents—for example, they do not deprive the spermatozoa of their motility and metabolic activity.

Metabolic processes in spermatozoa and their relation to the so-called dilution effect were dealt with by Dr. M. W. H. Bishop (Cambridge), who reported also on the use of a new glycine-containing artificial medium in the practice of semen preservation. He was followed by Dr. T. Mann (Cambridge), who spoke on the biochemical mechanisms underlying the action of spermicidal agents, and on his recent investigations which make it possible to distinguish clearly three groups of spermicidal substances: enzymic inhibitors, which act directly upon certain intermediary reactions in sperm respiration and fructolysis; sulphydryl-binding substances which combine with the vital thio-groups in spermatozoa; and surface-active substances which owe their spermicidal property to a detergent action on lipoprotein and other protein-constituents of the sperm-cell.

As in previous years, the papers presented at the Conference will be published by W. Heffer and Sons, Ltd., Cambridge, as a separate volume (No. 6) of the *Proceedings of the Society for the Study of Fertility*.

METEOROLOGY AND SCOTTISH AGRICULTURE

TWO symposia were held by the Royal Meteorological Society as part of its summer meeting during July 15–17 in the Natural Philosophy Department of the University of Edinburgh. The first was on "The Upper Atmosphere" (see *Nature*, August 21, p. 334), and the second, which was held on July 17, was devoted to "Meteorology and Scottish Agriculture". The first speaker at this latter symposium was Dr. John Grainger (West of Scotland Agricultural College, Auchincruive), who suggested, by graded examples, that studies on relationships between climate and crop diseases should consider effects on the host plant, in addition to those on the parasite.

The attainment of a soil temperature of 45° F. (7·2° C.), for example, imposes an initial limit to the activity of larvæ of the potato root eelworm, with no such limit to growth in the early Epicure potato-host. This has important economic and pathological repercussions, and the growth of such early crops provides, moreover, the only cultural possibility of obtaining even moderate yields on infested land. Low incidence of club root disease of swedes is associated with a relatively high soil temperature in July, relatively high amounts of bright sunshine in June, July and September, relatively low rainfall in September, and relatively high rainfall in October. The effect of bright sunshine on disease can only arise through its effect on the host. Practical measures for the grower would be to control soil moisture in September and October.

A second paper by Dr. Grainger, in which he had collaborated with J. L. Sneddon, E. de C. Chisholm and A. Hastie (Auchincruive), reported that higher yields of barley grain are related to lower maximum air temperature and higher rainfall in June. The production of bean grain is stimulated by higher average maximum air temperature in May, lower bright sunshine in June, and higher rainfall in July. Yields of oat grain are higher with lower average air temperature in July, and wheat grain with lower average air temperature in April and higher rainfall in July. Winter varieties of wheat give higher yields of grain when, in addition to these correlations with climate in April and July, there is a lower amount of bright sunshine in March. The practical value of the results lies in the precision they bring in suggesting that conservation of soil moisture is most necessary in particular months for each crop in a given area.

Dr. F. L. Waterhouse (University College, Dundee; University of St. Andrews) gave detailed assessments of seasonal and diurnal differences in climate within grass crops, with the view of their suitability for the development and successful existence of insects. The differences are mainly related to the height, density and mode of growth of the crop and also to the angle of the sun's rays. A matted basal layer of dead grass in wild grassland, or the co-existence of a clover crop in hay and silage fields, maintains a cool humid atmosphere next to the ground. This is favourable to insects when more arid conditions exist at higher levels, where wind speed is the most significant factor. These varying conditions can make available to an insect a considerable range of body temperatures and states of water-loss during periods of insolation. The presence of broad-leaved weeds can interfere with the relatively uniform habitat presented by pure grassland.

A preliminary report on continuous records of profile soil temperatures within an afforested area was given by Dr. J. R. H. Coutts (Soil Science Department, University of Aberdeen), who said that mean annual temperatures were found to be practically the same throughout the soil profile, but that inversions of the profile occurred in April and August. Future results from this study should yield information of considerable importance. Mr. J. M. Caborn (Forestry Department, University of Edinburgh) reviewed work on the effect of shelter belts on the climate of the areas influenced by them. He laid stress upon the density of the shelter. A completely dense belt, for example, is 80 per cent ineffective at 10 heights away in the lee, whereas a less-dense belt is effective 15 heights away, and a density of 50 per cent has been found to be the most effective. In detail the temperature in the lee of a shelter belt is often 1° F. higher than in the open, during the day; relative humidity is about 3 per cent less in the lee, and soil moisture is about 1 per cent higher in this area. Crop yields have also been found to be higher in the lee of shelter belts.

Mr. F. H. D. Green (Nature Conservancy) considered the importance of climate and climatic studies on the ecological work of the Conservancy. One important conclusion is that the climate and conditions in mountain-top valleys should not be considered on a basis of their floor altitude, but as part of the mountain top itself. An indirect effect of summer rainfall on the response to phosphatic fertilizers was mentioned by Dr. A. M. Smith and Dr. K. Simpson (East of Scotland College of Agriculture, Edinburgh). It is fairly common knowledge that response to phosphatic fertilizers tends to be small in a dry season and high in a wet one. It was found, however, that the percentage recovery of phosphorus is more closely related to soil pH than to summer rainfall. The correlation between phosphate recovery and soil pH is, nevertheless, much more significant when the effects of summer rainfall are eliminated.

The symposium served a most useful purpose. Biologists and meteorologists have remained separate for too long, and it is to be hoped that this conscious joining of their forces may be followed by further similar meetings.

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT FOR 1953–54

THE annual report of the Astronomer Royal for the period May 1, 1953–April 30, 1954 deals as usual with three separate sections of the Royal Greenwich Observatory in Greenwich, Abinger and Herstmonceux*. The Greenwich Octagon Room, which was formally opened on May 8, 1952 (referred to in last year's report), is accessible to the public, and Halley's transit and Bradley's zenith sector are displayed in the room, as well as copies of various old prints of the Observatory. A considerable amount of work has been done to the New Building, and the hot-air furnaces have been overhauled; repair and maintenance work has been carried out in the old buildings, and the boundary fences have been repaired and strengthened. A new boiler has been installed for heating the Record Rooms and Time Department Office.

The Yapp 36-in. reflector has been used with the single-prism spectrograph in continuation of observations of the standard stars of the Yerkes Atlas, and 86 spectra of 74 stars have been secured. During October 30–April 26, while the 21-ft. eclipse telescope was under test, the instrument was out of use. In last year's report reference was made to the proposal to televise Jupiter and its satellites, and on January 13 the scheme was carried out with great success; unfortunately, the next night, on which a full-scale programme was scheduled, was cloudy, and a 'stand-by programme' had to be substituted.

* Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, Read at the Annual Visitation of the Royal Observatory, June 12, 1954. Pp. 30. (Herstmonceux: Royal Greenwich Observatory, 1954.)

Observations at the Magnetic Observatory, Abinger, are so disturbed by the local electric railways that the Board of Admiralty has approved, in principle, its removal to a site near Hartland, North Devon. It is highly desirable that observations in the new site should begin not later than the middle of 1957, and an overlap of observations with those at Abinger of at least a year will, it is hoped, include the International Geophysical Year. If it does, the magnetic data for that year would then include results from two observatories in the south of England and from the two northern observatories at Lerwick and Eskdalemuir.

While substantial progress in the removal to Herstmonceux has been made, it is disappointing that delays in the construction of the meridian group of buildings have taken place; the transit circle building is still unusable, and the photographic zenith tube building has only reached the foundation stage. The decision by the Admiralty that no official houses for the observing staff will be provided at Herstmonceux increases the need for close co-ordination between the building programme at the Observatory and the provision of houses for the staff through the local Rural District Council. The delay in the completion of the consulting architect's plans for the buildings to house the Time Department, the Nautical Almanac Office and the workshops will still further postpone the date of the removal.

Mr. J. Evershed has presented the Observatory with the principal parts of his solar spectroscope from his private observatory at Ewhurst; these include a coelostat for a 15-in. mirror, a train of three large liquid prisms and many accessory items. He had previously presented the Observatory with a pair of large solid glass prisms of 45° angle and a 21-ft. collimator lens. The large reflecting prism of 30° angle which the Royal Society had lent him has been transferred to the Observatory.

Cosmic ray recording with the Clintel apparatus has been continued, but some of the data obtained were unreliable: some modification of the apparatus has, in consequence, been done. The investigations of the atmospheric cosmic-ray Čerenkov effect have been discontinued because the slit in the solar dome was found to be too narrow for a satisfactory arrangement. A project of high-energy shower recording has been given some consideration.

The "Nautical Almanac" for 1955, which was published in April, contains a list of observatories, the first it has given since 1941, and, generally speaking, the list is confined to those observatories of which the work demands a knowledge of accurate values of the geographical co-ordinates. To comply with the recommendations of the International Astronomical Union made at the Eighth General Assembly in Rome in 1952, the first part of the "Nautical Almanac" for 1960 has been completely redesigned, and preparations of copy for 1960 will soon be started. Good progress has been made in the calculation of the ephemerides of the sun and planets for the years 1960–80. In the report of the Observatory for 1952–53, reference was made to the preparation of illustrative examples for the use of different methods of calculating perturbations of comets and minor planets for the third volume of "Planetary Co-ordinates", and Encke's method has been completed, while Hansen's method is nearly finished. Some progress has been made with the method of variation of elements and with Herrick's method of variation of parameters. In connexion with the "Star Almanac", the 1955 edition of which is expected to appear in June, it is interesting to know that it is now an established success and that reprints have been necessary in 1953 and 1954 in spite of printing increased numbers.

The figuring of the 98-in. disk of the Isaac Newton telescope has been suspended pending further tests in August during the works holiday period, when there will be an absence of vibration from heavy machinery. The broad features of the design of the mounting have been decided: it will be an offset fork mounting with polar axis in the form of an inverted and truncated cone.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

ANNUAL REPORT FOR 1953–54

THE annual general meeting of the Indian Association for the Cultivation of Science was held on July 30 at Jadavpur, Calcutta. Prof. P. Ray, acting director, in presenting the annual report on the Association for 1953–54, said that the six research departments, the library, the workshop and the administrative office continued to function actively for the third year in the new research laboratory building at Jadavpur. The Association has prepared a five-year plan of development, covering the financial years 1954–59, which envisages, for the existing departments, the expansion of facilities with respect to equipment and staff so as to consolidate the present research activities and also improve the level of efficiency, but does not involve establishment of any new department. For the five years 1954–59, the non-recurring requirements of the Association for equipment, standard reference books, etc., have been worked out at Rs. 1,138,200, and the projected development under land and building would involve an expenditure of Rs. 1,771,393. During the same period the normal recurring grant for running the Association will have to be increased from Rs. 465,630 in 1954–55 to Rs. 777,415, thus requiring a total sum of Rs. 3,227,592 for the entire five-year period. It is expected that the Association's non-recurring demand will be met by the Government of India and the Government of West Bengal in the proportion of 2 : 1. The present recurring charges will continue to be borne by the Government of India, and it is expected that the additional requirements will be also borne by the Governments of India and of West Bengal in the proportion already mentioned.

Prof. Ray reported that the Association has under operation four research schemes of the Council of Scientific and Industrial Research of the Government of India, three research schemes under Prof. S. R. Palit and one under Prof. B. N. Srivastava. The Government of India, through the Ministry of Natural Resources and Scientific Research, has established a number of senior and junior scholarships for providing research training to deserving students at the Association under the Scientific Man-Power Committee Scheme.

During the year the Association started a publication section and undertook the publication of a number of books and monographs, including a book on the history of science in Bengali, "Bijnaner

Itihas", by Sri S. N. Sen, which was subsidized by the Government of Bengal, "Nuclear Induction", by Dr. A. K. Saha and Sri T. P. Das, and a monograph, "Non-aqueous Titration", by Dr. S. R. Palit, Dr. M. N. Das and Sri G. R. Somayajulu. Of the lectures given during the year, Prof. G. I. Finch, who was awarded the Association's Jay Kissen Mookerjee Gold Medal for 1950, delivered a course of three lectures on electron optics and study of surfaces, crystal growth in electro-deposition and in surface reactions, and polish, mechanical wear and lubrication; and another course of three lectures was given by Dr. J. N. Ray, as Coochbehar professor for 1949, on carbohydrate metabolism and the role of some plant nucleotides in the phosphorylation of glucose, curariform drugs and their action and anæsthetics. The Ripon professorship lecture for 1950 was delivered by Prof. T. R. Seshadri, who spoke on a line of investigation in the field of plant drugs and insecticides, and Dr. S. K. Banerjee, Dr. M. S. Krishnan and Dr. D. S. Kothari, the Ripon professors of the Association for the years 1948, 1949 and 1950, delivered lectures on, respectively, Himalayan earthquakes; ancient Indian iron-ore and its manufacture, the iron ore deposits in India, and the modern iron industry in India and its future prospects; and recent advances in statistical thermodynamics. Dr. Dilip Kumar Banerjee was awarded the Sri John Wood Burn Medal for 1950 and gave a lecture on steroid synthesis. Dr. J. C. Ghosh, the retiring president of the Association, delivered the Memorial Lecture, speaking on the petroleum industry with special reference to India, this being the occasion of the fiftieth anniversary of the death of the late Dr. Mahendra Lal Sircar, the founder of the Association. A symposium on high polymers, including rubber, resins and plastics and fibre, was organized during the year by the Department of Physical Chemistry of the Association, and was followed by a very successful three-day summer course on the subject.

In his report, Prof. Ray gave a brief review of the work carried out in the six research departments of the Association during 1953–54. In the Department of General Physics, X-rays and Magnetism, studies were made on transport properties of matter, thermodynamics of irreversible processes, low-temperature physics, X-ray crystallography, study of low-angle scattering, X-ray study of coal, X-ray study of glass, crystal magnetism, cryogenics, and semiconductors. Investigations carried out in the Department of Optics have related to ultra-violet absorption spectra or organic substances in the solid state at low temperatures, Raman spectra of some organic compounds in the solid state at low temperatures, Raman spectra of organic compounds in the vapour state, Raman spectra of liquids and solutions, relaxation time of polar molecules in the liquid state, absorption of ultra-high-frequency radio waves by organic liquids, absorption of microwaves by organic liquids, and cosmic rays. In the Department of Theoretical Physics, investigations were carried out in meson field theories and nuclear scattering, Born approximation and its connexion with covariant perturbation theory, capture of electrons by ions passing through gases, cosmology, and nuclear shell structure model. The Physical Chemistry Department has conducted its research activities under two broad headings: high-polymer chemistry, and general physical chemistry. Under high-polymer chemistry some of the problems investigated relate to chain transfer in vinyl polymerization, copolymerization, kinetics and chain transfer studies in polymerization initiated by hydrogen peroxide, vinyl polymerization with metallic soaps, kinetics and chain transfer studies with substituted peroxide and azonitriles, synthesis of hydro peroxides and their use in polymerization, polymerization in the aqueous phase, physico-chemical studies on cellulose compounds, polyelectrolytes, studies on reaction kinetics, fractionation and distribution of polymers. Kinetics of the decomposition of peroxides, studies in co-solvency, non-aqueous titration, alkalimetric determination of mercury, and measurements of dipole moment constituted some of the problems of study under general physical chemistry during the year. In the Department of Organic Chemistry, work was carried out in diterpenoids, dicyclic terpenes, steroids, polynuclear aromatic hydrocarbons and related subjects. The chemistry of co-ordination complexes and analytical chemistry were the two broad subjects for investigation by the research workers of the Department of Inorganic Chemistry.

The complete Council of the Association is as follows: *President*, Hon. Sri C. C. Biswas; *Vice-Presidents*, Prof. S. K. Mitra and Dr. K. S. Krishnan; *Director*, Prof. M. N. Saha; *Members*, Prof. N. R. Sen, Dr. Atmaram, Dr. B. C. Guha, Dr. Triguna Sen, Prof. P. C. Mahanti, Sri Ramani Mohan Roy, Dr. J. C. Ghosh, Dr. Hiralal Roy, Dr. B. B. Dey, Dr. S. R. Bose, Sri J. M. Sen and Dr. D. N. Wadia; *Trustee Member*, Hon. Mr. Justice R. P. Mookerjee; *Nominees of the National Institute of Sciences of India*, Dr. K. N. Bagchi and Prof. D. S. Kothari; *Nominees of the Government of India*, the Secretary of the Ministry of Natural Resources and Scientific Research (or his nominee), the Educational Adviser to the Government of India (or his nominee), Sri C. S. Menon, and the Joint Secretary to the Ministry of Finance, Government of India; *Nominee of the Government of West Bengal*, Dr. D. M. Sen; and *Professor Member*, Prof. B. N. Srivastava.

MELLON INSTITUTE, PITTSBURGH

ANNUAL REPORT FOR 1953–54

THE annual report of the president of the Mellon Institute, Dr. E. R. Weidlein, to the Board of Trustees for the year ended February 28, 1954*, refers to growth in the size of fellowships in operation and an increase in comprehensive fundamental projects. Almost a quarter of the Institute's expenditure of 4,375,712 dollars was spent on investigations in pure science in the Institute's six research departments and on eleven fellowships, 131 members of the Institute being engaged in pure science research projects. 383 members were engaged in the sixty-five fellowships in applied science, and, of forty-nine multiple fellowships and twenty-seven individual fellowships listed as in operation during the year, two had been proceeding for forty years, five for thirty-five, one for thirty, ten for twenty years and twenty-five others for more than ten years.

In the Department of Chemical Physics the Raman spectrum of dicyanoacetylene has been redetermined on a larger sample, using a new grating in the Raman spectrograph. The Raman-active fundamental postulated at 260 cm.$^{-1}$ in earlier work has now been observed at 263 cm.$^{-1}$, and the vibrational spectrum of hexafluoro-Δ^{2}-butyne has been interpreted in fairly complete detail. An extensive survey was made of the alkali metal content of calcite marbles by emission spectrographic analysis, and an earlier photographic technique for the study of the diffraction structure of carbon black has been replaced by a speedier and more accurate X-ray spectrometric method, in which the monochromatization of the X-ray beam is achieved through the low sensitivity of the argon-filled Geiger tube for the short wave-lengths of the white radiation, and a small residual correction made empirically. An improved quantitative method has been developed for measuring crystallinity in elastomers, and an instrument has been constructed for the precision measurement of linear distances on diffraction films.

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* Scientific Research of Mellon Institute, 1953–1954. (Annual Report Series, No. 41.) Pp. iv+56. (Pittsburgh: Mellon Institute of Industrial Research, 1954.)

In the Physical Chemistry Department the Mellon Institute digital computer was being built for a new Department of Applied Mathematics, and is of the low-speed magnetic drum type with large storage capacity. At the end of the year this Department was combined with the Department of Physical Measurements, which has been responsible for several advances in the application of thermal diffusion to the separation of organic liquids, and has recently modified the gas-adsorption apparatus so as to permit the use of krypton or argon-gas for surface-area measurements of materials with low area. In the Department of Instrumentation a method has been devised for the determination of humidity based on the titration of a concentrated solution of lithium bromide with water until the solution humidity balances the atmospheric humidity, and a preliminary study made of the electrical pulse transmission characteristics of sodium chloride solutions.

A programme of research on drug standards which has been continued for twenty-three years in the Department of Organic Chemistry has now been divided, leaving the Department responsible for aromatic chemicals and surgical supplies. It is hoped now to turn attention to the development of systematic schemes for distinguishing chemically the individual analogues in groups all of which possess therapeutic value, and to the investigation of the use of heteropoly inorganic acids in the determination of organic bases. In the Division of Analytical Chemistry an attempt was being made to develop a scheme of analysis for sulphur compounds in crude oil and petroleum fractions, while the study by the Division of Microbiology and Microscopy of the bacteriology of bituminous coal-mine effluents has given a clearer understanding of the bacterium responsible for increasing the formation of acid from sulphuritic materials associated with bituminous coal.

Among the investigations of the pure science fellowships noted in the report may be mentioned those on techniques for ascertaining the quantitative distribution of pollution from industrial or other sources over large geographical areas, in which, for example, an hourly dust-fall sampler was developed, and the work on simpler and more reliable apparatus and techniques for measuring dust loading in stack gases. Results already obtained in a long-range investigation in the toxicological laboratory have demonstrated that the acute toxic effects of fine synthetic and natural inorganic particles may be of fundamental importance in explaining the action of fine particles on lung tissues. Zinc dust fires and zinc losses in metallizing operations were under investigation to learn why frequent fires occurred in the dust-collector system, and to see if zinc losses through the dust collector could be reduced. Preliminary studies were made in the pharmacology of eighty newly available chemicals and more advanced investigations on thirteen other compounds likely to be retailed. The plastisol shoe-pillar devised under the multiple fellowship on orthopædic appliances has relieved some two hundred cases of foot distress, an improved knee lock has been developed for an aluminium tubular brace, and the project on the traction brace has supplied a means of walking for persons with missing or dislocated hip joints.

Fundamental researches in glass science have included the design and assembly of microwave spectrographic equipment for following paramagnetic resonance absorption, the spectrophotometric study of the colour centres of irradiated natural crystalline silica samples, and the study of glass surfaces. Under the multiple fellowship on the properties of synthetic rubber, increased attention has been given to molecular size, chain stiffness and the extent to which the long-chain molecules may deviate from linearity because of branching. A semi-quantitative method has been developed for estimating the degree of branching in diene polymers, and research on the dynamic and flow properties of concentrated solutions of polymers has resulted in a theory of flow of visco-elastic materials which accounts for non-Newtonian viscosity, dynamic behaviour and the 'normal stress' or Weissenberg effect. The fellowship on artists' materials has succeeded in isolating factors involved in the ageing of spirit varnishes and in developing materials superior in each respect. Under the multiple fellowship on computor components two novel devices for storing binary information were developed and tested, and the non-linear voltage-current characteristics of semi-conducting materials were further applied in constructing complete logical switching circuits.

Researches under the applied science fellowships included the development of an improved synthetic lubricant for horological instruments; the improvement of selenium power rectifiers; the development of improved methods for testing the effect of weathering on glazes and coating materials for bricks and tiles, and of a more satisfactory method for determining the refractoriness of materials used in industrial furnaces; and studies of the dynamic properties of glass at temperatures in the transformation region, which point to the possibility of manufacturing glass with a permanently oriented structure. The ceramic chemicals fellowship has concentrated its effort on simplifying enamel formulations so as to determine more precisely the effects of varying amounts of single components and of combinations of two or more components. Under the abrasive grinding wheel programme, investigation of factors which influence residual stresses in ground surfaces of tool steel has been extended to a study of the effect of grinding severity on residual stresses in ball-bearing steel. Another fellowship is exploring the chemical behaviour of silicon carbide with the view of finding new uses for this compound; the chemical storage fellowship has investigated widely the storage of aminoethyl alcohol, lard, tallow, raw sewage sludge, calcium carbonate and acetylene, and much work was done on the cause of cracking in making welded joints and on the properties of the metal in welded joints. Further progress is reported in the development of the icosasphere, a new type of spherical tank, and research continued on components for supersonic wind tunnels, as well as on the 'Stypol' resins, a series of liquid thermosetting materials devised by the Robertson multiple fellowship on protected metals. Research was started on the chemistry of the nickel sulphides, and the multiple fellowship on coal-waste control has recommended methods of constructing refuse piles that assure a desired degree of resistance to spontaneous, incidental or deliberate ignition and has studied in the field a number of methods of extinguishing refuse fires.

The multiple fellowship on acid recovery has extended its scope to include the investigation of other wastes from the manufacture of steel, besides spent pickle liquor, and a survey of literature on the toxicity to aquatic and animal life of substances in streams and on tastes and odours has induced an investigation to determine whether a balance between phenol-consuming and phenol-producing organisms can result in a phenol equilibrium concentration. The chemical potentialities of pyridine were being studied, as well as the development of methods for the treatment and disposal of industrial wastes, the utilization of the ethylbenzene in aromatic petroleum-naphtha fractions for the manufacture of styrene, and the suitability of plastic pipe in a low-pressure distribution system for natural gas. A study of the kinetics of the oxidation of lubricating oil has been leading to new concepts of the function of additive materials in the process, and work on hydrocarbon synthesis over catalysts of the iron group was being completed. Much effort was being given to the development of analytical techniques for detecting and determining the sulphur compounds of petroleum. Work continued on the composition of petroleum waxes and the relation between their composition and physical and engineering properties, and a theory has been formulated which relates the solubility of a gas in wax to the critical constants of both solvent and gas.

A chemical study of the pyrrole pigments and their relations to the chlorophylls and hæmins was resumed, while that of the chemical composition of petroleum waxes and petrolatums led to the devising of special analytical techniques for measuring the physical properties of small fractions. Further detailed research was conducted on the factors affecting absorbent efficiency in cane-sugar refinery operations, and experiments on the variation in composition of gases dissolved in purée fruit and vegetable products over prolonged storage confirmed that a fundamental reaction in discoloration is oxidation. Most of the end-products of the discoloration of fruit and vegetables are small enough to go through a dialysis membrane. Compositions containing piperonyl butoxide have now been shown to be safe and effective additions for protecting grain and other stored products from infestation by insects. Zein emulsions have been obtained which possess low viscosity at high solid content and yield films comparable in clarity, gloss and resistance to water to coatings obtainable from alcoholic solutions. Investigations of industrial fabrics have centred on the improvement of dimensional stability and resistance to heat, water and chemicals, and those on alkyd resins indicate the value of 1 : 3-dimethyl-2-hexenolide as component. Work on the utilization of non-ionic surface-active agents has progressed, and much was done on test methods for evaluating soil conditioners and on the utilization of vinyl resins and silicones.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1953

IN the annual report for 1953 of the Rothamsted Experimental Station*, it is apparent to the most casual reader that the research staff of the Station have been by no means idle during the year covered by the report. The rapid expansion in the scope of Rothamsted's activities since the Second World War—there are at present approximately three hundred and seventy people actively engaged in research and administration—has necessitated an active building programme, and several new buildings are being provided to meet the more pressing needs for accommodation.

In the Chemistry Department the assessment by laboratory and field tests of the agricultural value of water-insoluble phosphates is receiving attention in view of the attempts made by manufacturers to economize in the use of sulphuric acid for phosphatic fertilizer production. In general, the outstanding merits of water-soluble phosphates on most classes of land have again been evident, particularly when used as a starter dose placed close to the seed; but on some soils and with certain crops, various forms of insoluble phosphates have yielded results comparable to superphosphate. On all classes of soil, with potatoes and swedes, dicalcic phosphate in finely divided form gave results only slightly inferior to superphosphate; silicophosphate gave good results with potatoes on very acid soils, but was markedly less effective on moderately acid and neutral soils. On the other hand, 'Gafsa' phosphate was ineffective for potatoes on even very acid soils. All three forms gave good results with swedes. Experiments with nitro-phosphates indicate that the phosphate in these compounds has a value akin to that in high-soluble basic slags.

Work on fertilizer placement with potatoes indicates that with moderate dressings better results follow when the fertilizers are placed than when broadcast; the reverse is the case when heavy dressings are applied. With horticultural crops—lettuce, cabbage, beetroot, broad beans and runner beans—better results are obtained by placement of fertilizer.

In the Physics Department, work on the crumb structure of soils continues, and a technique for measuring the resistance of crumbs to dispersion developed. Using this technique on grass and lucerne plots sited on a field that had been under arable cultivation for many years, it has been established that two to four years under grass has materially improved the cohesion of the surface crumbs. By using a deep-rooted crop to dry out the subsoil during the summer, the permeability of heavy clay soils during the winter months may be improved, a point of practical importance to those concerned with drainage of heavy clay soils.

A simple method for measuring the deficit of divalent ions in soils flooded by sea water has been devised and will be used for estimating the dressings of gypsum needed on such land to prevent breakdown of crumb structure during the next few years.

The production of antibiotics in the soil by certain Actinomycetes and their influence on combating root-infecting fungi is being studied by the Soil Microbiology Department. Such antibiotics tend to be adsorbed and rendered inactive by certain soil constituents, particularly the clay fraction, and attempts are being made to ascertain which Actinomycete antibiotics are least affected in this way and to measure their activity in various types of soil. Pot experiments have definitely confirmed that root rot by *Helminthosporum sativum* is significantly reduced by some of the Actinomycete strains.

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* Report of the Rothamsted Experimental Station for 1953. Pp. 228. (Harpenden: Rothamsted Experimental Station, 1954.) 7s. 6d.

The work on the nodule organisms of legumes has reached an interesting stage. The number of nodules developing on the root is apparently determined more by the susceptibility of the root to infection than by the population of the nodule bacteria surrounding it, and in the case of clover it has been shown that hereditary factors influence the time at which the nodules first appear, the number of nodules produced and their effectiveness in fixing nitrogen.

In the Botany Department it has been established that some of the ill effects of excess of manganese, vanadium and molybdenum may be prevented by increasing the supply of iron, and farmers troubled with wild oat infestation will learn with interest that the sowing of winter corn instead of spring corn will result in lessened germination, and production, of new seeds by this plant pest.

Heat therapy as an aid in the control of plant viruses has received the attention of the Plant Pathology Department, with variable results. It would appear that viruses of spherical shape are inactivated by heat treatment but not rod-shaped viruses. Much information on other aspects of virus infection is contained in the report.

The study of enzyme action is the main concern of the Biochemistry Department. Special attention is being paid to ribonuclease in view of the fact that every plant virus hitherto obtained in a pure state has proved to be a ribonucleoprotein. Oxidative enzymes are also being studied, since plant hormones and growth regulators are subject to enzymatic oxidation, and such enzymes by their effect on the concentration of these substances may play a part in the regulation of plant growth. The enzymic breakdown of cellulose and chitin is also receiving attention.

Eelworms, which are becoming an increasing menace to cereal and potato growers, are being intensively studied by the Nematology Department. In attempts to combat this pest, endeavours have been made to discover resistant crop varieties and suitable crop rotations for infected land. One spring and two or three winter oat varieties appear to be resistant to stem eelworm attack, but no commercial variety of potato resistant to potato tuber eelworm was discovered. Attempts are being made to obtain resistant varieties by crossing commercial strains with *Solanum indigenum*, which is resistant to eelworm attack. Work is also in progress on root diffusates which stimulate the hatching of eelworm cysts, and on the control of eelworm by the application of chemicals to infested soils.

In the Entomology Department the work on insect migration, on the influence of weather on insect populations, on gall midges of economic importance and on aphid problems has continued. Three points of interest may be singled out: lepidopterous larvæ apparently develop and grow more rapidly when crowded together than when solitary; aphids do not normally reproduce unless they have previously made a flight, however brief; and wheat bulb flies have been successfully bred under laboratory conditions.

The Bee Department's report contains much of importance to apiarists. The fumes produced by adding small quantities of ammonium nitrate to burning smoker fuel provide a simple anæsthetic for use when transferring bee colonies from one site to another a short distance away, since on recovery the bees lose their tendency to drift back to the original site. The known ability of worker bees to cluster together when dispersed in an area in total darkness is associated with their search for warmth and food, and, if a queen is present, for 'queen substance'. Queen honey bees secrete on all parts of their bodies this 'queen substance' which is eagerly sought for by the worker bees, and is considered to be most important in the maintenance of colony cohesion. A temporary shortage of supply of this substance or a breakdown in its distribution leads to toleration by the workers of eggs and larvæ in the queen cup cells and a consequent tendency to swarm. The report contains suggested rules, based on this work, to be followed when introducing to colonies mated queens of any age or strain.

The Insecticides and Fungicides Department has continued its work on particle size and toxicity of suspensions of contact insecticides, and on insect esterases and their inhibition by organo-phosphorus compounds. The work on the relationship between the insecticidal activity and the chemical constitution of pyrethrin-like compounds has now reached an important stage. By means of displacement chromatography four known active constituents have been separated from each other and from some inactive constituents of pyrethrum extract, and their relative toxicities compared. The report also contains much useful information on bio-assay techniques, toxicity-persistence of insecticidal deposits, the mechanism of the selection of strains of insects resistant to insecticides, and, in the field, on the control of *Aphis fabæ* on field beans, control of the vectors of potato virus and control of wireworms.

CITY MUSEUM, BRISTOL

REPORT FOR 1953

THE two well-produced and excellently illustrated booklets*—the annual report of the City Museum, Bristol, for 1953 and the new handbook to Stratford Mill in Blaise Castle House Folk Park—bear unmistakable testimony to that invaluable tripartite combination, an appreciative committee, an understanding and far-seeing director and a loyal and enthusiastic staff.

The inside of the cover of the Museum report details activities and offerings of specimens, collections and services of which Bristol can justly be proud, and the report shows the gratifying and growing response received. The main duty of the Museum is rightly taken to be the portraying of local history and local natural history, and the commendable progress made is recorded in the succeeding departmental reports. Rearrangement of the collections is being made to bring the exhibition series into accord with both modern scholarship and contemporary museum display methods. The new gallery of geology has been opened, and the famous series of Lias and Inferior Oolite ammonites in the Tutcher Collection classified and labelled. Popular study of botany has been encouraged by the wild plant table throughout three of the seasons, while even winter had its offering of displays of twigs. British birds and their nests have been prepared for exhibition, while for students accessions include skins of mammals and birds from the region and the Marle collection of shells, many from the district.

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* City Museum, Bristol. Report of the Committee for the Year ended 31 December, 1953. Pp. 16+2 plates.
Stratford Mill in Blaise Castle House Folk Park. Pp. 8+2 plates. 6d. (Bristol: City Museum, 1954).

The work of the department of archæology ranges from salving small Romano-British relics to erecting "an unclimbable fence" around the Roman villa at Kings Weston, and one wonders if there is any connexion between this and the reference to the unruly behaviour of certain young visitors on Sunday afternoons—a time-honoured complaint that belies "The better the day, the better . . .". Bristol played its part during the year by organizing an administration course for students for the Museums Association diploma, and in its turn sending members of its own staff to technical courses elsewhere. Twenty major temporary exhibitions were staged in the Museum, 3,420 cases of specimens were circulated to schools, etc., and 8,118 children attended for lessons—an entirely creditable performance.

The little handbook to Stratford Mill, costing sixpence, gives on art paper some five pages of text on the history and mechanism of corn-mills in general, and this one in particular, together with a photograph of the mill on its new site and an attractive drawing of its working parts. May we have others on the thatched dairy and the gypsy caravan ?

BLUE HILL OBSERVATORY OF HARVARD UNIVERSITY

THE report of the visiting committee to the Blue Hill Meteorological Observatory, Harvard University, Milton, Mass. (Reprint No. 7, 1953), includes the activities of the Observatory over the previous five years. During this period the facilities of the Observatory have had many users, among which may be noticed not only students working on research problems but also a number of Harvard departments, the United States Weather Bureau, the United States Air Force, the Massachusetts Institute of Technology, Clark University, Illinois State Water Survey, American Meteorological Society, Woods Hole Oceanographic Institution, Mt. Wilson Observatory, the Lowell Institute's Cooperative Broadcasting Council Station *WGBH*, and various business corporations and local towns.

The work of the Observatory staff is concerned with the following topics: evaluation of the Blue Hill and other climatic records, especially as indicators of climatic change; development of statistical aids to the forecasting of snow-storms for Greater Boston; designing and comparing station equipment and exposures; researches concerning clouds and the physics of precipitation; training of graduate students; and improvement of the library and its service. A very complete and mostly automatic record of the weather has been kept since the winter of 1884–85, when it was started by Abbott Lawrence Rotch. A record kept of the temperature in Milton by the Rev. A. Breck from 1849 has supplied further data on temperature conditions, and it appears that during the past hundred years there has been a remarkable amelioration of the climate. In recognition of the value of the Observatory's current work on climatology, the United States Weather Bureau is supplying it with standard instruments, broadcasting its monthly data and publishing its records. Under instrumentation is included an account of the work of Dr. Wallace E. Howell and Mr. John H. Conover in designing and testing new instruments for Blue Hill and other institutions. In research on clouds and precipitation, work was carried out at Blue Hill before Schaefer's experiment in November 1946 of dropping solid carbon dioxide on a cloud of supercooled droplets to make snow, and a month after this Dr. W. E. Howell successfully repeated the experiment on Mt. Washington.

Finally, mention must be made of the Observatory's Library, which is widely used by professional meteorologists all over the country, but particularly in the large group in Boston ; so great has been the demand for the Observatory's research publications that Blue Hill has always received on an exchange basis the publications of weather services, universities, research stations or institutes and individuals from all over the world.

THE COLLECTION OF DATA FROM FIRMS

THE research workers who need to collect data from firms cover a wide range of studies and use the data for many different purposes. As, nevertheless, they have many difficulties and problems in common, the Acton Society Trust held a conference on April 28 on "The Pitfalls in the Collection of Data from Firms", at which twenty-three research workers attended, drawn from universities, national research organizations, government departments, co-operative research associations and private industry. They included economists, psychologists, sociologists, statisticians and some whose particular speciality it would be hard to define.

After the formal opening of the conference by Mrs. Honor Croome, Dr. T. E. Easterfield (Department of Scientific and Industrial Research) opened the first session with a discussion of some of the main sources of error in data obtained from firms. The firm's own records may not be kept correctly, or may be kept in a form suitable for its own needs but misleading to the research worker. Information supplied in reply to questionnaires is particularly unreliable, as even the simplest question may not fit every case and may be misunderstood in many different ways.

The second morning session was opened by Mr. Stafford Beer (Samuel Fox and Co.), who spoke of the pitfalls found in data by workers doing research inside industry. Many seemingly excellent data are derived from notebooks and scraps of paper filled up by the semi-literate. Measurements may be given a misleading appearance of accuracy by being recorded to too many significant figures. Nomenclature may also be misleading, the same words being used in different senses in different places. But the worst source of error is the pure blunder : Mr. Beer himself recently reached some quite wrong conclusions by analysing a column giving furnace numbers under the impression that it gave the number of ingots in the furnace. The best way of avoiding these errors, he said, is to record the data oneself, or to control the recording. This makes it especially necessary for the research worker to have technical knowledge of the industry he is studying. Mr. Beer thought the use of automatic recording devices to be necessary if human error is to be eliminated.

In the afternoon, Mr. W. F. Luttrell (National Institute of Economic and Social Research) described his methods of collecting economic data. He said that the sending of questionnaires is useful only for collecting figures already kept in an agreed form, and even then visits to firms are often necessary. In all other cases data must be gathered personally. Mr. Luttrell starts to work in a firm by making a list of all the records which can possibly bear on the matter being investigated. Where the records do not show what is wanted, it is often possible to get it from the notebooks in which the data were first recorded; but these may have been destroyed. The notebooks are also useful for test checks—to show how the records derived from them are compiled. The cost records of firms are seldom suitable for research as they stand; it is quite common, for example, for overhead costs to be allocated in an arbitrary and distorting way, perhaps by a fixed percentage addition to labour costs. A further source of bias is the greater readiness of firms to give information about successes than about failures. The last session was opened by Mr. J. D. Handyside (National Institute of Industrial Psychology), who stressed the large amount of work involved in the various methods of avoiding errors suggested by other speakers.

The conference as a whole showed that a methodology of research on industry has grown up which cuts across the normal boundaries of a number of disciplines. It also showed that the data produced by industry to-day are not sufficiently accurate to be worthy of the elaborate methods developed by theoretical statisticians.

SIPHONOPHORA OF THE INDIAN OCEAN

STRUCTURE and taxonomy of the Coelenterata continue to interest zoologists even in this period when the concern of the majority is experimental. Since the War three major monographs have been published in Great Britain alone. The life-work of the late Cyril Crossland culminated in his report (edited by A. K. Totton) on the Madreporaria, Hydrocorallinae, Heliopora and Tubipora of the Great Barrier Reef Expedition. Following in the footsteps of Ellis, Forbes, Allman, Hincks and Browne, E. S. Russell has produced his admirable "Medusae of the British Isles". Now A. K. Totton renders no less service by the work here reviewed*.

Opportunity has been taken not only to study and report on collections made by the *Discovery II* in 1935, 1950 and 1951, but also those made by the *John Murray* and other expeditions since 1933, eight collections in all. We gain some idea of the labour involved, and so of the stimulating enthusiasm inspired initially by study of H. B. Bigelow's 'Albatros' Report on the Siphonophora. "For many years now", the author informs us, "I have been occupied with the laborious task of picking out hundreds of thousands of fragmentary specimens from plankton samples and of trying to form some idea of how many species are represented, and then attempting to apply old specific names and, where none are available, giving new ones". And again, "One may search for a very long time before being lucky enough to find a really well-preserved specimen, or a larval or other much desired stage, of some particular species. . . . There is also the inherent difficulty of dealing with fragmentary specimens. Again, many of the species occur in two phases. . . .". Meanwhile in the Discovery collections alone there are thousands of still unexamined plankton hauls.

The suspected wide distribution of Siphonophores is confirmed; no species would appear confined to the Indian Ocean or, apart from purely antarctic species, excluded from it. There is great restriction of species within the Red Sea, as there is in the Mediterranean in comparison with the Atlantic, and probably for similar reasons, namely, outflow of deep water over the sill and high minimum temperatures in deep water.

Attempts to interpret the extraordinary complexity of structure in the Siphonophores, on the success of which must depend final conclusions about classification, raise what are among the most perplexing, if not *the* most perplexing, problems in zoology. The fantastic development of polymorphism probably involves, apart from precocious budding, both neoteny and early manifestation in ontogeny of structures or individuals which appeared late in phylogeny. Totton pays tribute to the morphological acumen of Garstang, who made fundamental contributions by revealing that the 'medusome' theory of Haeckel is untenable and that the pelagic habit of the Siphonophores probably represents prolongation of an actinula-like larval phase.

Unfortunately Garstang failed to realize the extent of the dissimilarity between the Chondrophora (= Disconanthae) comprising *Velella*, *Porpita* and *Porpema* and the Siphonophora (= Siphonanthae). As Totton clearly shows, these represent distinct orders, not suborders. The former are really floating Tubulariid hydroid-phases of inconspicuous Codonid medusae. The ancestral Siphonophora, on the other hand, had probably a larval polypoid stage and an adult medusoid stage, both, in various structural manifestations, eventually making simultaneous appearance in the same colony.

This is a beautifully produced report, admirably illustrated by text-figures and plates, a credit alike to author and to publisher.

C. M. YONGE

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* Discovery Reports. Vol. 27: Siphonophora of the Indian Ocean, together with Systematic and Biological Notes on Related Specimens from other Oceans. By A. K. Totton. Pp. 1–162+plates 1–12. (Cambridge: At the University Press, 1954.) 60s. net.

THE CYTOCHROME *b* COMPONENT OF CHLOROPLASTS

By DR. ROBERT HILL, F.R.S.

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DAVENPORT[1] isolated etiolated chloroplasts from barley seedlings grown in the dark and observed in them the spectrum of cytochrome *f*. As the chloroplasts in this case are developed to a size and number approaching those in the normal green leaf, this appeared to establish beyond doubt that the cytochrome *f* isolated from green leaves was not an artefact but was a characteristic component of the green cell. The chloroplasts of the etiolated barley leaves were found to contain also a cytochrome *b* component[1,2] present in amount definitely larger than that of cytochrome *f*. The *b* component, which here will be designated b_6, was autoxidizable in the chloroplast suspensions and did not combine with carbon monoxide. It was not found possible to remove it from the solid material in an unmodified form. It was easily modified by treatment with various organic solvents and then reacted with carbon monoxide. The position of the sharply defined α-band was visually estimated as 563 mμ, and after modification either by reagents or by heating to 70° the α-band became broader and less sharp. It has been found that by treating chloroplasts from normal green leaves with acetone and suspending the chlorophyll-free residue in buffer at *p*H 7, on reduction with sodium dithionite ($Na_2S_2O_4$), the α-band corresponding with that of the b_6 component present is similar to that observed in the etiolated barley chloroplasts. An apparently identical b_6 component was found to be present, together with cytochrome *f*, in *Chlorella*[3]. If the treatment of the chloroplast material with acetone is carried out rapidly in the cold, the α-band of b_6 is sharp and carbon monoxide produces only a slight weakening effect on the absorption spectrum, showing that only a portion of the hæm reacts. Thus it was concluded that the rapid removal of the chlorophyll with acetone only modifies a small amount of the b_6 component. In contrast to this, treatment of the Keilin–Hartree preparation of the cytochrome system with acetone at once destroyed the component *b* and allowed the resulting denatured hæm protein compound to combine with carbon monoxide. This made it probable that the b_6 component observed in the chloroplast differs from *b* in the normal cytochrome system. Experiments on the oxidation-reduction behaviour of cytochrome b_6, when in equilibrium with the ferri–ferro–oxalate system, $E_0'h$ = zero[4], now confirm that it is different from the *b* component of the normal cytochrome system.

Preparations of the chloroplasts from etiolated barley were made according to Davenport. They were suspended in 0·5 *M* potassium oxalate and *M*/15 phosphate buffer at *p*H 7. Ferric iron was added to give a concentration of *M*/1,000, and part of the mixture was examined spectroscopically in a vacuum tube in absence of air. The mixture was then titrated *in vacuo* with a solution of ferrous sulphate (*M*/2). As soon as a minute amount of ferrous iron was added, there appeared to be almost complete reduction of cytochrome *f*; but no reduction of cytochrome b_6 was observed. No reduction of b_6 could be detected until the logarithm of the ratio ferrous/ferric iron was equal to 0·16. The titration was continued and the amounts of b_6 reduced estimated by visual comparison with another portion of the chloroplast preparation reduced with sodium dithionite. The practicable limit was reached when the logarithm of the ratio of the ferrous to the ferric iron was equal to 1·1, and at this point the cytochrome b_6 was about half reduced. In making these observations time was allowed for equilibrium to be approached, and the system was shown to be reversible with respect to the ferri–ferro–oxalate system. The result is shown in Fig. 1, where the

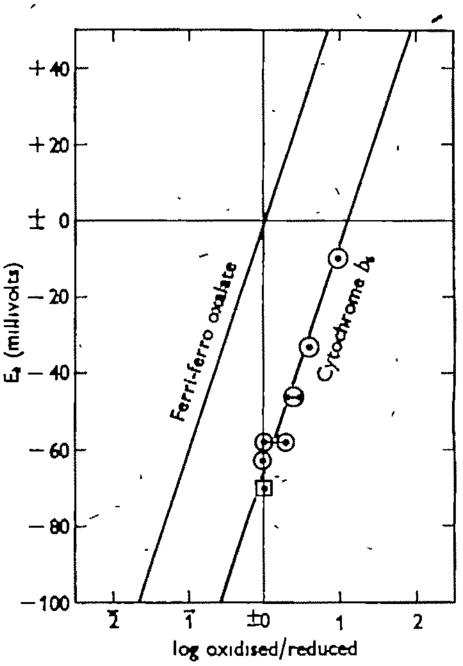

Fig. 1. Oxidation-reduction equilibrium of cytochrome b_6 with the iron oxalate system at *p*H 7 and 20°
⊙, Barley; ⊡, cabbage

logarithms of the ratios of oxidized and reduced cytochrome b_6 are made equal in potential to the corresponding values derived from the logarithms of the ratios ferric/ferrous iron in equilibrium. The results indicate that the $E_0'h$ of cytochrome b_6 at *p*H 7 is of the order of −0·06 V., and definitely more negative than the ferri–ferro–oxalate system. The characteristic potential of component *b* of cytochrome in a Keilin–Hartree muscle preparation was estimated to be nearly equal to that of the iron oxalate system.

It was found that preparations of chloroplasts made from the pale yellow mesophyll tissue of cabbage hearts contained appreciable amounts of both cytochrome *c* and *a* in addition to the components *f* and b_6; thus considerable contamination with other cytoplasmic particles was probable. Such a preparation, when examined in the presence of the iron oxalate system, showed a definite amount of a reduced *b* component when the oxidation-reduction potential was estimated as zero. If it was assumed that this corresponded to half-reduced cytochrome *b* of the normal cytochrome system present together with oxidized b_6, the potential corresponding to half-reduced b_6 after further addition of ferrous iron was estimated to be −0·07 V.

The chloroplasts thus contain a characteristic cytochrome component which is autoxidizable and which has, in the barley chloroplast preparation, an oxidation-reduction potential of about −0·06 V. The presence of cytochrome b_6 could account for the experimentally observed reducing properties of chloroplast preparations when illuminated in the presence of certain hydrogen acceptors. As this cytochrome component can be readily reoxidized by molecular oxygen, it could limit the range of possible 'chloroplast reagents' to those with characteristic oxidation-reduction potentials more positive, at neutral *p*H, than about zero volt (*r*H 14). The difference between the characteristic oxidation-reduction potentials of cytochrome *f* and b_6 is

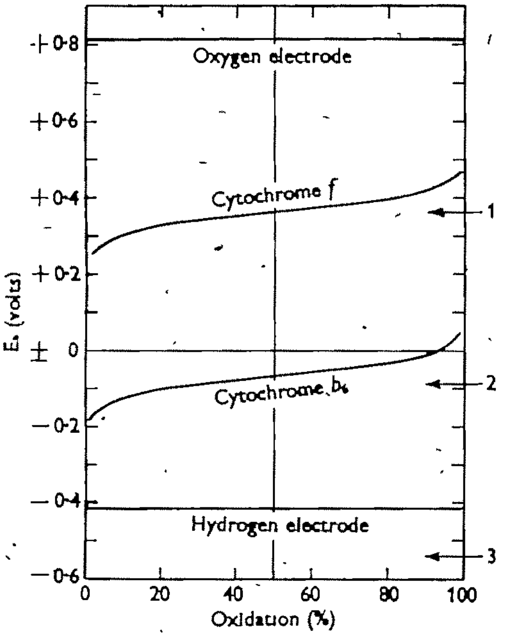

Fig. 2. Oxidation-reduction potentials of cytochromes *f* and b_6 in relation to the hydrogen electrode at *p*H 7. The arrows represent three hypothetical oxidation-reduction steps referred to in the text

approximately equal to the difference between the potential of cytochrome *f* and the oxygen electrode. Davenport and Hill[5] pointed out that the free energy of the reaction at *p*H 7:

$$4f\,(\mathrm{Fe}^{2+}) + \mathrm{O}_2 + 4\mathrm{H}^+ = 4f\,(\mathrm{Fe}^{3+}) + 2\mathrm{H}_2\mathrm{O}$$

(representing the oxidation of four equivalents of cytochrome *f* by one molecular equivalent of oxygen) was equal to the energy of one mol.-quantum of light corresponding to the maximum of the fluorescence spectrum of chlorophyll *a* in the plant. This is shown in the diagram, Fig. 2, where also the potential of b_6 is shown in relation to a second hypothetical oxidation-reduction step. If a third step is postulated, this would correspond to a system the characteristic potential of which, at *p*H 7, would be slightly less than that of the hydrogen electrode. These three steps are sufficient to cover (in theory) the whole range of hydrogen transport required for photosynthesis. The chloroplast reactions *in vitro* observed up to the present time appear to cover the first and second steps only, and this limitation may be due to the ready oxidation of cytochrome b_6 by the oxygen liberated during the photochemical reduction of the hydrogen-accepting reagent.

In the living cell, it seems possible that the cytochrome b_6 may be in a nearly completely reduced state even though oxygen is being produced. With the leaves of the 'golden varieties' of certain plants, a sharply defined absorption band can be observed visually with the microspectroscope at 563 mμ. When chloroplast preparations from the plants are examined, no absorption band can be observed in this position until the preparation is reduced with sodium dithionite; in this condition, however, the absorption band is broadened towards the region of shorter wave-lengths. The absorption might then be due to the mixture of reduced cytochrome *f* and b_6; if this is so, it would mean that in an illuminated leaf (of a golden variety) cytochrome b_6 is reduced while cytochrome *f* is oxidized. This represents obviously a definite amount of available chemical energy, as may be seen from Fig. 2. It should not be assumed at this stage, however, that cytochrome *f* and b_6 alone determine the course of the hydrogen transport. The fact that the absorption spectrum of the chlorophyll in a leaf shows a relative minimum in the region of the α-bands belonging to cytochromes of groups *b* and *c* makes the two particular cytochrome components (b_6 and *f*), in a few cases, accessible to direct observation in living cells.

This work is part of a research programme supported by the Agricultural Research Council.

[June 23.

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EFFECT OF PITUITARY STALK SECTION ON LIGHT-INDUCED ŒSTRUS IN THE FERRET

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It is well known that œstrus may be induced in the sexually quiescent ferret by artificially increasing the length of day during the winter months[1]. This response is dependent on increased anterior pituitary secretion of gonadotrophic hormone, since it is abolished by hypophysectomy[2]. The sensory receptors for the light stimulus appear to be the eyes, since animals with the optic nerves cut fail to respond to extra illumination[3].

Recent reports from the Department of Anatomy, University of Birmingham, have dealt with the anatomical pathways underlying the light-induced œstrous response. Thomson[4] has investigated the optic structures involved. His conclusion that the optic nerve fibres are essential for the response is in agreement with previous workers; but his experimental data are unsatisfactory owing to the techniques employed to blind the animals. The three methods used were: (i) section of the optic nerve fibres inside the sheath of the optic nerve; (ii) midline sagittal section through the optic chiasma; and (iii) incision between the posterior margin of the optic chiasma and the anterior limit of the hypothalamus. From the neuroanatomy of the visual pathway there is no reason for believing that the animals subjected to the latter two procedures, at least, would be blind, and since the post-mortem examination of the brains of these animals has not been made (Thomson, personal communication), this work is unconvincing.

The pathway traversed by the light stimulus between the optic nerves and anterior pituitary gland is unknown. It is possible that the structures involved are nerve fibres passing from the optic tract into the hypothalamus, and the hypophysial portal vessels of the pituitary stalk. There is no good evidence of a direct secreto-motor nerve supply to the adenohypophysis[5].

Thomson and Zuckerman[6] have reported the results of experiments in which the light-induced response of ferrets was studied after section of the pituitary stalk. The pituitary stalk was cut by a buccal approach, and out of twenty-three animals so operated the stalk was found to be completely severed in seventeen. Two ferrets that reacted to the light stimulus by becoming œstrous were found to lack any vascular connexions between the median eminence and the adenohypophysis. On the basis of these two animals, the conclusion was drawn[6,7] that the hypophysial portal vessels do not form part of the pathway by which the stimulus reaches the anterior pituitary gland.

In the present study, a temporal approach to the hypothalamus and pituitary has been used. This operative exposure has several advantages, for the present purpose, over the parapharyngeal or buccal route: (i) it permits an excellent view of the whole pituitary region, (ii) it allows the insertion of a large waxed paper plate (5 mm. × 3 mm.) between the cut ends of the pituitary stalk, and (iii) it leaves a clean field in the pituitary region (intact skull base and dura mater), so that the microanatomy of the stalk area can be more easily studied at a later date.

The pituitary stalk of twenty-four ferrets has been exposed by this method. In four animals the stalk was left intact, in six simple stalk section was performed, and in fourteen the stalk was cut and a paper plate inserted between the hypothalamus and pituitary gland. Twelve of these twenty-four ferrets became œstrous during the winter of 1953–54 when exposed to prolonged illumination. These included the four blank-operated control animals, five of the six subjected to simple stalk section and three in which a paper plate had been inserted. After killing, the vascular system was perfused through the aorta with 200 ml. diluted mandarin black indian ink (1 part ink : 3 parts distilled water), the head fixed in formalin, decalcified and a block of tissue containing the hypothalamus, pituitary gland and base of the skull embedded in low viscosity nitro-cellulose. Serial sections were cut at a thickness of 130–200 μ (usually 160 μ). In two cases the pituitary region of anœstrous ferrets with plates was dissected, without indian ink perfusion, and the gland placed in Susa's fixative for more detailed cytological study.

Histological examination of the pituitary region gave the following results:

(a) The pituitary stalk had been successfully sectioned in all but the blank-operated animals.

(b) The appearance of œstrus could be correlated with the presence of vascular connexions between the median eminence of the tuber cinereum and the anterior pituitary gland. These connexions were clearly visible in all eight stalk-sectioned ferrets that became œstrous. Study of the three animals in this group, in which plates had been inserted, showed that the plates had been misplaced (two were situated too anteriorly and one obliquely) and that vascular connexions had been re-established around the borders of the plates. No case of œstrus was observed in the absence of vascular connexions.

(c) The anœstrous animals had few, if any, vascular connexions between the median eminence and anterior pituitary gland. The animals in this group (one simple section, and nine with plates) showed a well-marked primary plexus and a well-vascularized adenohypophysis.

(d) Some atrophy of the pituitary gland occurred in all animals in which the stalk was sectioned. It may be seen from Table 1 that the posterior lobe of the stack-sectioned ferrets is less than 50 per cent the volume of the posterior lobes of the blank-operated animals, whereas the anterior lobe (pars distalis) has a volume of more than 75 per cent that of the controls. There was no correlation between the development of œstrus in the stalk-sectioned animals and the extent of anterior lobe atrophy.

Table 1. COMPARISON OF THE VOLUMES OF THE PITUITARY GLANDS AND OF THE ANTERIOR AND POSTERIOR LOBES IN THE BLANK-OPERATED, ANŒSTROUS AND ŒSTROUS FERRETS

These figures were obtained by the 'paper weight' method, and are the averages for the animals in each group

	No. in group	Total volume	Anterior lobe	Posterior lobe
Blank-operated (œstrus)	4	100	100	100
Stalk-cut (anœstrus)	10	73	95	45
Stalk-cut (œstrus)	8	61	80	39

From these results it is concluded that the hypophysial portal vessels form a necessary part of the pathway of the light-induced œstrous response in the ferret. This conclusion is in keeping with much previous work[8]. The suggestion of Greep and Barrnett[9] that the disturbance of reproductive activity following section of the pituitary stalk is due to ischæmic atrophy of the pars distalis is unlikely to be true for the rat, and can be eliminated as a possible explanation of the present results on the ferret.

The conclusion of Thomson and Zuckerman[6] that light-induced œstrus occurs in the absence of nervous or vascular connexions between the tuber cinereum and adenohypophysis may best be explained on the following grounds:

(i) Their conclusion was based on the results obtained in only two animals.

(ii) The surgical approach used by these workers (buccal route)[10] gives poor facility for placing plates between the cut ends of the stalk, and the plates are "with a few exceptions . . . eliminated from the wound"[6]. Further, this operation often results in anatomical disorganization of the pituitary stalk region, which complicates the final histological study.

(iii) The microscopic study of serial sections through the pituitary–hypothalamic region was made after imbedding the specimens in wax and sectioning at 10 μ (Zuckerman, personal communication). In our experience, it is necessary to imbed in 'Celloidin' and cut thick sections at 100–200 μ in order to obtain a clear picture of the vascular anatomy.

(iv) Through the kindness of Dr. Thomson and Prof. Zuckerman, we have had the opportunity of examining sections through the pituitary region of one of their critical ferrets. Inspection revealed that a significant proportion of the visible blood vessels did not contain indian ink. Conclusions drawn from incompletely injected specimens must be regarded as unreliable. [June 15.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Composition of the Earth's Outer Core

ATTENTION has lately been given to the following set of four postulates: (*a*) the Earth, Mars and Venus have a common primitive composition; (*b*) compressibility is essentially a smoothly varying function of pressure at pressures beyond $0 \cdot 4 \times 10^6$ million atmospheres in all three planets; (*c*) the outer core of the Earth is a high-pressure modification of ultrabasic rock; (*d*) each planet has an inner core chemically distinct from the matter in the outer core.

With the use of an Earth model referred to as Model B[1], I showed[2,3] that this set of postulates yielded values of the mean densities of Mars and Venus and of the ellipticity of figure of Mars that were within the standard errors of the observational data available to me at the time. The purpose of the present communication is to direct attention to implications of revisions of the data in question, and to bring up to date a statement in my recently published book[4].

I am indebted to Dr. G. P. Kuiper for kindly supplying me with the latest information on revisions of the astronomical data. He informs me that the most probable diameter of the solid surface of Mars is now about 3,330 km., as against 3,389 km. computed using postulates (*a*)–(*d*); also that estimates of the diameter of Venus are being reduced. In addition, Dr. Kuiper has informed me that it is innate in Woolard's work[5] that, while the observed ellipticity of Mars is not sensibly changed from Struve's value which had been used by me in my previous calculations, the standard error of the determination has been reduced by roughly two-thirds. This has the effect of making the ellipticity calculated on the basis of (*a*)–(*d*) different from the observed value by about three times the standard error of the latter.

The effect of these revisions is to demand some reconsideration of postulates (*a*)–(*d*), especially (*c*). A significant feature of the revisions is that they all point the same way. Examination of a diagram of Bullen and Low[6] shows that the influence of postulate (*d*) is to increase the computed mean diameters of both Venus and Mars above the values which would be yielded if the inner core were composed of iron silicate rather than of purely uncombined iron. The effect of this is to show that, given the masses of Mars and Venus and assuming the postulate (*a*), then increasing the assumed amount of uncombined iron in their cores diminishes the calculated diameters. Further, with the use of postulates (*a*)–(*c*), it had been found[3] that the assumption of (*d*) led to an estimated ellipticity of Mars of 1/188, as against 1/181 if the inner core contained no uncombined iron. Thus increasing further the assumed quantity of uncombined iron in the core has the effect of bringing the estimated ellipticity of Mars closer to Woolard's value of $1/191 \cdot 8$ ($\pm \frac{1}{2}$ per cent).

On the assumption that the terrestrial planets have a common primitive composition, all three of the astronomical revisions indicate that the Earth's outer core is composed of a mixture of uncombined iron and of material the representative atomic number of which is smaller than that of iron. It is interesting that this conclusion finds support in two other independent investigations. In 1952, Birch[7] concluded that the density in the outer core "is perhaps 10–20 per cent lower than the density of iron or nickel-iron under the same conditions"; Birch suggested alloying with other materials as a possible explanation of the discrepancy. Again, recent work of Knopoff and Uffen, kindly communicated to me in advance of publication, indicates a mean atomic number of 22 for the region *E*, a value four units less than that for iron, six units less than that for nickel.

The lighter material which seems to be present in the outer core may consist of material such as the rock fayalite. The latter may be in the form of a high-pressure modification as assumed in postulate (*c*), although Dr. W. M. Elsasser informs me (in a personal communication) that there are serious theoretical difficulties in assuming an accompanying density increase in a ratio as high as $1 \cdot 6$, which is the ratio of the densities on the two sides of the boundary between the core and mantle of the Earth. It is possible that a more detailed calculation which I hope to carry out will throw some light on this question.

An incidental point, of some cosmological importance, is that it still appears possible, by a suitable modification of postulate (*c*), to reconcile seismic and astronomical data with the hypothesis of a common primitive composition for the Earth, Mars and Venus, although further calculation is needed to confirm this. Such a result is important in that earlier work[8] appeared to have excluded this hypothesis. Moreover, there is little difficulty in adapting any model to bring the Moon into the same picture. Mercury remains an apparent exception; but I have earlier suggested[9] that observations of the present-day Mercury may be inapplicable to the primitive Mercury.

K. E. BULLEN

Dominion Observatory, Ottawa,
and
University of Sydney. July 31.

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Proposal for a New Æther Drift Experiment

IT is interesting to learn from L. Essen's communication[1] that the accuracy of measurement of frequencies in the 9,000 Mc./s. region attained at the National Physical Laboratory with existing equipment is high enough for the new æther drift experiment to be carried out. I understand that preparations have been made for the same purpose at the Zeeman Laboratory of the University of Amsterdam by F. Bruin, to whom I suggested the experiment last summer.

May I point out that the experiment proposed by me[2] is not a repetition of the Michelson–Morley experiment, in which interference between *progressive* waves is observed. It is an experiment with *standing* waves, and resonance frequencies are measured for different orientations of the axis of the resonator.

A fixed distance ('axis') between two parallel mirrors, moving with uniform velocity through the æther of classical physics, represents a variable 'effective optical length' for standing waves, depending on the angle between that velocity and the axis. Therefore, according to classical optics it ought to be impossible to keep the resonant frequency of a cavity resonator constant for any length of time if the resonator is fixed in a certain position in the laboratory; for the orientation of its axis relative to the earth's velocity with respect to the æther changes in the course of the day and the year. The resonant frequency would in general change periodically between two limits during one stellar day, and the frequency-range would periodically expand and contract annually, reaching its greatest width when the directions of the earth's orbital movement and of the movement of the solar system coincide.

Analysis of records of frequency fluctuations of a stationary cavity resonator could in principle give information on whether an æther drift exists; but it is most probably not possible to keep the system free from external disturbances for a sufficient length of time.

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Chislehurst, Kent.
May 6.

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Transformation in a Titanium - Chromium Alloy

IN metallic systems which may undergo a diffusionless (or martensitic) transformation on cooling, it has been found that transformation may also be induced above M_s by plastic deformation under favourable conditions[1]. The phenomenon has been investigated exhaustively in steels and in one or two non-ferrous systems; but its study in titanium alloys has received little attention up to now. Many titanium systems show a very interesting phenomenon in that a rather abrupt drop in M_s occurs when the alloy content is increased above a certain critical value[2]. Such an effect is not to be expected from general thermodynamic considerations of the constitution diagrams and has been attributed to the occurrence of some form of stabilization[3]. To examine this in greater detail, an investigation was made of the effect of deformation on a titanium – 10 per cent chromium alloy, for which, according to extrapolation of known data, M_s should be about 200° C.[3], although the alloy can be cooled down to – 196° C. without transformation occurring.

The alloy used was arc-melted in an inert gas (argon) atmosphere and received in the fully β-condition, as metallographical and X-ray examination confirmed. Specimens about $\frac{1}{16}$ in. × $\frac{1}{4}$ in. × $\frac{1}{4}$ in. were cut off under water and deformed by compression between two steel blocks; low-temperature deformation was carried out by surrounding the specimen and blocks with liquid nitrogen. X-ray examinations were made at room temperature using filtered copper $K\alpha$ radiation and an aluminium foil 0·002 in. thick placed over the photographic film to absorb the secondary radiation. The surface of the specimens were electrolytically polished and set at an angle of 20° to the incident beam, with an oscillation to 25°, in a cylindrical camera of 10 cm. diameter.

Room temperature deformation (expressed in terms of true stress and strain) up to 20 per cent (corresponding to a stress of about 150 kgm./mm.^{2}, 210,000 psi) produced no transformation of the body-centred cubic structure. The diffraction pattern obtained from the electropolished surface of the specimen parallel to the compression axis showed only spotty body-centred cubic lines due to coarse grain size. The same result was obtained after a heat treatment of 42 hr. at 1,100° C. (to eliminate any inhomogeneity that might have existed in the alloy as received) followed by quenching in 20 per cent sodium hydroxide solution at 10° C., and then deforming at room temperature.

Similarly, deforming at – 196° C. until fracture occurred (at about 17 per cent strain and 175 kgm./mm.^{2}, 250,000 psi) gave no definite evidence of transformation either, judging by the X-ray pattern from the fractured surface. By pre-straining (in compression), however, approximately 2 per cent at room temperature prior to the sub-zero deformation quite definite diffraction lines of the hexagonal close-packed structure were discovered in addition to those of the body-centred cubic structure; the sub-zero deformation was produced at – 196° C. by a stress not much above 200 kgm./mm.^{2} (300,000 psi), at which the specimen fractured (the amount of deformation could not be measured as the specimen fell apart on removing it from between the deformation blocks).

These observations confirm that the β-phase is very stable thermodynamically, and in addition indicate that it has also considerable mechanical stability, which, however, may be influenced under certain conditions.

This work was done at the Case Institute of Technology, and Prof. A. R. Troiano's interest is gratefully acknowledged.

H. M. OTTE

Columbia University,
New York, N.Y. April 26.

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A Light Source for Köhler Illumination

THE advantages of Köhler illumination have recently been discussed by Barer and Weinstein[1], and also the difficulties involved when a single auxiliary lens is used. They describe a new microscope lamp with a variable auxiliary lens-system which overcomes these difficulties. For most purposes, however, a single auxiliary lens can be used if a sufficiently large and reasonably uniform light source is available. This can usually be obtained without serious loss of light if a piece of ground glass can be placed very close to the filament of a suitable car headlamp bulb or projector bulb; but unfortunately, in most lamps, whether commercially available or home constructed, it is difficult to arrange this. A satisfactory method is to grind lightly a circular patch on the end of the bulb, using a mixture of fine well-worn 'Carborundum' powder and water on a glass plate. It is not suggested that this provides so versatile an illuminant as that described by Barer and Weinstein; but it does enable an ordinary so-called 'research' lamp to be used for Köhler illumination with medium- and high-power objectives, while if the auxiliary lens is of large diameter it will also illuminate most of the field of low-power objectives.

A bulb treated in this way is also very satisfactory with a field diaphragm as a source for 'critical' illumination, and the grinding process then has the advantage of removing the maker's name and other lettering which would otherwise be liable to appear in the field of view.

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Reaction of Stearic Acid Monolayers with Copper and Cuprous Oxide

A number of workers have obtained results which indicate that only a portion of an adsorbed monolayer of stearic acid will react immediately with a copper substrate. (Of course, the reaction is actually with cuprous oxide since, at room temperature in air, all clean copper surfaces rapidly oxidize to cuprous oxide.) Bowden and Moore[1] studied this reaction by putting stearic acid monolayers on radioactive copper and measuring the activity which could be removed by extraction with benzene. They found that when they placed a Langmuir–Blodgett monolayer of stearic acid on a copper surface and allowed it to stand for 18 hr. or heated it, only about 0·14 atom of copper reacts for every molecule of acid in the monolayer. They interpreted this as signifying that their procedure lost 75 per cent of the cupric stearate activity, due to adsorption on their equipment, since reaction was presumed to be complete. Consequently, they adopted an empirical correction factor of 4.

Since the present work was begun, this interpretation was apparently refuted by Beischer's work[2], in which he found that, if radioactive stearic acid is placed on a clean copper surface and the surface is heated until reaction occurs, initially only about 30 per cent of the stearic acid reacts. Here, there can be no possibility of the results being in error due to adsorption on apparatus since, in this technique, unreacted stearic acid is removed and the remaining stearic acid is measured. Therefore, Bowden and Moore are apparently mistaken in assuming that a Langmuir–Blodgett monolayer reacts completely. The molar ratio of copper to stearic acid (0·14–0·30) seems to indicate quite clearly that, in the initial reaction of the Langmuir–Blodgett monolayer, about 30 per cent of the stearic acid reacts to give cupric stearate.

Bowden and Moore's results on the reaction of copper with a benzene solution of stearic acid were difficult to interpret quantitatively in this fashion. Therefore, experiments were carried out to measure the exact extent of the initial reaction of adsorbed monolayers. Clean copper foils were weighed on a microbalance, immersed in a 0·1 per cent solution of stearic acid in benzene, and the excess stearic acid washed off with benzene. After drying, the foils were reweighed, the increment representing the weight of stearic acid adsorbed. The foils were then extracted overnight with benzene in Soxhlet extractors and the extracts analysed for copper using a colorimetric method with sodium diethyl dithiocarbamate[3]. The foils were then weighed again. Since the final weights were equal to the initial weights minus the amount of cuprous oxide removed, the extraction must have removed virtually all the stearic acid and soap.

Analysis of the results indicated that the ratio of moles of copper reacted to moles of stearic acid adsorbed was approximately constant and equal to 0·26 ± 0·04 for varying amounts of adsorbed acid. According to Preston and Bircumshaw[4], when copper is oxidized in air at room temperature, the preferred orientation is for the (111) plane of the cuprous oxide to be parallel to the metal surface. In this plane, there is one copper atom for every 7·8 $A.^2$. Since the cross-sectional area of stearic acid in a monolayer is 21·0 $A.^2$, each stearic acid molecule adsorbed on the cuprous oxide surface should have about 2·6 copper atoms available to it for chemical reaction. Even if one takes planes at somewhat different angles, the amount of copper per unit area will be at least enough to furnish a copper atom for each stearic acid molecule. It is therefore difficult to understand why only about one-quarter of the adsorbed stearic acid reacts, since thermodynamic calculations indicate that complete reaction should occur.

Of course, other planes will be exposed, and these may contain no copper atoms at all or may vary greatly in their rates of reaction with the monolayer. At present, however, no really satisfactory explanation of this phenomenon is available.

It is also of interest to see if copper itself will react with adsorbed stearic acid. Tingle[5] has shown that when a copper surface is cut under a 1 per cent solution of lauric acid in paraffin oil, the fresh metal surface has a high coefficient of friction, which indicates that no reaction takes place. The previous experiments were repeated under an atmosphere of hydrogen, using copper foils which had been reduced in hydrogen at 450° C. Blanks were run in the same way, merely omitting the copper foil. Application of the *t* test to the results indicated that there was no significant difference between the blanks and the runs with copper. Thermodynamic calculations confirmed that metallic copper should not react with stearic acid in a non-oxidizing atmosphere.

We are indebted to Dr. E. A. Gulbransen for illuminating discussions on surface oxides. A full account of this work will be published elsewhere.

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Henry E. Mahncke
Chemical Department,
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East Pittsburgh, Pennsylvania. March 16.

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The interesting results on partial reaction of the monolayer quoted by Dobry and Mahncke are of general interest and do in fact support the earlier observations of Bowden and Moore[1]. Even allowing for the factor of 4, they found that with copper surfaces immersed in a benzene solution of stearic acid the initial reaction was very slow, and after an immersion time of 5 min. considerably less than a single monolayer of soap was formed (see their paper, footnote p. 904). After prolonged immersion, chemical attack was quite heavy and corresponded to the reaction of several molecular layers. Results of this type obtained with layers adsorbed from solution are probably more significant than those obtained with layers deposited from the Langmuir trough. The latter are often unstable and tend to collapse; they appear to form bridges over the surface irregularities so that the area of molecular contact may be

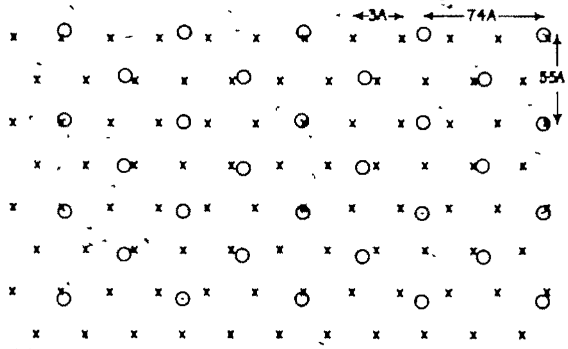

Fig. 1. Approximate lattice arrangement: ×, copper atoms in (111) face of copper oxide; ○, fatty acid molecules in basal plane of fatty acid lattice

considerably smaller than the area of coverage. With layers adsorbed from solution this is not so, though as Daniel[2] and Hirst and Lancaster[3] have pointed out, dilute solutions themselves may give less than a complete adsorbed monolayer.

The difficulty of obtaining effective chemical reaction between adsorbed fatty acids and metal oxide surfaces has also been observed by Tingle[4], by Hirst and Lancaster[5] and Lancaster and Rouse[6]. In general, the presence of water facilitates reaction, and it may be that the non-reactivity of reduced copper surfaces described by Dobry and Mahncke is due to this effect, rather than to the supposed absence of any oxide on the surface.

The main observation that only about one-quarter of the adsorbed fatty acid molecules on a copper surface react (although there are numerous copper atoms available for complete reaction) could be explained as a steric effect. The copper atoms in the 111 face of the cuprous oxide crystal constitute a regular hexagonal array (crosses, Fig. 1) while the molecules in the basal plane of the fatty acid form a face-centred rectangular array (circles, Fig. 1). If an attempt is made to fit these lattices, it is found that the best fit (over a limited area) corresponds to the arrangement in Fig. 1 where only one out of every three rows of acid molecules is close to a copper atom. Thus if the surface consists of small cuprous oxide crystals and the acid is adsorbed as a close-packed film possessing limited mobility at room temperature, only 33 per cent of the molecules would be able to react. With prolonged immersion (or on heating), diffusion of the reacted molecules would enable further reaction to occur. This explanation must be treated very tentatively since the solid surfaces are by no means atomically smooth, and in addition adsorbed long-chain monolayers often have appreciable mobility even at room temperature. If, however, this mechanism is valid, one might expect a different behaviour with other types of metal oxides. On the other hand, if, as the work of Hirst and Lancaster[5] suggests, the observation is mainly due to the effect of minute quantities of moisture on the surface or in the reagents, controlled experiments should readily reveal this.

D. TABOR

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Trapped Atoms and Radicals in a Glass 'Cage'

THE preparation of highly reactive free radicals and atoms in non-equilibrium concentrations high enough for their direct observation by physical methods has hitherto depended on the use of special rapid techniques such as that of flash photolysis. Here we describe a general method for the preparation of these species under conditions which permit their observation at high concentrations for an indefinitely long period of time. The method involves the photolytic dissociation of a substance dissolved in a transparent rigid solvent at very low temperatures. The only related work which we have been able to find is that of Lewis and Lipkin, who showed that certain rather stable radicals, such as triphenyl methyl, could be detected after photolysis of the parent saturated molecule[1].

The essential conditions to be fulfilled if a reactive species, such as an iodine atom, is to be permanently isolated are: (1) diffusion to the vicinity of another atom must be prevented by using a very viscous solvent; (2) reaction with the solvent must not occur; such reactions are usually accompanied by appreciable activation energies and may therefore be avoided by working at a sufficiently low temperature. We have found that both conditions are fulfilled, for most radicals so far investigated, by using glasses formed from a mixture of hydrocarbons or from ether, alcohol and *iso*pentane at the temperature of liquid nitrogen.

The method was first tested in a very simple manner by irradiating a 10^{-3} *M* solution of molecular iodine in a hydrocarbon glass at 86° K., using a conventional high-pressure mercury arc. The absorption spectrum of the iodine molecule occurs at a wave-length considerably less than that corresponding to the energy of dissociation to normal atoms, and it was believed that this energy might be sufficient to allow the atoms to diffuse apart through the rigid solvent by a process of local softening of the glass. Rapid dissipation of this energy would then result in a system of trapped iodine atoms. In complete accordance with this reasoning, we have found that, on irradiation, such an iodine solution becomes colourless throughout the visible and quartz ultra-violet regions of the spectrum and remains so indefinitely at 86° K. On softening the glass, by warming, the colour returns as the atoms recombine.

Further experiments have established that the phenomenon is a very general one. The results of photolysis of a number of other substances in glassy solvents at liquid nitrogen temperatures are summarized below.

(1) *Ethyl iodide.* On irradiation, the spectrum of ethyl iodide decreases in intensity; but no other spectrum appears. On warming, molecular iodine is formed and recooling has no further effect. We conclude that the iodine atoms have been trapped as before, and it seems probable that trapped ethyl radicals were also present.

(2) *Carbon disulphide.* The first four bands of the $v'' = 0$ progression of CS appear at very high intensity after several minutes irradiation and can be observed for many hours. The spectrum is removed instantly on warming and cannot be detected during irradiation of an ordinary solution at room temperatures. In the gas phase, carbon disulphide disappears by polymerization in a few minutes[2].

(3) *Chlorine dioxide*. The spectrum of chlorine dioxide, which is mainly diffuse in the glassy solvent, is rapidly destroyed and replaced by a second diffuse spectrum the position of which agrees exactly with that of the ClO radical[3]. It has been shown[4] that the flash photolysis of gaseous chlorine dioxide results in the formation of ClO, the life-time of which at comparable concentrations to ours is only a few milliseconds.

(4) *Aromatic compounds*. Porter and Wright have recently shown that the gas-phase photolysis of many single-ringed aromatic molecules results in the appearance of transient banded spectra with life-times less than 10^{-4} sec., which are attributed to free radicals such as benzyl[5]. We have observed similar spectra from the same series of compounds for several hours after photolysis in rigid solvents. These spectra vanished completely on warming the glass, and were therefore readily distinguished from the spectra of permanent products.

In all these examples the spectra were observed, with undiminished intensity, several hours after photolysis; they were removed by softening the glass and did not reappear on cooling.

This method should have many applications. It may be used for trapping the primary products of photochemical or radiation chemical processes for identification. It makes possible the measurement of properties such as infra-red spectra of free radicals, which has not hitherto been possible owing to the need for rapid recording. Bearing in mind the possibility of using still lower temperatures and other solvents, the method should be applicable to practically all free radicals which can be produced by photolysis.

Full details of our techniques and results will be submitted for publication in the *Transactions of the Faraday Society*. One of us (I. N.) is grateful to the Fulbright Commission for a fellowship during the tenure of which this work was carried out.

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Anhydrous Trifluoroacetic Acid as a Solvent for Proteins

IT has recently been reported[1] that liquid anhydrous fluoride is a powerful solvent for a wide variety of proteins. It has now been found that the lower perfluoro-aliphatic carboxylic acids possess solvent properties for proteins very similar to those of hydrogen fluoride. Thus it has been observed that trifluoroacetic acid (m.p. − 15·6° C., b.p. 72° C.) readily dissolves the proteins lysozyme, ribonuclease, trypsin, pepsin, crystallized egg albumin, bovine plasma albumin, bovine plasma globulin, edestin, peanut protein globulin, casein, zein, urease, uricase, blood fibrin, insulin, silk fibroin, hide collagen and rat-tail tendon. Solutions in the concentration-range 20–30 mgm./ml. of the above proteins can easily be prepared at 25° C. Solutions of proteins in trifluoroacetic acid prepared *in vacuo* are clear and colourless; on exposure to air, a purple colour develops. Cytochrome *c*, hæmoglobin and catalase are also soluble; solutions of these iron-containing proteins are browner in colour than are the corresponding solutions in hydrogen fluoride.

The physical properties of trifluoroacetic acid are such that dissolved proteins can be readily recovered either by direct evaporation or by lyophilization. Of the proteins listed above, ribonuclease, bovine plasma albumin, trypsin, lysozyme, insulin, cytochrome *c*, hæmoglobin, hide collagen and rat-tail tendon are recovered in a water-soluble condition. Recovered bovine plasma albumin dissolves readily in distilled water; the *p*H of such a solution can be adjusted to neutrality without precipitation of protein, and the recovered material yields a pattern on ultracentrifugation identical with that of the starting material. Cytochrome *c* recovered from trifluoroacetic acid gives a typical ferricytochrome spectrum in aqueous solution; this solution can readily be reduced to ferrocytochrome *c* with sodium hydrosulphite. Cytochrome *c* recovered from hydrogen fluoride, on the other hand, although still water-soluble, can neither be oxidized nor reduced.

Perfluoropropionic and perfluorobutyric acids behave like trifluoroacetic acid except that proteins are dissolved at a much slower rate, especially by perfluorobutyric acid. The lower perfluoro-aliphatic carboxylic acids are all reasonably volatile and can be handled in ordinary glass apparatus. They therefore pose much less serious experimental problems than does the manipulation of hydrogen fluoride. The experiments described here were all carried out on a conventional glass vacuum line with the solvents transferred by vacuum distillation.

As in the case of hydrogen fluoride, these media lend themselves to the carrying out of chemical reactions on proteins, and reactions on proteins using nitrogen dioxide, hydrogen peroxide and trifluoroacetic acid anhydride, as well as other reagents have been carried out. It has further been observed that hydrogen fluoride and trifluoroacetic acid are miscible in all proportions with each other and with sulphur dioxide in the liquid phase. While most proteins are substantially insoluble in pure liquid sulphur dioxide, mixtures of sulphur dioxide and hydrogen fluoride, or sulphur dioxide and trifluoroacetic acid are very good solvents, even when the sulphur dioxide is present in large excess. These mixed solvent systems may be of special interest in protein fractionations and in the study of other high polymeric materials.

A detailed description of these experiments is being prepared for publication elsewhere.

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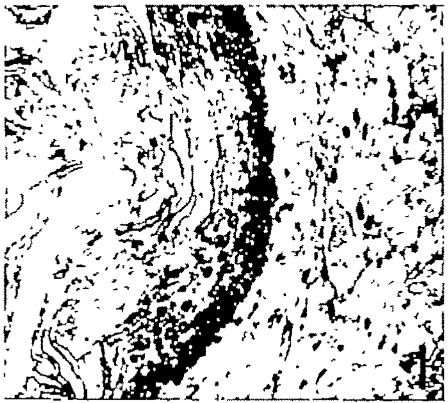
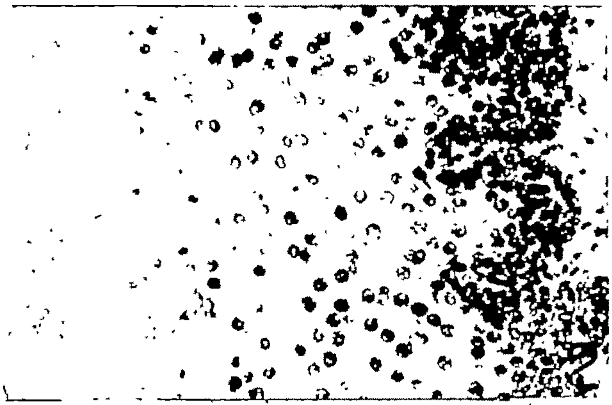
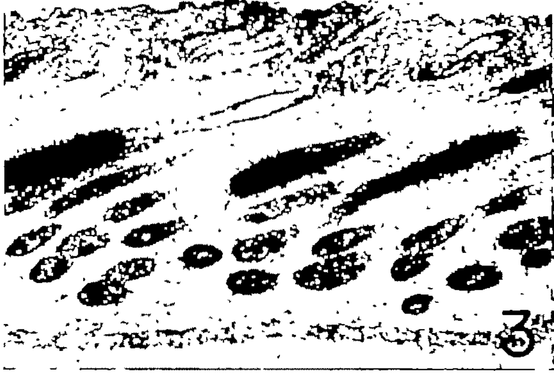
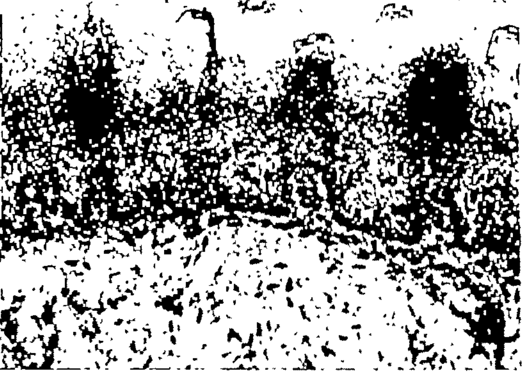
Histology and Chemistry of Keratin Formation

KERATINIZATION, by the holocrine transformation of epithelial cells, occurs normally in the mammalian epidermis, œsophagus, œstrous vagina, and thymic corpuscles. It accompanies abnormal epithelial transformations after œstrogen administration (in genital organs), in vitamin A deficiency, consequent to trauma (including radiation), and in certain cancers. The etiology of keratinization, which represents differentiation by organized cell deaths,









(1) Transverse section through oesophageal wall of dusky-footed wood rat (*Neotoma fuscipes*) Note distinct stratum granulosum Hæmatoxylin and eosin × 175.

(2) Transverse section through oesophageal wall of mountain beaver (*Aplodontia rufa*). Note absence of keratohyalin. Hæmatoxylin and eosin × 175.

(3) Radioautograph of sagittal section of mouse belly skin showing hair follicles in anagen. Note concentration of radiocystine in keratogenous zone 8 hr after injection Emulsion coating. Hæmatoxylin and eosin, prestained × 70

(4) Radioautograph of conical papillæ of mouse tongue in transverse section. Note concentration of radiocystine above dermal papilla (base of spine) 8 hr. after injection. Emulsion coating Hæmatoxylin and eosin, post-stained. × 175

remains unknown; however, the suggestion that a local lack or inactivation of vitamin A is responsible is a possibility[1,2].

A principal obstacle to our understanding of the mechanism of keratin formation is the lack of correlation between morphological and biochemical knowledge of the process. The significance and reality of the organelles in keratinizing cells are still being debated. Recently, Medawar[3] has termed artificial the tonofibrils and the intercellular bridges, hitherto two of the best-established microstructures of the mammalian epidermis (and of keratinizing epithelia generally). While his interpretation of the intercellular 'bridges' as really intracellular structures seems justifiable, these areas do represent definite contact points between adjacent cells. Changes in these areas associated with the growth-rate of epidermis are indicated in the electron microscopic studies of von Albertini[4]. We have seen[5,6] alterations with acanthosis following topical application of vitamin A similar to those occurring in the initial phases of carcinogen-induced hyperplasia[4], wherein the cells are closely applied to each other, the intercellular spaces disappear and the 'bridges' are reduced to desmosomes.

Little evidence remains to indicate that the keratohyalin granules of the classical histologist are keratin precursors, as was originally supposed. Leuchtenberger and Lund[7] have shown that granules containing ribonucleic acid occur in the stratum granulosum region of human and dog epidermis, and we find such granules to be distributed extensively even in the thin rat epidermis, although they appear considerably different from those seen with routine histological stains. In addition, whereas ribonuclease treatment results in the disappearance of azurophilic granules from the normal rat epidermis, it does not affect the appearance of the hæmatoxylin-staining granules (cf. Montagna[8]). Thus, the keratohyalin granules may consist only in part of ribonucleic acid, as Leuchtenberger and Lund suggest[7], or conceivably the keratohyalin and the azurophilic granules are different entities. No granules are seen with the Bennett or Barrnett–Seligman methods for protein-bound sulphydryl groups[6,9–11]. It is difficult to conceive of the significance of keratohyalin in terms of cytoplasmic basophilia associated with protein synthesis. Acanthosis of the nipple epidermis of the guinea pig involves a striking increase in keratohyalin whether accompanied by hyperkeratosis (after œstrogen treatment) or presumed hypokeratinization (after vitamin A treatment)[6].

Leblond[12] has pointed out that 'hard' keratin, such as occurs in nails and in the cuticle and cortex of hair, can be distinguished from 'soft' keratin by the absence of keratohyalin, the adhesion of the cells, the lower lipid content, and the higher sulphur content. That the presence of keratohyalin always characterizes 'soft' keratinization may be questioned. A stratum granulosum is a constant feature of the œsophagus of many rodents (rat, mouse, guinea pig, gopher, several cricetids, etc.); in the mountain beaver (*Aplodontia rufa*) and the fox squirrel (*Sciurus niger*): however, the granular layer is absent (Figs. 1 and 2) (cf. Goetsch[13]). This is also true of the œsophagus of man and carnivores, where the process can be described as parakeratotic, resulting in the sloughing of cells with pycnotic nuclei. In the mountain beaver and squirrel, however, the sloughing layers remain temporarily as true 'soft' keratin, just as in other rodents. Eisen *et al.*[10] question the distinction between 'soft' and 'hard' keratinization and consider the latter to represent parakeratosis, evidently ignoring its characteristic 'non-scurfiness' (cf. Medawar[3]).

It might be expected that an active synthesis of keratin, such as Biggers[14] postulates for the œstrogen-treated vagina, would involve a specific uptake of cystine and other sulphur-containing amino-acids. Radioautographic and tracer studies of mouse vaginal epithelium now in progress[15] do not indicate an uptake of cystine labelled with sulphur-35 in œstrogen-induced keratinization appreciably different from that in androgen-induced mucification (in both instances cell proliferation and protein synthesis are involved). However, during the active growth phase (anagen) of mouse hair, high activity of the keratogenous zone of the hair follicle is seen 8 hr. after administration of radiocystine (Fig. 3). The 8-hr. radioautograph parallels almost exactly the published figures of localization of sulphydryl[10,16].

The conical papilla of the mouse tongue presents an interesting picture in that it consists of a core of 'hard' keratin projecting posteriorly, covered on its anterolateral surfaces by a sheath of 'soft' keratin. The 'hard' keratin (readily distinguished by its refractoriness to eosin staining and its affinity for picric acid) arises from a keratohyalin-free area at the apex of the small dermal papilla. Eight hours after administration of radiocystine, this region is highly radioactive, in contrast to the limited activity in the adjacent 'soft' keratin-forming epithelium (Fig. 4). The concentration of cystine by 'hard' keratin-forming structures may reflect specific uptake by keratogenous zone cells for the synthesis of keratin or 'capture' by rapidly proliferating cells of the cystine which is not turned over once the living cells keratinize. Work in these areas is being continued.

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Biosynthesis of *l*-Ascorbic Acid

THE rat is known to synthesize ascorbic acid in the course of its normal metabolism. It has been observed by Longenecker and associates[1] that this synthesis can be greatly stimulated, resulting in the high urinary excretion and tissue reserve of the vitamin, when the rats are given daily a variety of compounds, particularly narcotics like chloretone. It has been previously reported in several communications[2-6] from this laboratory that the high urinary excretion of ascorbic acid stimulated by chloretone can be completely suppressed, if the animals are made deficient in thiamine, riboflavin, pantothenic acid or folic acid. This action of the narcotic can be restored by correcting the respective deficiency with the particular vitamin. The effect of inanition has been taken into account by pair-feeding the experimental animals. The excretion under chloretone is unaffected by adrenalectomy or pancreatectomy of the rats. A definite inhibition of pyruvic acid oxidation by brain tissue of the rat has been observed in presence of chloretone under aerobic condition. The high urinary excretion of ascorbic acid stimulated in the rat under chloretone can also be almost entirely suppressed by the daily administration of either adenosine triphosphate, malic acid or thyroxine in suitable doses. The effect of chloretone is promptly restored when the administration of these compounds is stopped. Other compounds, such as adenosine diphosphate, adenylic acid, dinitrophenol, glutathione and dicarboxylic acids such as oxaloacetic, fumaric and succinic, have been tried without any such suppressive effect on the urinary excretion of ascorbic acid by the narcotized rat.

With the inhibition of pyruvic acid oxidation under chloretone there is a simultaneous decrease in the phosphorus esterification by the brain tissue of the rat. Relative to oxygen consumption, the phosphorylation of that tissue decreases considerably in the presence of chloretone. In the chloretonized condition, the inorganic phosphorus-level in the liver tissue of the rat is appreciably raised, while the adenosine triphosphate phosphorus, hexose-phosphates and triose-phosphates determined both by the chemical and the paper chromatographic methods are considerably diminished, the lowest value being obtained in the case of phosphopyruvic acid. The tissue reserves of these intermediary phosphorylated compounds can be restored to normal levels by the administration of adenosine triphosphate or malic acid or thyroxine in spite of the administration of chloretone being continued simultaneously. We have previously suggested[6] that pyruvic acid might be a precursor for the synthesis of ascorbic acid by the rat. The results of some *in vivo* experiments by Ghosh[7] from this laboratory lent additional support to this view. He showed that pyruvic acid administration increased the ascorbic acid excretion by the chloretonized rat. It has now been observed that by incubating liver tissue with sodium pyruvate under suitable conditions, an increase of 15–20 per cent in the ascorbic acid content occurs over that without the added substrate. This increase becomes more than 30 per cent, if the incubation is carried out in presence of thiamine.

Further evidence in support of these findings has been obtained by the use of the tracer technique. By administering labelled pyruvamide ($CH_3{}^{14}COCONH_2$) to rats under chloretone, it has been possible to separate in a pure and crystalline form both radioactive ascorbic acid and the 2 : 4-dinitrophenyl hydrazine derivative of dehydroascorbic acid from the urine of the experimental animals[4]. In this separation, column chromatography with Brockmann alumina or ion-exchange resin as adsorbing material has been used. The purity of the ascorbic acid isolated and its derivative has been established by chemical analysis and also by absorption-spectra measurements. The ascorbic acid and its derivative gave 315 and 110 counts per min. per mgm. of the compound respectively with a Geiger–Muller counter.

After administration of the isotopic pyruvamide to the chloretonized rats, the following intermediary compounds were separated from the liver tissue of the treated rats by paper chromatographic technique: glucose-1-phosphate, glucose-6-phosphate, fructose-1-6-phosphate, *dl*-glyceraldehyde phosphate, dihydroxyacetone-phosphate, 3-phosphoglyceric acid, and phosphopyruvic acid. Radioautographs of the different compounds have been prepared by the method of Benson *et al.*[8] by prolonged exposure of the paper containing the individual compound to the X-ray film and developing the latter for the radiation study. It has been observed that none of the phosphorylated intermediaries studied had incorporated any carbon-14 in their respective molecules. By the application of the same techniques and from the same liver tissue either treated or hydrolysed, as the case may be, it has been possible to separate the citric, α-ketoglutaric, succinic, fumaric and malic acids of the Krebs cycle and also fifteen amino-acids. The radioautographs of these acids indicate that no carbon-14 had been incorporated into any of them. Glycogen isolated in pure form from the same liver tissue gave an activity of 70 counts per min. per mgm.

It would appear from the above that pyruvic acid lends itself to the synthesis of ascorbic acid in the chloretonized rat. The exact pathway of this synthesis requires further exploration.

We are indebted to Prof. B. D. Nag Chaudhuri and Mr. B. Bose of the Institute of Nuclear Physics, Calcutta, and to Dr. D. P. Burma of the Bose Research Institute, Calcutta, for their help, and to Prof. M. Calvin and Dr. A. A. Benson of the Radiation Laboratory, University of California, for gifts of some of the phosphorylated intermediary compounds used for comparison. One of us (S. C. R.) is indebted to Dr. E. S. G. Barron and Dr. R. Redfield of the School of Medicine, Chicago, for their kind co-operation in the preliminary investigation of the problem with labelled pyruvamide. Acknowledgment is made to the Indian Council of Medical Research for financing this work. One of us (N. C. G.) is indebted to the Ministry of Education, Government of India, for a scholarship.

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Metabolism of Elastin in the Adult Rat

The fully formed collagen fibrils of connective tissue in adult animals are known to have a very slow rate of metabolic turnover[1]. Recently, evidence has been presented for the existence of a soluble precursor of collagen of high turnover-rate[2]. By contrast, I have been unable to find any published information about the metabolism of elastin—another important connective-tissue protein which is a major constituent of the larger arteries and certain spinal ligaments. The following experiments were therefore conducted to supply some information on elastin metabolism.

In view of the high glycine content of elastin, and since carbon-14 labelled glycine had been used in the experiments on collagen metabolism referred to above, (α-^{14}C)-glycine, injected intraperitoneally in a dose of 10 μc. per 100 gm. body-weight, was used in these experiments. The rats used were all adult males and were in two groups of twelve rats each. The first group were normal rats killed in two lots of six at one day and nine days after injection of the labelled glycine. The second group were rats with atrophy of the right hind-limb produced by operation six weeks previous to receiving the labelled glycine[3]. These were also killed in two lots of six rats, one day and nine days after injection of (α-^{14}C)-glycine. On killing, the aortæ were dissected out from the heart down to the bifurcation of the common iliacs and pooled in lots of three or six to ensure a sufficiency of material. Elastin was separated and purified according to Tunbridge and co-workers, who state that this method appears to give homogeneous preparations on examination by electron microscopy[4]. Although our material has not been examined in this way, the morphology and staining characteristics suggest that the preparation consisted of pure elastin. Crystalline glycine samples from hydrolysates of the elastin were separated by column chromatography as the dinitrophenyl derivative and the radioactivity determined on solid samples[5].

RADIOACTIVITIES OF DINITROPHENYL-GLYCINE PREPARED FROM ELASTIN OF AORTÆ OF RATS WHICH RECEIVED (α-^{14}C)-GLYCINE BY INTRAPERITONEAL INJECTION

	No. of rats used	Interval between injection and killing (days)	Radioactivity of DNP-glycine (counts/min./sq cm ('infinite thickness'))	Total wet weight of aortæ (gm)	Weight of DNP-glycine recovered (mgm.)
Normal	6	1	175	1 26	66
	3	9	153	0 71	37
	3	9	186	0 57	29
Operated	6	1	169	1 38	55
	3	9	191	0 68	32
	3	9	142	0 61	23

The radioactivities found in glycine derived from elastin of the aortæ of the normal and operated rats are shown in the accompanying table. It will be seen that there is no significant fall in specific activity with time in the elastin glycine from either normal or operated rats. Indeed, all the observed counts are very similar, and are of the same order as those found previously in adult bone collagen[1,3]. Although the time interval of this experiment is not very long, it is long enough to have allowed demonstration of an active metabolic turnover in elastin if indeed this did occur in adult rat aorta. It therefore seems probable that in the adult rat elastin, in common with the major portion of collagen, has a very slow rate of metabolic turnover.

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Enzymatic Conversion of Two Geometrical Isomers into Enantiomorphs

MUCONIC acid is an intermediate in the oxidation of certain aromatic compounds by bacteria. It is formed enzymatically by an oxidative ring cleavage from catechol[1], and is then re-arranged to β-ketoadipic acid, which cannot be further degraded by the cell-free extracts. Evans, Smith, Linstead and Elvidge[2] studied the action of crude cell-free bacterial extracts on the three isomers of muconic acid, and found that only the *cis-cis* isomer could be converted to β-ketoadipic acid. They also tested the ability of extracts to attack certain lactones related to the muconic acids, and demonstrated that γ-carboxymethyl-Δ^{α}-butenolide could be rapidly converted to β-ketoadipic acid. On the basis of these findings they postulated the reaction sequence shown in Fig. 1.

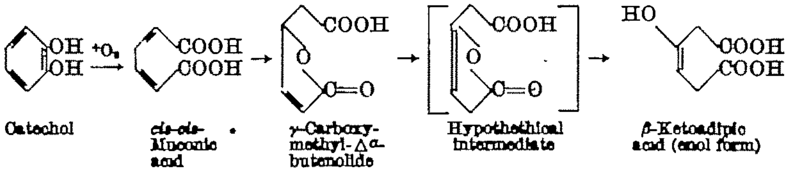

OH
OH
+O₂
COOH
COOH
COOH
O
C=O
COOH
O
C=O
HO
COOH
COOH
Catechol
cis-cis-Muconic acid
γ-Carboxymethyl-Δα-butenolide
Hypothethical intermediate
β-Ketoadipic acid (enol form)

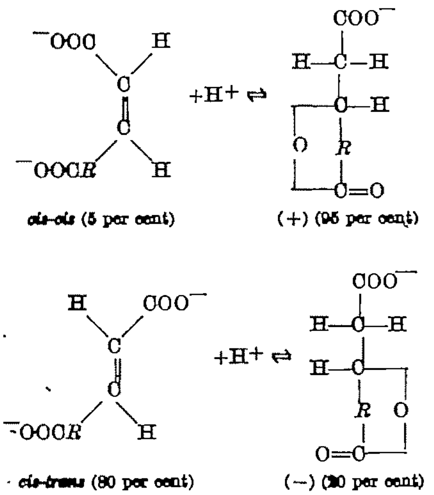
Fig. 1. Mechanism proposed by Evans *et al.* (ref. 2) for conversion of catechol to β-ketoadipic acid

From extracts of *Pseudomonas fluorescens* we have isolated a lactonizing enzyme which converts *cis-cis*-muconic acid to γ-carboxymethyl-Δ^{α}-butenolide, and a delactonizing enzyme which converts this lactone to β-ketoadipic acid, thereby confirming the reaction mechanism postulated by Evans *et al.*[2]. The details of the work will be described elsewhere, and the main purpose of the present communication is to direct attention to a remarkable pair of reactions catalysed by the lactonizing enzyme.

When γ-carboxymethyl-Δ^{α}-butenolide is formed from *cis-cis*-muconic acid, a centre of asymmetry is established at the γ-carbon atom. Consequently, the chemically prepared lactone[2] is a racemic mixture. The lactone prepared enzymatically from *cis-cis*-muconic acid is the (+)-lactone ($[\alpha]_D = +53\cdot2°$). Since whole cells and also the delactonizing enzyme are stereospecific for the (+)-lactone, the unnatural (−)-lactone can be simply prepared by allowing a cell suspension to act upon the synthetic lactone. By these means we were able to obtain both isomers of the lactone.

The lactonizing enzyme catalyses a freely reversible interconversion of *cis-cis*-muconic acid and the (+)-lactone. At pH 8·0, the equilibrium mixture contains 95 per cent lactone. The *trans-trans* isomer of muconic acid is not attacked; but the *cis-trans* isomer can be decomposed at a rate about 0·02 per cent of that with the natural substrate. Moreover, the (−)-lactone can be substituted for the (+)-lactone in a back reaction. Further study has established the fact that the lactonizing enzyme can catalyse a second reversible reaction, parallel to the natural reaction, which results in the interconversion of *cis-trans*-muconic acid and the (−)-lactone, but cannot interconvert the two geometrical isomers or the two enantiomorphs. At pH 8·0 the equilibrium mixture of *cis-trans*-muconic acid and (−)-lactone contains 20 per cent lactone. From the equilibrium constants of the two parallel enzymatic reactions, the free energy change for the *cis* → *trans* isomerization can be calculated; it is − 2·5 kcal., a value which agrees with the known chemical properties of the two isomers and is within the range recorded for similar isomerizations.

Since the double bond in the lactone ring has a *cis* configuration[2], it is evident that the lactonizing enzyme must act upon the *trans* bond of *cis-trans*-muconic acid. The essential features of the two reactions which it catalyses are shown in Fig. 2. It seems clear that the basis of this pair of reactions is an ability of the enzyme to distinguish between two chemically identical atoms or bonds. Thus in the forward reaction, only one of the two component bonds of the γ-δ double bond is split; and in the back reaction only one of the two δ-hydrogen atoms is removed. The ability of an enzyme to distinguish between chemically identical groups has been demonstrated in the dehydration of citric acid[4] and the oxidation and reduction of diphosphopyridine nucleotide by alcohol dehydrogenase[5]; a three-point attachment of substrate to enzyme has been proposed as the mechanism for this discrimination. Fig. 3 shows graphically how such a mechanism would apply in the present case. For simplicity, the drawing shows only those regions of the molecules concerned with the stereoisomeric changes. The following arbitrary restrictions are imposed: (*a*) when the double bond is attacked, only the lower bond is opened, and (*b*) in the removal of *HB* only the right-hand hydrogen is removed.



cis-cis (5 per cent) (+) (95 per cent)

cis-trans (80 per cent) (−) (20 per cent)

Fig. 2. The two reversible reactions catalysed by the lactonizing enzyme, $R = -CH{=}CH-$. The equilibrium values shown are for pH 8·0

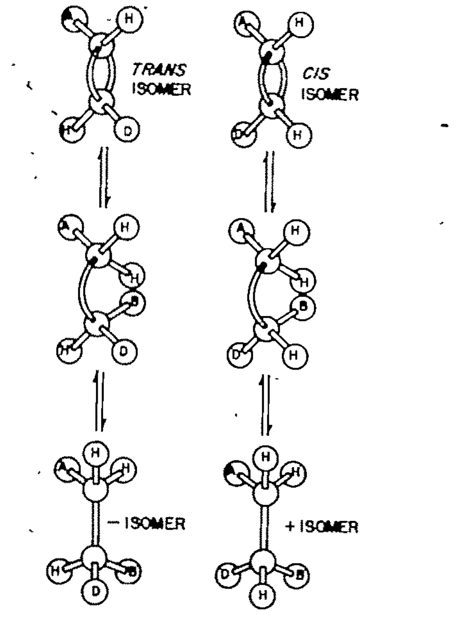


Fig. 3. A three-dimensional diagrammatic representation of the reactions catalysed by the lactonizing enzyme

Krebs[6] has postulated that the formation of L-malic acid from fumaric acid by fumarase involves a similar mechanism. Fumarase apparently cannot catalyse the 'unnatural reaction', maleic acid → D-malic acid; this is not surprising, since the structural difference between maleic acid and fumaric acid is much greater than that between *cis-cis* and *cis-trans*-muconic acids.

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Cell Activity and Deoxyribonucleic Acid Content of the Nuclei of the Thyroid Gland of the White Rat

Recently, it has been claimed that the deoxyribonucleic acid content of the interphasic nuclei in the different tissues corresponds, for a given species, to a value which is double that for the deoxyribonucleic acid content of the spermatic nuclei of that same species. Nevertheless, some exceptions were observed, namely, by L. Lison and J. Pasteels, J. Govaert, C. Leuchtenberger and A. Schrader[1], and lead to the hypothesis that this 'theoretical diploid value' would only be an equilibrium value, from which the deoxyribonucleic acid content would vary more or less widely as a function of the cell activity.

From this point of view, we have carried out some experiments on the thyroid gland of the white rat. It is easy to influence the activity of the cells of this organ and to control histologically its physiological state[2]; and it is well known that the activity of the thyroid cell can be inhibited by thyroxine and stimulated by thiouracil. On histological examination, the physiological states are represented on one hand by the endotheloid aspect, on the other by the columnar aspect of the cell.

Fifteen white male rats aged six to seven months were used. A first group of five rats served as controls; a second group received daily during seventeen days an intramuscular injection of 0·1 mgm. thyroxine; a third group received daily, by gastric probe, and during the same period a dose of 20 mgm. propylthiouracil. All the rats were killed at the same time. The thyroids were quickly removed and fixed in a mixture of alcohol (96°, 75 parts), formalin (40°, 20 parts) and acetic acid (5 parts) as well as a testicle of a control rat. All the manipulations of dehydration and embedding were performed simultaneously. The sections (10 microns) were placed on the same slide and treated by the Feulgen reaction. The deoxyribonucleic acid content of each nucleus was measured with Lison's histophotometer. The extinction coefficient obtained in the wave-length region 5200–5400 A., multiplied by the projection area, gives in arbitrary units the relative value of the deoxyribonucleic acid content. Details of this technique have been given by L. Lison[3].

In every thyroid gland we measured a hundred nuclei. The results of the statistical computations for each rat are shown in Table 1. We noted some haploid and doubly charged nuclei, probably prephasic[4]. For the present computations we took into consideration only the diploid nuclei; this explains why the number of measured nuclei was sometimes less than 100. The mean value for the spermatocytes I being at 1,934, the theoretical diploid value will be at 967 arbitrary units.

Table 1

Spermatocytes I		n	$\bar{x}$	$S_{\bar{x}}$	S
		100	1,934	± 15·5	155·4
Controls	Rat 52	93	825	± 22·8	220·4
	Rat 53	87	827	± 15·0	140·2
	Rat 54	87	828	± 17·0	159·4
	Rat 55	97	830	± 23·2	229·1
	Rat 56	79	817	± 20·4	181·1
Thyroxine	Rat 57	97	747	± 18·5	182·3
	Rat 58	98	700	± 18·7	185·9
	Rat 59	94	758	± 18·7	179·0
	Rat 60	94	732	± 19·9	193·0
	Rat 61	100	557	± 14·6	146·4
Thiouracil	Rat 62	92	877	± 16·7	160·4
	Rat 63	98	838	± 16·9	167·6
	Rat 64	100	906	± 17·6	176·4
	Rat 65	98	825	± 16·5	163·8
	Rat 66	92	948	± 23·8	228·6

n, Number of measurements; $\bar{x}$, mean value; $S_{\bar{x}}$, deviation of the mean; S, standard deviation.

The mean values of the five controls (rats 52–56) are statistically very constant but obviously less than the diploid value.

The mean value of the five rats receiving thyroxine (rats 57–61) is reduced by 10 per cent and even, for one, by 32 per cent. This marked decrease cannot arise from a technical error, as the mean, itself, arises from a hundred consistent measurements.

On the other hand, the mean value of the five rats receiving thiouracil (rats 62–66) shows a clear tendency to increase.

In order to demonstrate more clearly these variations, we pooled all the measurements in each group; Rat 61 was not included, since its mean value was not 'consistent' with the four other rats of the same group (Table 2).

Table 2. POOLED RESULTS

	n	$\bar{x}$	$S_{\bar{x}}$	S
Controls	443	884	± 8·6	179·7
Thyroxine	383	737	± 9·4	185·0
Thiouracil	480	879	± 8·4	185·8

By 'Student's' t-test we have demonstrated that the observed variations are highly significant (Table 3).

Table 3. t-TEST

	t	P
Controls/thyroxine	7·5	< 0·001
Controls/thiouracil	3·7	< 0·001
Thyroxine/thiouracil	11·0	< 0·001

By these experiments we have demonstrated the existence, in the thyroid of the white rat, of a correlation between the variations in cell activity and the deoxyribonucleic acid content of the nuclei; the deoxyribonucleic acid increases with stimulation of cell activity and decreases with inhibition of cell activity. The deoxyribonucleic acid content of the thyroid of normal rats, and especially those with thyroxine-inhibited thyroids, is markedly below the diploid value; on the other hand, in the stimulated thyroid, the content of deoxyribonucleic acid reaches, approximately, the theoretical diploid value.

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Composition and Action of Yeast Polygalacturonase

YEAST polygalacturonase is an exo-cellular pectic enzyme produced by *Saccharomyces fragilis* in a synthetic, protein-free medium. The enzyme is constitutive and is not accompanied by pectinesterase[1]. When it is allowed to act on pectic acid, the following series of reactions occurs[2]:

(a) Pectic acid → penta- + tetra- + tri- + digalacturonic acids;

(b) Pentagalacturonic acid → tetra- + galacturonic acids;
Pentagalacturonic acid → tri- + digalacturonic acids;

(c) Tetragalacturonic acid → tri- + galacturonic acids;

(d) Trigalacturonic acid → di- + galacturonic acids.

Reactions (a) and (b) comprise the initial rapid linear phase of the hydrolysis. The optimum pH of (a) is 4·4. A slower linear phase, beginning at 25 per cent hydrolysis, is characterized by reaction (c) which is optimal at a pH of approximately 3·5. After about 50 per cent hydrolysis, (d) is the main reaction, and it occurs at a very low rate. Finally, after 70 per cent hydrolysis, the reaction ceases, leaving the dimer and monomer as end products. Reaction (d), like (c), is much slower at the higher pH; hence at pH 4·5, the reaction appears to cease at 50 per cent hydrolysis and the apparent end products are tri-, di- and galacturonic acids[3].

In view of the postulations of Dingle *et al.*[4] and Schubert[5] which suggest that several polygalacturonase components occur in mould pectic enzymes, the nature of yeast polygalacturonase was studied.

We have found that yeast polygalacturonase of the crude culture liquid can be adsorbed in the cold on a pectic acid gel at pH 3·0 and eluted with 1 N acetate buffer at pH 5·0. This resulted in a 13-fold concentration, but only in a negligible increase in specific activity. An electrophoretic analysis was performed after further concentration by precipitation with saturated ammonium sulphate followed by dialysis. The pattern indicated two components. The major one comprised about 95 per cent of the total protein. A variable solvent solubility test also indicated two fractions. At 4° C., the minor fraction was precipitated at 0·2 ammonium sulphate saturation and the major one was salted out between 0·8 and complete saturation. A specific property solubility test based on the procedure of Falconer and Taylor[6] showed that only the major fraction had yeast polygalacturonase activity. The specific activity of this fraction, calculated by the last method, was 0·179 yeast polygalacturonase unit per mgm. protein (1 unit of activity releases 1 mM of reducing groups per min. at pH 5·0 from a 0·5 per cent pectic acid solution). The material which was precipitated between 0·75 and complete saturation moved as a single boundary in the ultra-centrifuge.

The rates of yeast polygalacturonase activity on tri-, tetra- and poly-galacturonic acids were compared, using the filtrates obtained at four different concentrations of ammonium sulphate. The ratios of activity remained roughly constant during the salting out, indicating that the hydrolysis of pectic acid to the digalacturonic acid stage is catalysed by a single enzyme. Full details of this work will be published elsewhere.

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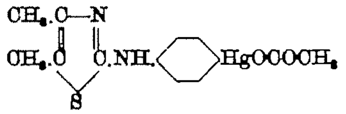
Use of Mercurated Thiazoles as Fungistatic Agents

In the course of our studies on methods of synthesis of thiazole derivatives and their possible useful applications, it appeared of interest to examine their fungicidal properties, since these contain in a cyclic ring structure the grouping N—C—S which is present in known fungicides like tetramethyl thiuram disulphide, thioureas and thioacetamide. Some new mercurated derivatives of thiazoles have also been prepared by us, and since mercury is a powerful fungicidal element, phenyl mercuric acetate being actually used for such diseases as apple scab, it was considered worth while to test these mercurated thiazoles for their fungicidal action.

The thiazole compounds employed were thirteen new 2-substituted-amino 4-5-dimethyl thiazoles prepared by reaction of ethyl methyl ketone with substituted thioureas in presence of iodine by a modified method already reported by us[1]. These compounds have been mercurated by treatment with mercuric acetate in acetic acid. The position taken up by the acetoxy mercuric group has also been fixed by us[2]. The resulting mercurated thiazoles have been assigned the structure :



All the twenty-six new thiazoles (thirteen unmercurated and the rest mercurated) have been tested. For fungicidal assay, the method of Montgomery and Moore[3] was used. *Alternaria polandui* Ayyangar was used as the fungus indicator.

The unmercurated thiazoles completely inhibited spore germination even at a concentration of 100 parts per million. At 250 p.p.m. the percentage of inhibition was only 25–30 per cent.

The mercurated thiazoles were, however, more powerful, being 100 per cent effective in inhibiting spore germination of the fungus even at a concentration of 2 p.p.m.

Detailed investigations will be published elsewhere.

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Glutathione Breakdown and Transpeptidation Reactions in *Proteus vulgaris*

The enzymic breakdown of glutathione by animal tissues has been extensively studied[1]. Both peptide bonds are split by enzymes of rat kidney homogenates ; the γ-glutamyl bond is first hydrolysed to glutamic acid and cysteinylglycine, the latter being afterwards further broken down to cysteine and glycine[2]. In 1950, Hanes, Hird and Isherwood[3] demonstrated that preparations of sheep-kidney not only hydrolysed glutathione, but also catalysed the transfer of the γ-glutamyl residue to the products of hydrolysis and to other added amino-acids. A more detailed analysis of the relative reactivities of various amino-acids with glutathione has recently been carried out[4]. Transpeptidation reactions were also observed between other γ-glutamyl and glycyl peptides and amino-acids in animal and plant tissues[5]. The discovery of such reactions led to speculation on their possible role in the formation of new peptides and of proteins. Although cell-free extracts of *Escherichia coli* synthesize glutathione from its component amino-acids[6], these extracts do not hydrolyse the tripeptide. Breakdown of glutathione and transpeptidation in micro-organisms have not been previously reported ; a study of these reactions in the bacterium *Proteus vulgaris* is described here.

Washed whole-cell suspensions or cell-free extracts of *Pr. vulgaris* (prepared by sonic disintegration) were incubated with glutathione with or without added amino-acids at *p*H 7·4 for 1 hr. at 37°. After deproteinization with ethanol containing N-ethyl maleimide[3], the supernatant was examined for amino-acids and peptides by paper chromatography. Fig. 1 shows a typical chromatogram of the products obtained when *Pr. vulgaris* suspensions or extracts are incubated with glutathione. In addition to the glutamic acid, glycine and small amounts of cysteine expected (cysteine is further metabolized to pyruvate, hydrogen sulphide and ammonia by *Pr. vulgaris*[7]), two new ninhydrin-positive materials with R_F values similar to γ-glutamylglutamic acid and γ-glutamylglycine are produced. The new compounds are increased in amount respectively by the addition of L-glutamic acid or glycine to the original incubation

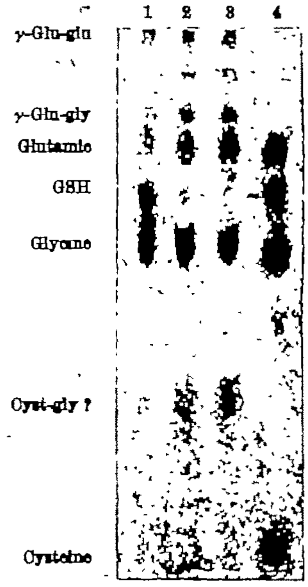

Fig. 1. Descending paper chromatogram showing products of the reaction of *Proteus vulgaris* on glutathione. 1, 2 and 3 represent respectively 7·2, 14·4 and 21·6 mgm. dry weight of organism in phosphate buffer *p*H 7·4 in 0·4 ml. incubation mixture containing 5 μM glutathione. 4 is a control strip of amino-acids and glutathione. Incubations were carried out for 1 hr. at 37°. Whatman No. 3 filter paper developed in propanol–water (80 : 20) for 17 hr. Colour developed by spraying paper with 0·1 per cent ninhydrin in chloroform and heating for 5 min. at 105°

mixtures. Unless high concentrations of the micro-organism are used (of the order of 12 mgm. dry wt./5 μM glutathione), detectable quantities of the new materials are not produced and only small quantities of the component amino-acids of glutathione are observed. The new material obtained when glycine is added to the incubation mixture was eluted and shown to behave like γ-glutamylglycine when compared chromatographically with authentic samples of the α- and γ-peptides. This material was obtained in chromatographically pure form, hydrolysed and shown to contain only glutamic acid and glycine.

Transpeptidation to foreign amino-acids added to the incubation mixture has been likewise observed. New materials corresponding to the γ-glutamyl peptides have been obtained with L-methionine, L-valine, L-phenylalanine, L-leucine and L-glutamine. As with the system from kidney, the quantities of new γ-peptides formed are dependent not only on the amount of acceptor amino-acids present, but also on the particular amino-acids in the system; thus, for example, phenylalanine is more active in transpeptidation than leucine as judged by the intensity of paper chromatographic spots. Using concentrations of acceptor amino-acids up to ten times the concentration of glutathione, increasing the amount of amino-acid increased the amount of γ-peptide formed. The abilities to hydrolyse glutathione and cause transpeptidation remain with the supernatant after centrifugation of the extract for 60 min. at 11,000 *g* and are lost on exposing the extract to temperatures of 55° for 10 min. Of the antibiotics known to interfere with protein synthesis in *Staphylococci*[8], terramycin, aureomycin and chloramphenicol had no effect on transpeptidation at levels of 100 μgm./ml.

These experiments demonstrate the presence in bacterial cells of enzymes catalysing transpeptidations of the same type as in mammalian tissues[3]. Although these exchange reactions appear to be widely distributed in Nature, their significance as a potential mechanism of peptide formation remains uncertain.

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Norvaline: a Growth Factor for Excised Tomato Roots

EARLY reports[1] that norvaline, a synthetic amino-acid, was detectable in protein hydrolysates have not been confirmed using modern techniques[2]. No reports are known to me of the detection of norvaline as a free amino-acid in tissues. It has, however, been reported[3] that on addition of α-ketovaleric acid and glutamine to extracts of rat liver, the α-ketovaleric acid was converted to norvaline. A number of other α-keto acids were converted to the corresponding amino-acid by the extract. The conversion to norvaline, therefore, could be attributed to low specificity of the postulated enzyme. In spite of this, it was decided to include DL-norvaline in a series of amino-acids tested for ability to replace pyridoxine in the nutrition of a clone of excised tomato roots. Some nutritional requirements of this clone and the experimental techniques are given elsewhere[4].

Replacement of pyridoxine by norvaline gave approximately 50 per cent of the growth obtained in the presence of pyridoxine. The best concentration was found to be 4×10^{-4} *M* of the free base. A representative result, using this concentration of norvaline, is shown in Table 1.

Table 1. FINAL LENGTH OF MAIN AXIS PER ROOT (MM.) OF EXCISED TOMATO ROOTS GROWN FOR SIX DAYS IN: MEDIUM (1) WITHOUT PYRIDOXINE; (2) WITH PYRIDOXINE; AND (3) WITH NORVALINE REPLACING PYRIDOXINE. MEANS ARE FOLLOWED BY STANDARD ERRORS AND NUMBERS OF REPLICATES IN BRACKETS

Medium	Length of main axis per root (mm.)
1. Minus pyridoxine, minus norvaline	23·1 ± 1·05 (9)
2. Plus pyridoxine, minus norvaline	97·6 ± 4·24 (9)
3. Minus pyridoxine, plus norvaline	62·0 ± 6·09 (9)

This result has been confirmed on separate occasions and using DL-norvaline from two different sources. Paper chromatography of solutions obtained on autoclaving norvaline, either in water or in the medium, did not reveal any substance with an R_F value, or colour (ninhydrin test), different from those of norvaline. The calculated amount of norvaline per spot on the chromatogram was 125 μgm.

The fact that norvaline may act as a growth factor provides tentative evidence that it is involved in 'normal' metabolism. Whether this is so, and the precise relation of vitamin B_6 to norvaline, is being examined.

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Succinoxidase Inactivation by a Lecithinase in Barley Seedlings

RECENTLY, several investigators[1–4] have isolated mitochondrial fractions from plant tissues which are similar to animal mitochondria in that they are capable of oxidizing all the known substrates of the Krebs citric acid cycle, concomitantly synthesizing adenosine triphosphate from adenylate and inorganic phosphate. However, the oxidative and phosphorylative capacities of mitochondria from different plant tissues vary considerably. For example, mitochondria from oats show much less activity in the oxidation of Krebs-cycle acids than do those from the mung bean; while mitochondria from mung bean hypocotyls are more effective in oxidative phosphorylation than particles from leaves and roots of the same plant[2,3]. Paquin (unpublished work) in our laboratory has also observed that the mitochondria from tomato leaves are considerably less active in the oxidation of succinic acid than are those from hypocotyls of the same plant, and that this is accompanied by a higher endogenous oxygen uptake in the former as compared to the latter.

In our studies on the enzymic activity of mitochondria isolated from barley seedlings (*Hordeum vulgare* L. var. Montcalm) by the procedure of Millerd *et al.*[1], we have observed that fractions from 4–5 day old seedlings apparently lose the ability to oxidize succinic acid, whereas embryonic mitochondria (after 24 hr. soaking) actively oxidize this substrate. Also, there is a marked increase with seedling age in the dependence of mitochondrial cytochrome oxidase on exogenous cytochrome *c* for the oxidation of *para*phenylenediamine (Table 1). The injurious effect of the physical environment on the enzyme activities of plant mitochondria, studied by Laties[4], was found to bear no relationship to the inactivation of barley succinoxidase. However, he also observed that mitochondrial enzyme systems suffer damage by processes of an enzymic nature during their isolation. A characteristic feature of mitochondria from barley seedlings which lack the ability to oxidize succinic acid is their relatively high endogenous oxygen uptake ($QO_2(N) = 100$). This value is five to ten times greater than that of mitochondria from mung bean[1] or tomato hypocotyl (Paquin, unpublished work), pea seedling[6], or cauliflower[5]. Similarly, the endogenous oxygen uptake of embryonic barley mitochondria is only one-tenth of the value of those from 4–5-day old seedlings.

Table 1. ENZYMIC ACTIVITIES* OF MITOCHONDRIA FROM BARLEY SEEDLINGS AT DIFFERENT AGES

Enzyme systems	Hours from soaking 24	36	48	60	72	110
Cytochrome oxidase	—	—	282	236	181	48
" with 10^{-4} *M* cytochrome *c*	—	—	347	330	304	253
Succinoxidase	214	172	83	28	0	0
Lecithinase *C*	0	22	—	317	—	648
Lipoxidase	512	—	704	—	—	782

* Average values expressed as $QO_2(N)$ except lecithinase $QCO_2(N)$.

We have shown that the endogenous oxygen uptake of barley mitochondria is catalysed by a lipoxidase which appears to be distributed among particulate and soluble fractions of the cytoplasm. Mitochondria are capable of oxidizing lecithin and linoleic acid, but not oleic acid. The oxidation of these substrates, like the endogenous oxidation, is activated by cupric and ferric ions and is inhibited by diethyldithiocarbamate, hydroquinone and manganous ions, thus characterizing both the endogenous and the substrate-supported reactions as lipoxidase-catalysed oxidations. However, the loss of succinoxidase activity from older seedlings cannot be due to this enzyme, since it occurs in considerable concentration in embryonic tissue from which 'active' mitochondria may be isolated (Table 1).

We have also identified a lecithinase *C* in older seedlings using the method of Zamecnik, Brewster and Lipmann[7]. This enzyme is absent from the embryo but appears early in the growth of the seedling and rapidly increases in activity. Quastel and Braganca[8], and also Nygaard and Sumner[9], have demonstrated the inactivation of succinoxidase in animal mitochondria by lecithinase *A* prepared from snake venom. We believe that by a similar mechanism lecithinase *C* in barley inactivates the mitochondrial succinoxidase system during the course of isolation. The inverse relationship between succinoxidase and lecithinase activity in mitochondria from seedlings of different ages is shown in Table 1. Moreover, this table shows that the dependence of cytochrome oxidase upon exogenous cytochrome *c* is also inversely related to lecithinase activity; but it is clear that other parts of the whole system, perhaps succinic dehydrogenase, are more sensitive to the damaging effect of this enzyme.

Lecithinase *C* is inhibited by sodium fluoride, and the inactivation of succinoxidase in 4–5-day old seedling mitochondria can be partially prevented by adding 0·01 *M* sodium fluoride to the isolation medium (0·4 *M* sucrose, 0·02 *M* phosphate, *p*H 6·8). This protection is increased if the seedlings are infiltrated with 0·02 *M* sodium fluoride under vacuum prior to grinding.

Lecithinase *C* attacks phospholipids at the phosphate–glycerol linkage, yielding phosphorylcholine and a diglyceride. Phospholipids occur in high concentration in plant mitochondria[10], and apparently play an important structural part in the enzymic organization of these bodies. It is evident that hydrolysis of these 'cementing substances'[11] would bring about a breakdown in the functional integrity of complex enzyme systems such as succinoxidase. Mitochondria which lack the ability to oxidize succinic acid have a high endogenous oxygen uptake because lecithinase *C* has caused a partial disintegration of the mitochondrial structure, and the unsaturated fatty acid components of phospholipids have been exposed to the oxidizing action of lipoxidase. Conversely, mitochondria which have a fairly high succinoxidase activity show a low endogenous oxygen uptake because the phospholipids remain intimately associated with the architecture of the particles, and are inaccessible to oxidation by lipoxidase.

Reports in the literature[12] indicating the apparent transience of the whole or part of the succinoxidase system of seedlings may require re-interpretation in view of this demonstration of *in vitro* inactivation by a native lecithinase in barley seedlings.

Grateful acknowledgment is made to the National Research Council of Canada, which provided generous financial assistance for this study.

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May 7.

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The Rat as a Test Animal in evaluating Artificial Human Milk for Infants

MANY attempts have been made to develop artificial milk formulations to replace breast milk in the feeding of young infants. Tests have been carried out on infants themselves, and there are very few reports of attempts to use animals in such studies[1-3].

We believe that animal experimentation is necessary in studies of artificial human milk, and we have tried to find an indicator which would rapidly show the influence of different formularies on the animal. We observed that feeding with human milk or cow's milk, respectively, causes similar changes in the fæces of rats and the fæces of infants. Using the *p*H of the fæces as an indicator, we then tried to modify cow's milk in such a way that its effect on the rat would be similar to that of human milk.

The technique used in our experiments was very simple. Rats previously kept on an ordinary laboratory diet were caged individually and fed the milk or milk mixtures to be studied *ad libitum*. No extra water was given, and since the experimental period was always very short (1–2 weeks) no minerals or vitamins were added to the milks. The fæces were collected during a few hours each day, suspended in distilled water and the *p*H of the suspension determined electrometrically.

In the first experiments, three-weeks old weanling rats were used. In accordance with Scott and Norris[1], it was found that human milk was unsuitable for these young rats, whereas the cow's milk permitted some gain in weight (Table 1). In later experiments, older rats (9–22 weeks) were used. Although neither cow's milk nor human milk produced growth in these rats, the animals maintained their weight, and it was evident that the results obtained during the short experimental periods were not due to inanition.

Table 1. EFFECTS OF COW'S MILK AND HUMAN MILK AS DIET FOR RATS OF DIFFERENT AGES

Age of rats	Diet	Average body-weight (gm.) initially	Average body-weight (gm.) at 2 weeks	Gain in weight in 2 weeks (gm.)	No. of survivors
3 weeks	Cow's milk	34	51	17	5/6
3 weeks	Human milk	32	29	−3	4/6
9 weeks	Cow's milk	145	162	17	7/7
9 weeks	Human milk	143	148	5	7/7
22 weeks	Cow's milk	214	220	6	5/5
22 weeks	Human milk	220	215	−5	5/5

In Fig. 1 are given some typical *p*H curves of the fæces of rats fed either human milk or cow's milk. It can be seen that there is a distinct difference between the rats on these two diets. Feeding with human milk has given *p*H values between 5 and 6 whereas cow's milk, on the other hand, has given *p*H values above 7. This difference was usually apparent as early as two days after the beginning of the experiment.

The purpose of the further experiments was to find out how cow's milk must be modified to get the *p*H of fæces down to the human-milk level. A great number of cow's milk modifications were prepared including changes in the quality and quantity of protein, fats, carbohydrates, minerals and vitamins. In most of these cases the *p*H of the fæces did not change in the desired way. However, decreasing the calcium content of the milk and a simultaneous addition of lactose led to positive results. In all experiments with decreased calcium and added lactose the *p*H of the rat fæces was distinctly acid, the acidity curve closely resembling that obtained with human milk.

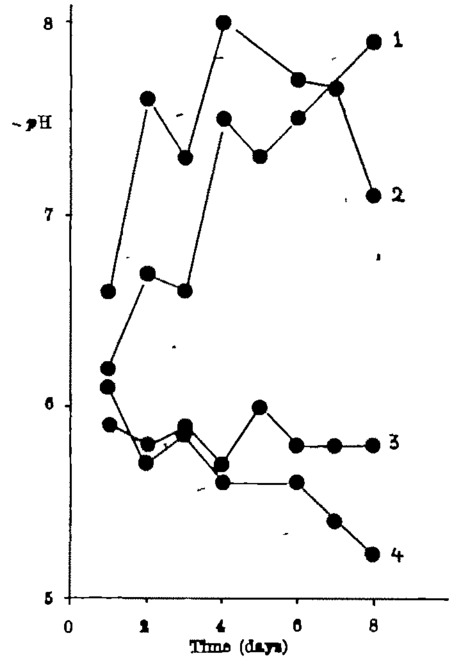

Fig. 1. *p*H of the fæces of rats fed either cow's milk or human milk (averages of 5–7 rats): (1) cow's milk, 9 weeks old rats; (2) cow's milk, 22 weeks old rats; (3) human milk, 9 weeks old rats; (4) human milk, 22 weeks old rats

The calcium content of the milk was lowered by treatment with cation exchangers ('Zeokarb 215' proved satisfactory, removing about 30 per cent of the calcium), by precipitation with sodium sulphate, sodium oxalate or sodium carbonate (cf. ref. 4), or by adding sodium hexametaphosphate ('Calgon') to the milk. The last-mentioned substance, which is known to form soluble complex ions with bivalent ions such as calcium and which is generally used for softening water, has earlier been used by Schwartz *et al.*[5] for the preparation of 'soft curd' milk. Of the different substances tried it was found to be the most suitable for reducing the content of the ionizable calcium. Lactose was added to the milk at the level of 5–10 per cent. Other carbohydrates, for example, dextrin, maltose and sucrose, did not lower the *p*H of the fæces when added to the milk in the same quantities.

The effect of the hexametaphosphate–lactose–milk on the *p*H of the fæces is probably due both to changes in the curdling properties of casein in the stomach and its absorption in the intestines, and to alterations in the composition of the intestinal flora. Further investigations into these questions and into the applicability of such milk formulations as food for young infants are in progress.

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Size of Trichostrongyle Infective Larvæ in 'Monobacterial' Culture

In 1911, Looss[1] noticed first- and second-stage larvæ of *Ancylostoma duodenale* ingesting the bacteria 'contaminating' his cultures. He dismissed bacteria as a regular food source, however, because such larvæ "all show the outward signs of insufficient nutrition". Later, it was established by McCoy[2], and confirmed by Lawrence[3], that living bacteria were normally necessary for the nutrition of hookworm larvæ. Lapage[4] also reared the third stages of a number of strongyloid worms, including *Trichostrongylus retortaeformis*, in broth cultures of coliform bacteria. Although McCoy[5] made measurements of *Ancylostoma caninum* larvæ reared in coliform cultures, none of these workers reported any comparisons made between such measurements and those of larvæ grown in ordinary fæcal culture.

Present attempts to obtain standard larvæ of *Trichostrongylus retortaeformis* by these culture methods reveal a constant reduction in the size of the third stage compared with that achieved in fæces at the same temperature. This is so whether the bacteria are available as growing colonies on agar or in broth, or merely suspended in Ringer's solution. If, however, the micro-organism is added to autoclaved fæces, then a suitable environment seems to be provided, for the larvæ reach their normal 'fæcal' size.

The nematode eggs used in cultures 2–5 were extracted from the fæces of infected rabbits by centrifugal-salt-flotation, and surface-sterilized with White's solution[6]. The micro-organisms used as food were *Bacterium coli* Types I and II and an organism intermediate between *Bact. coli* and *Bact. aerogenes* (classification as in ref. 7).

FIGURES FOR 30° C. CULTURES

Type of culture	No of larvæ measured	No. of cultures	Mean length third stage	%
1. Fæces (normal)	100	3	646 μ	100
2. Fæces (autoclaved with coliform added)	50	2	658 μ	102
3. Monobacterial (agar)	250	10	591 μ	92
4. Monobacterial (broth)	50	2	576 μ	89
5. Monobacterial (Ringer's)	50	1	591 μ	92

A *t* test shows that the difference between grand means of (1 + 2) and (3 + 4 + 5) is significant at the 0·1 per cent level of probability.

The techniques to which the eggs and larvæ were subjected have been tested to discover whether they affected the size of the latter in an artificial manner. The results of cultures of type 2 show that centrifugal-salt-flotation of the eggs and treatment with White's solution have no depressing effect on larval size. These same cultures show, in addition, that the strain of micro-organism was not at fault, since it was also used in some of the agar, broth and Ringer's solution cultures. Comparison of larvæ grown in monobacterial flasks closed either with cotton plugs or rubber bungs has shown that limitation of oxygen to this extent has no adverse effect on size. The fact that a rubber bung seal encloses sufficient oxygen for complete development is also brought out by the results for culture 2 (see table), in which such a method of closure was adopted. The possible influence of osmotic phenomena on the size of larvæ extracted from fæces by Baermann technique was examined by the measurement of 'monobacterial' larvæ before and after approximately twelve hours subjection to this treatment. No significant increase in size was noted.

Whether the depression in size is due, as Looss supposed, to nutritional deficiencies in bacteria alone is still not established; but the elimination of many procedural factors makes the existence of a non-living, thermostable, fæcal contribution to larval nutrition a possibility.

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Cobalamin Requirement in Chrysophyceae

One of the active principles in aqueous extracts of liver essential for growth of *Ochromonas malhamensis*[1] was identified as cobalamin (vitamin B_{12})[2]. Since this requirement was also found in one or two other chrysomonads, it was suggested that all members of the class might need cobalamin[3]. Some evidence lending further support to this tentative suggestion has recently been obtained from three chrysomonads isolated from brackish supra-littoral pools at Millport: *Monochrysis lutheri* Droop (Strain 60), *Prymnesium parvum* Carter (Strain 65) and *Syracosphaera elongata* nom. prov. (Strain 62).

The three strains, which were grown in bacteria-free culture, required for growth soil or, preferably, liver extract and natural sea water. Both the soil and liver extracts could be replaced completely by cobalamin plus thiamin, the latter apparently having the function of a stimulating substance rather than one for which there was an absolute requirement.

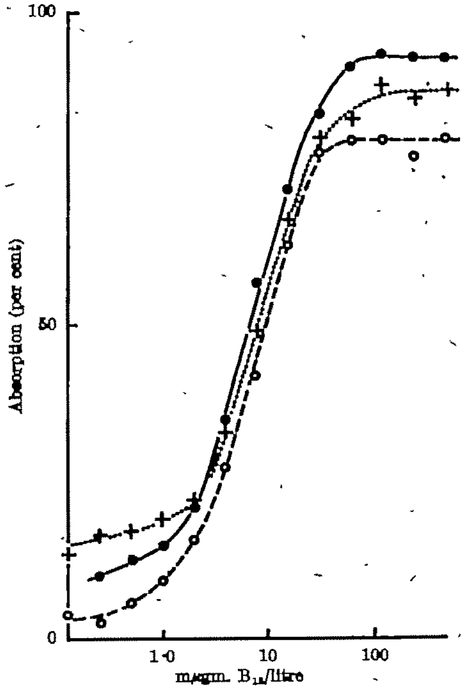

Fig. 1. Response of chrysomonads to doses of cobalamin (Oxo Ltd.). Final yields of cultures measured optically. Continuous curve, *Prymnesium*; dotted curve, *Monochrysis*; dashed curve, *Syracosphaera*

The natural sea water was replaced by an empirical synthetic metal-buffered medium of composition rather similar to Provasoli and Pintner's[3] for *Gyrodinium*, but with guanine and glycine as principal organic constituents. This medium is not ideal and it requires considerable simplification; but it has supported growth of the three strains through nine transfers without undue diminution in yield.

The requirement for cobalamin proved to be absolute and quantitative (Fig. 1); and, so far as experience goes, it was not influenced by the composition of the medium, or eliminated by methionine, some nucleotides and bases. The full pattern of specificity has, however, not yet been ascertained. Maximum growth of all three strains was given by 30–100 mμgm. cobalamin/lit., compared with 200 mμgm. for a marine *Stichococcus*[4], and 100–200 mμgm. for *Euglena*[5]. In the case of *Monochrysis*, maximum yield in culture is about 16,000 cells/c.mm., a figure comparable with that of *Monochrysis* blooms in rock pools but far above any recorded for μ-flagellates in the sea[6]. Concentration of essential nutrients in the pools is probably responsible for the blooms in them; certainly cobalamin must attain a concentration of at least 30 mμgm./lit. On the other hand, it does not appear that this vitamin is a limiting factor in the sea at all times of the year. Preliminary assays with *Syracosphaera* suggest the appreciable figure of 5–10 mμgm./lit. for coastal waters during February and March of this year; Lewin[4] suggests 10 mμgm./lit. If these estimates are even approximately of the correct order, it can be inferred that cobalamin is not a limiting factor in the early spring.

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Marine Station,
Millport. May 5.

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Gene Frequencies in Strains of *Trifolium repens* L.

The frequencies of glucoside lotaustralin and enzyme linamarase genes were investigated in lowland[1] and altitudinal[2] populations of *Trifolium repens*. The results obtained disclosed a continuous diminution in the occurrence of the dominant alleles from the Mediterranean region to north-eastern Europe[1], and from the lowland to the higher altitudes[2] within a range of 100–0 per cent. A significant correlation was found between the dominant allele frequencies and January mean temperature. Further study was concerned with the determination of gene frequencies in strains of *T. repens*. The picrate-paper test used was that described by Corkill[3], modified for determining small amounts of enzyme. The results obtained were used for calculating the occurrence of genes in the samples (Table 1).

The dominant glucoside allele (*Ac*) shows a decrease from 100 to 0 per cent, and the dominant enzyme allele (*Li*) from 86·3 to 10·5 per cent. Striking similarity became evident in the gene frequencies of wild and cultivated strains of *T. repens* derived from the same geographical region. The British and New Zealand strains possess high frequencies of the dominant alleles. In contrast, the Swedish, Danish and north Italian strains show comparatively low frequencies of the dominant alleles, with the exception of the Weibull's Robusta and Nora for enzyme gene.

Table 1. Frequencies of the Dominant Glucoside Lotaustralin and Enzyme Linamarase Alleles in Strains of *T. repens* (per cent)

Strains	Origin	No. of plants	Glucoside allele *Ac*	Enzyme allele *Li*
S.100 Nomark	British	321	100·0	86·3 ± 1·92
Kersey	British	151	88·5 ± 2·60	60·1 ± 3·98
S 100	British	332	80·2 ± 2·19	79·5 ± 2·22
N.Z. certified 'Mother' seed	New Zealand	178	60·5 ± 3·72	66·0 ± 3·60
S.184	British	304	57·5 ± 2·84	59·4 ± 2·82
N.Z. certified 'permanent pasture' seed	New Zealand	104	44·5 ± 4·87	50·0 ± 4·90
Morse	Danish	116	17·1 ± 3·51	10·6 ± 2·87
Weibull's Robusta	Swedish	183	8·6 ± 2·07	72·3 ± 3·31
Ladino	Italian	129	5·2 ± 1·95	25·8 ± 3·85
Weibull's Nora	Swedish	165	4·7 ± 1·65	74·2 ± 3·41
English Dutch	Dutch	126	2·8 ± 1·47	10·5 ± 2·73
Weibull's Tetraploid	Swedish	149	0·0	15·2 ± 2·92

The picrate-paper test also gives an indication of the relative chemical output of the gene. According to the amount of gene product, six colour reaction classes were distinguished. There was a positive correlation ($r = 0{\cdot}8971$, $P < 0{\cdot}001$) between the gene frequencies and the chemical output of the gene (Fig. 1).

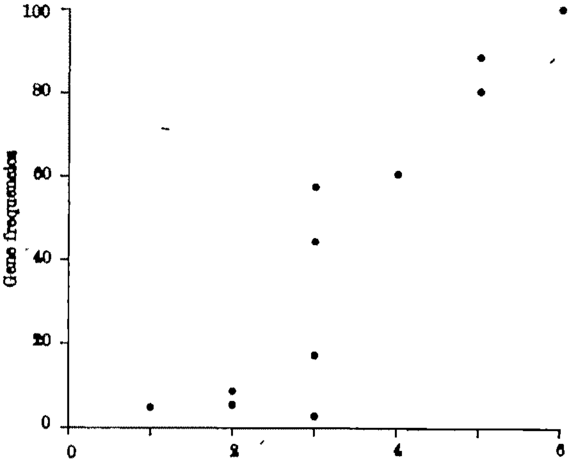

Fig. 1. Relation between the frequencies of the glucoside lotaustralin gene and the reaction intensity plotted as modal reaction classes

I consider that the variation between the gene frequencies in the samples of *T. repens* derived from different geographical regions is governed by natural selection.

I am indebted to Prof. T. J. Jenkin, former director of the Welsh Plant Breeding Station, for facilities for carrying out this investigation, and to Mr. Watkin Williams, former head of the Clover Breeding Section of the Station, for suggesting the experiment, and to Mr. R. C. O. Davies for his help.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Sunday, September 12—Friday, September 17

Society for Experimental Biology (in the Lecture Theatre, Department of Physics, The University, Leeds)—Symposium on "Fibrous Proteins and their Biological Significance".

Monday, September 13—Friday, September 17

Association of Applied Biologists (at Imperial College, South Kensington, London, S.W.7)—Jubilee Conference.

Monday, September 13—Saturday, September 18

International Union of Nutritional Sciences (at Amsterdam)—Third International Congress of Nutrition.

Wednesday, September 15—Friday, September 17

Faraday Society (in the Department of Chemistry, The University, Sheffield)—General Discussion on "Coagulation and Flocculation".

Friday, September 17

British Society of Rheology (in the Main Chemistry Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7), at 11.15 a.m.—Conference on "Viscoelasticity in Solids, Emulsions and Solutions".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Museum Assistant (with a degree, including geology to at least pass standard, and an interest in palaeontology) in the Geology Department—The Secretary, University College London, Gower Street, London, W.C.1 (September 18).

Lecturer or Assistant Lecturer in Psychology—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (September 20).

Lecturer or Assistant Lecturer in the Department of Pure Mathematics—The Registrar, University College of Wales, Aberystwyth (September 20).

Scientific Officer (with an honours degree in bacteriology, or an honours degree in science with a diploma in bacteriology, and preferably with a good knowledge of chemistry) in the Bacteriology Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (September 20).

Lecturer (with good academic qualifications and practical experience in the electrical engineering industry) in Electrical Engineering—The Registrar, The University, Leeds (September 21).

Physicist (with a first- or second-class honours degree in physics, and considerable experience of instrumentation research and development), in the Rocket Propulsion Department, Ministry of Supply, Westcott, Bucks, to lead a small section on rocket instrumentation research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.235/54A (September 29).

Bacteriologist (graduate, with postgraduate training or experience in bacteriology), at the Wallaceville Animal Research Station, New Zealand Department of Agriculture, for research concerning the control of bacteriological diseases of domesticated animals—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting 3/4/37 (September 30).

Senior Lecturer (with a degree in statistics or in mathematics with research experience in statistics) in Mathematical Statistics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 30).

Experimental Officer or Assistant Experimental Officer, in the Pomology Section, to assist with laboratory and field investigations on effects of orchard soil management practices, on the tree and the soil—The Secretary, East Malling Research Station, near Maidstone, Kent (October 1).

Senior Lecturer or Lecturer in Mathematics at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 15).

Chair of Physics; Chair of Chemistry; Chair of Botany; Chair of Zoology at University College, Salisbury, Southern Rhodesia—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 18).

Chair of Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (October 25).

Assistant Lecturer (with special qualifications in applied mathematics) in Mathematics—The Registrar, The University, Manchester 13 (October 30).

Lecturer (with an honours degree in chemical engineering or equivalent with postgraduate or industrial experience in chemical engineering) in Chemical Engineering, and a Lecturer (with an honours degree in petroleum, chemical or mechanical engineering or geology, with postgraduate or industrial experience) in Petroleum Production Engineering—The Registrar, The University, Edgbaston, Birmingham 15 (November 1).

Senior Lecturer (specializing either in soil science or in agricultural organic chemistry) in Agricultural Chemistry, at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 30).

Head (with research and teaching experience) of the Physics Department—The Northern Polytechnic, Holloway, London, N.7.

Senior Technical Officer (with a degree in agriculture or botany or equivalent qualifications, and with practical experience in seed production), in the Herbage Section of the Seed Production Branch—The Secretary, National Institute for Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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ADULT EDUCATION IN GREAT BRITAIN

WRITING on "Democracy and its Discontents" in the June issue of *Encounter*, Mr. M. Beloff argues that the outstanding event in the political history of the past hundred and fifty years in Britain is the development of the Civil Service and of an educational system which has taken enough account of the claims of talent to enable it to create a race of administrators capable of maintaining the consistency of government in spite of the advance towards democracy. Implicit, if not explicit, in this argument is the plain truth, which no party politician dare admit, that wise government is impossible if the discretion of Ministers placed in office by a political party majority is fettered by having continually to consider the effect on voters of taking the measures which are clearly indicated by facts known to them in office but which are unknown, and cannot be made known, to the electorate, even if the electorate were able to appreciate their significance. Efficient and skilful government is, in fact, impossible if many decisions to-day are not removed from the range of popular choice.

Mr. Beloff does not, however, regard the excessive power of the party system or decrease in the prestige of Parliament as the real menace to the stability of British parliamentary institutions to-day. Rather it lies in the possibility of a serious attempt to achieve literal educational equality and to kill the élite which has enabled us to afford the luxury of popular government. The claim that British democracy has been so successful largely because it has become undemocratic is not likely to pass unchallenged. It will at least be asked what has been the cost to the quality of public life and to the wisdom of public policy. Nevertheless, whatever reservations are made as to the full validity of Mr. Beloff's argument, it emphasizes the importance of education for leadership and of maintaining the highest standards of training in the schools and universities from which our future ministers, administrators and experts are drawn. In the context of such episodes as Crichel Down, the words of the University Grants Committee in 1936 regarding the responsibility of the universities are indeed pregnant: a university should stimulate and train its students "at least to think, and to think strenuously about the great issues of right and wrong, of liberty and government, on which both for the individual and for the community, a balanced judgment is essential to a rational life".

While Mr. Beloff, at least by implication, thus emphasizes the importance of education for leadership and the danger inherent in any educational policy which by levelling down hinders the emergence of such an élite, Sir Ivor Jennings's recent exposition of the working and institutions of British democracy, "The Queen's Government", points to the importance of education at the other end. He finds an explanation of the stability of British institutions rather in the fact that the coming of universal suffrage has placed the balance of political power in the community into the hands of the lower ranges of the middle class, mainly salaried employees and small proprietors, whose votes determine which political party shall win the relatively few marginal seats. The interest of these voters is on the whole against violent change, and since political parties must appeal to these voters, violent conflicts of principle are abated and a high degree of uniformity imposed on party programmes.

Whether or not Sir Ivor Jennings's theory be correct—and his view does not necessarily exclude Mr. Beloff's—it indicates the importance of adult education if the issues of the day are to be resolved more impartially and factually and less according to party political doctrines. The stress lies on instruction of the electorate rather than on parliamentary discussion if the findings of the expert are to be used fully in shaping policy. Much more practical thinking about the functioning of Parliament and the relations between Parliament and Minister and administrator and expert is clearly required than Mr. Herbert Morrison foreshadowed in his recent book, "Government and Parliament: Survey from the Inside". The Crichel Down debate in the House of Commons on July 20 at least indicated an awareness of such issues and some readiness to examine them.

While the time is opportune for a re-examination of the working of our Parliamentary institutions and of the philosophy upon which they are based, that examination should be conducted with reference not merely to the structure of government itself and to the men and women responsible for the task of government, whether Ministers, Members of Parliament, or Civil Servants, but still more to the capacity and limitations of the public who placed them in power. In essence it is a re-examination of the problem of power and influence within the framework of a democratic society under the impact of technological change, and the critical factor is likely to be at least as much the receptivity and adaptability of the average citizen as the wisdom, initiative and ability of those responsible for the task of government. If the Technical Assistance programme or the Colombo Plan have done nothing else, they have demonstrated how sharply technical assistance and economic advance in the relatively undeveloped areas of the world are limited by the general standard of education and understanding of the peoples of those areas, as well as their capacity for self-discipline and co-operation.

Those factors set the limits of government action no less sharply among the more advanced nations. If Britain, for example, is to take full advantage of the opportunities of economic development and of raising the standard of living which technological development has made possible, much will depend on the ability of statesmen to secure public understanding and co-operation in the changes, the displacements and sacrifices that may be involved. There is no room for the demagogue in such developments, or in such institutions if the Social Welfare State is to endure. An educated electorate is as essential a condition as wise and competent leadership.

Recognition of this and of the dangers inherent in the present position lies behind much of the concern with which the Government's proposals in regard to television and broadcasting are regarded by responsible leaders of all political parties and walks of life. It is also a reason why educational policy is so important an issue. Even the persistent shortage of science teachers is a factor to be considered here. The direct effect of that shortage is to handicap plans for the expansion of technological education, for example, and to make it more difficult for the nation to obtain the increased numbers of well-trained scientists and technologists who are required in industry, in government service and in the universities and technical colleges. It also affects, however, the recruitment of teaching staff for such institutions, and the number of those coming forward from the schools to enter on careers in science and technology.

But a shortage of science teachers in the schools does not merely affect the supply of those who are willing and ready to undertake studies in science and technology at the university—or technical college—level. It limits the number of those whose general education enables them to leave school with some understanding of what science is—and is not—and of the bearing of applied science on everyday life. This effect, moreover, is likely to be accentuated by the general shortage of teachers required to meet the substantial rise in the school population between now and 1960 by up to some 20 per cent on the 1950 figure. From 1960 onwards there are likely to be ten per cent more children in the schools than in 1950, and unless the present annual increase in the number of teachers is fully maintained, the proportion of children receiving education even of the standard provided in 1950 is likely to fall. Prospects of a ten per cent increase in the number of those entering on a scientific or technological career merely through the overall increase in the school population are slender, even if the shortage of science teachers is removed.

From this point of view a determined effort to reduce the size of classes at least below the regulation forty might be well worth the price demanded. For the next generation, however, the standard of public understanding will depend in large measure on adult education. Indeed, debates on education in the House of Commons suggest that the measures required to avert a fall in the standards of primary and secondary education by eliminating the over-size classes and to secure the wisest use of our limited reserves of trained man-power must wait on the support which an informed public opinion could give.

Since the county colleges for further education now appear to be a remote possibility of the future, the main responsibility for adult education must lie with existing agencies. Admittedly, as Mr. Ernest Green points out in his book "Adult Education—Why this Apathy?"*, adult education must begin in the schools, and the desire for liberal education, as distinct from mere vocational training, is either stimulated or stifled at the time of leaving school. This situation may well have to be accepted for the next ten or fifteen years. By that time we may have, as he suggests, enough teachers, better trained and with wider experience of life, adequate buildings and equipment and a curriculum which is less concerned with the job a boy or girl is to enter and more concerned with their minds, character and personality; in that event, the schools will indeed be producing citizens in the schools instead of clerks, shop assistants, apprentices, etc.

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* Adult Education: Why This Apathy? By Dr. Ernest Green. Pp. 146. (London: George Allen and Unwin, Ltd., 1953.) 15s. net.

In the meantime, we have to face a situation in which the schools are still failing to lay the foundations for good and responsible citizenship and to strengthen the moral and spiritual values on which such citizenship is based and the preservation of all that is best in a cultured, democratic way of life. In this context the concern with which the passing of television under influences that are not primarily swayed by the idea of public service is regarded can be understood. As the Government's White Paper admits, "television has great and increasing power in influencing men's minds", and the Beveridge Report had earlier recognized that broadcasting could increase the danger of the passive acceptance by the masses of orders given to them and of things said to them. Such passivity is a serious danger to democracy and free institutions to-day, and one which television, even more than sound broadcasting, encourages.

Moreover, this concern over power and responsibility in television takes place at a time when, as various re-examinations of adult education, prompted in part by the celebration of the jubilee of the Workers' Educational Association, have shown, there appears to be a decline in both the efficiency of existing means of adult education and in the interest taken in them. Dr. Green, for example, points out that approximately one in four of the school leavers covered by his inquiry make no apparent effort to follow up their school experience, even in the direction of vocational training; and of those who do, nine out of ten appear to be uninterested in the arts or the humanities. Well may he urge that we should regard training for a job or profession as only one incident in the educational process, and that the curriculum should be one in which ideas are discussed and the student taught how to discover the facts for himself.

While Dr. Green rightly argues that we must relate all forms of education to life in society, when it comes to ways and means he focuses his attention on what he terms the educationally under-privileged, and the view he takes of the functions of the Workers' Educational Association is correspondingly narrow. He would limit its activities to meeting the needs of the manual worker. In this he takes an even more restricted view than was taken by the working party under Mr. A. Creech Jones's chairmanship which recently reported on trade union education to the Workers' Educational Association. That report called for a more specific and concentrated effort by the Association to meet the needs of the trade union movement; but it showed also a real awareness of the implications of the situation to-day, and did not suggest a policy limited exclusively to meeting even the widest educational needs of that movement.

The two reports reach similar conclusions regarding the measures which might be adopted to meet the limited demand, particularly by way of supplementing the tutors which the Workers' Educational Association draws from the universities. Useful as may be the experiments suggested, particularly in the effect on leadership in the trade unions, neither Dr. Green nor the working party pays attention to the wider aspect of the extra-mural activities of the universities. Only to a limited extent do they share the conception of adult education which Prof. R. D. Waller displays in his appreciation of H. Pilkington Turner: "Adult education", wrote Prof. Waller, "is what happens when knowledge is transmitted from mind to mind in such a way as to kindle a glow of love and hope and faith in life, and to confirm both those who give and those who receive in their sense of the dignity of human destiny and of their own responsibilities in the face of it".

Adult education in that sense is exactly what is needed to vitalize a democratic society to-day and to enable it to preserve its traditions and its free institutions. Broadcasting and television could help to encourage the receptivity on which such education proceeds; but they could equally, if misdirected, prove formidable obstacles to this enlargement by inspiration. This is not to deny that broadcasting has played an important part in raising the standard of public taste and understanding over the past twenty or thirty years; but that influence is due in large measure to the conception of public service which has dominated broadcasting policy. Only time can show whether the safeguards written into the Television Act will be adequate to ensure that the influence of television on standards is beneficial and that its educational possibilities are fully utilized.

Even if it is only to encourage the background of interest against which adult education proceeds most effectively, the importance of broadcasting and television is not to be under-rated. It is difficult to accept Prof. Robert Peers's statement that the most serious obstacle to the rapid development of science courses in adult education is the absence of any general interest in science. It may be true that the demand for science courses in extra-mural education is not advancing as briskly as might have been expected; but there is abundant evidence of a widespread interest in science which finds expression, for example, in the activities of amateur scientists in many ways. Such activities may not lead to any understanding of science as a whole and its implications; but they testify to an interest which in adult education could and should lead to such understanding, if teachers or tutors are available.

The supply of teachers is most probably the critical factor, and perhaps all the more if in future we are to look to the day-release class rather than to the traditional evening class as a vehicle of adult education. Scientists are showing themselves increasingly aware of the importance of explaining themselves. Though there are defects in scientific education in Britain to be overcome—and especially a tendency to segregate scientists—the danger is now more generally appreciated, and it is noteworthy that all proposals for the expansion of technological education seek to minimize that danger.

Scientists are already co-operating in extra-mural activities, and for all who possess some capacity for interpretation and exposition to participate, either formally in extra-mural activities, through their professional associations or in private in such ways as are open to them, this task of assisting in the public understanding of science and its implications, is one of the most important ways in which they can to-day discharge their obligations as citizens. The extent to which they respond to this need and take part in the critical discussion of proposals designed to alleviate the immediate shortage of science teachers, and assist in the most effective use of the resources at our disposal for teaching science and technology generally, will largely determine the ability of democratic institutions to adapt themselves to the needs of to-day, and to throw up leaders capable of formulating the policy required to preserve those institutions and their traditions. Whatever changes may be necessary in the nature of adult education, any limitation or segregation of students to particular social classes or industries would be deplorable.

Objective teaching cannot take place in the context of class prejudice, and the bringing together of a wide range of social strata, of men and women of varied experience and outlook, is a prerequisite if adult education is to make its full contribution to that balanced outlook and public understanding on which the continued functioning of free and democratic institutions so largely depends. It may at least be hoped that when the Minister of Education receives the report of Dr. Eric Ashby's committee on the finance and administration of adult education, she will be able to announce a policy that will do more than remove the uncertainties which, as the last report of the Universities' Council for Adult Education shows, have hindered work in this field for the past eighteen months or more. Not only is a policy required which will permit development to be planned with confidence while giving the necessary flexibility for vitality and wealth of experiment; it should equally encourage that type of adult education to which the Prime Minister referred in his message last year to the General Council of the Trades Union Congress: "The mental and moral outlook of free men studying the past with free minds in order to discern the future demands the highest measures which our hard-pressed finances can sustain". If it is also true that, as Sir Winston continued, the appetite of adults to be shown the foundations and processes of thought will never be denied by a British administration cherishing the continuity of our island life, it is no less true that the continuity of effective administration and of free institutions may well depend on the extent to which public understanding is fostered in exactly that way.

BIOCHEMISTRY OF GENETICS

The Biochemistry of Genetics
By Prof. J. B. S. Haldane. Pp. 144. (London: George Allen and Unwin, Ltd., 1954.) 15s. net.

THIS book, by Prof. J. B. S. Haldane, is, as one has come to expect, a remarkable, a stimulating, and yet a motley work. The brief volume is an outgrowth of a series of lectures delivered to the Department of Biochemistry, University College, London, in 1950 and 1952, and is thus directed primarily towards biochemists. The contents, however, may well prove even more stimulating to geneticists.

Haldane discusses primarily the action of genetic material, described in biochemical terms as deduced from studies on viruses, bacteria, fungi, higher plants and animals. He describes in brief terms the genetic control of biochemical reactions in bacteria and fungi, of pigment formation in higher plants and animals, of antigen formation, and the genetics and biochemistry of a variety of inborn metabolic errors in man. Thus the book is remarkable for the great diversity of material considered from a common point of view, and so bears testimony to the extraordinary wide reading and interests of the author. It is, in fact, this breadth of material as well as the point of view of the author which makes the book stimulating reading.

The brevity of the treatment of such a diverse field leads of necessity to a somewhat superficial consideration, as well as to a great deal of unevenness in the material covered. Furthermore, in considering fields in which he himself has not worked, Haldane's choice of material is rather selective. The book also contains numerous errors of fact. Thus, this work should not be used as a reliable source of information, but is rather a delightful essay on the genetics of biochemistry.

One cannot read this volume without deriving pleasure from certain sallies of the author, and taking exception to others. Thus Haldane's observation of the lack of appreciation by the "American School" of the origin of the postulate that genes make enzymes is a happy one and perhaps justified. On the other hand, when considering the Neurospora work of the "American School" he comments: "It is moreover possible that more is known than has been published. Some of the workers concerned are now paid by the Atomic Energy Commission and such an affiliation at best imposes a delay on publication, at worst holds it up indefinitely". It may well be true that more is known than has been published; but if so, as far as this reviewer knows, it is for human rather than political reasons. While it is true that a great deal of research on microbial genetics is supported by the United States Atomic Energy Commission, this support has facilitated research and has neither suppressed nor delayed publication in this unrestricted field. Haldane's book also has many political quips concerned with the Lysenko controversy. These lose a great deal, however, as Haldane poses the problem primarily on the basis of whether Lysenko is right or wrong, where it would appear to many that the controversy is on an entirely different level, namely, does Lysenko make use of truly objective scientific methods? This obscurantism again does not seriously detract from the book as a whole, since it consists primarily of asides and thus does not enter into the mainstream of the problems under consideration.

In reading the book as an essay, one derives great pleasure and stimulation, a great deal of which comes from the breadth of knowledge and interests of the author. The conclusions concerning the nature of gene action are refreshingly different. Haldane feels that biochemical genetics is approaching a critical epoch, a time one may well be able to specify what a given unit of genetic material is doing. With this most geneticists will agree. He feels, however, that this knowledge will stem from a study of 'vitaminless' mutants rather than 'amino acidless' mutants, as he feels the action of gene-controlling vitamin synthesis may well be direct, while the genetic control of amino-acid synthesis must be indirect. The evidence for such a difference in the action of genetic material is scant indeed, and, in the opinion of this reviewer, based on studies not referred to by Haldane, this difference is improbable. The discussion of problems of this nature makes, however, for pleasant speculation. Lastly, Haldane concludes that genes need not act by a direct replicating process, but rather that genetic material in its action and replication passes through a cycle involving intermediate states. Considerations of this sort have been given scant attention in recent years, and it is with pleasure that one reads and ponders these ideas, since the straws in the wind suggest that they will be the problems of the future. DAVID M. BONNER

STRESS WAVES IN SOLIDS

Stress Waves in Solids

By H. Kolsky. (Monographs on the Physics and Chemistry of Materials.) Pp. x+212+3 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 25s. net.

STRESS propagation in solids has recently become the object of a remarkable revival of interest. This is partly due to the recent development of electronic apparatus capable of generating and detecting stress pulses; for, without this, experimental work was a matter of considerable difficulty. Further, the study of stress pulses of large amplitude is obviously of military importance, and the Second World War not only focused attention upon elastic waves but also led to the initiation of plastic wave theory. However, those who are interested in stress waves have been handicapped by the lack of a reference book on the subject and by the state of the literature, which has become scattered in journals of engineering, physics, seismology, acoustics and mathematics. In writing this monograph, the author has materially improved the situation.

The book is divided into two parts and, of these, the first is concerned with elastic waves. The introduction to this subject is very clear and includes a brief treatment of æolotropic media. The theory of the extended isotropic solid is dealt with in detail, and some of the effects which are associated with boundaries are discussed; these include the two-dimensional problems of Rayleigh waves, reflexion and refraction. A chapter on propagation in bounded solids includes an outline of the various engineering theories of thin rods together with the 'exact' Pochhammer treatment of cylinders and a discussion of the ways in which the former approximate to the latter. The rest of this part of the book deals with experimental investigations, and mention is made of the well-known pressure-bar experiments of B. Hopkinson and of R. M. Davies. Some recent work on ultrasonics is summarized very briefly.

In the second part of his book, the author deals with stress waves in imperfectly elastic media; this is particularly welcome. It starts with a treatment of internal friction and stress propagation in visco-elastic solids. A chapter is devoted to the experimental determination of dynamic elastic properties and includes a discussion of results. A very interesting treatment is given of plastic and shock waves in solids, which includes the theories of G. I. Taylor, Th. von Kármán and K. A. Rakhmatulin for the infinite wire. In the last chapter, the author deals with the important subject of fractures produced by stress waves; he mentions the work of J. Hopkinson and of B. Hopkinson and describes the very illuminating experiments which he and his associates have made and which will surely become very well known.

The list of references indicates that the work is intended chiefly for the physicist; while it is excellent for this purpose, the engineer will find this list inadequate in some respects. The book is written lucidly and the mathematics is simple. Thus, the elasticity equations are presented in component form in the manner of Timoshenko, and the use of vectors is reserved as the subject of an appendix. There can be no doubt that this book will be widely read. It is excellently written and is a valuable contribution.

R. E. D. BISHOP

MKS UNITS

The M.K.S. System of Units

A Guide for Electrical Engineers. By T. McGreevy. Pp. xii+283. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 21s. net.

IN Britain, general interest in the MKS system of electrical units really began some four years ago with the publication by the Institution of Electrical Engineers of a symposium of papers on the subject. Since that time, the rationalized MKS system has gained considerable popularity with teachers, quite apart from its adoption in technical practice, and several short explanations of it have been published. Mr. T. McGreevy's book is considerably fuller than any of these, and is written both for the engineer who is concerned with using the system, and the teacher of electrical engineering for whom it offers new approaches to the subject. It will interest also teachers of physics, for the author discusses the fundamental principles of measurement in some detail.

The œrsted, gauss and maxwell always seemed to have a firm co-opted status as practical units, and it may be harder for the engineer to learn to think habitually in amperes per metre and volt-seconds than it is simply to accept the change of units. Here the book should be most helpful. The author derives many of the chief results in motor, generator and transformer theory from first principles, gives some worked examples on the properties of magnetic materials, and has tabulated formulæ and conversion factors for reference.

The earlier chapters are directed chiefly to teachers in technical colleges. A scheme for introductory classes at two different standards is outlined, in simple terms for part-time students and in a more analytical form for full-time students. With the ampere established as the fourth fundamental unit, the definitions of H as the line integral of I and of B in terms of a flux-cutting e.m.f. are logical first steps in electromagnetism. The ballistic galvanometer is used in the earliest stages, and no objection to using an instrument before its full theory is taught can fairly be made by teachers whose own study of electricity was probably initiated with the leaf electroscope. The treatment at both levels is convincing (though at one stage an imaginary experiment is invoked), and should be readily understood by students, which is its justification. In developing an introductory treatment, the teacher is rather in the same difficulty as the centipede; concern for logical sequence will not necessarily make things run more smoothly. The basis for accepting the Biot–Savart law and the first circuital theorem is the experimental work of Ampère; but a purely deductive approach on these lines would be too severe. Again, a rigid deductive presentation founded on Coulomb's law is within the grasp of accomplished mathematicians; but no beginner could ever understand it. Mr. McGreevy asks the student to accept the first circuital theorem and the concept of magnetomotive force with the help of rough quantitative experiments, and after this the path is clear and easy to follow.

The book is to be recommended, and should meet a need which has been felt for some time. It should also stimulate much thought and discussion about elementary teaching methods. G. R. Noakes

PROF. MEGHNAD SAHA: SIXTIETH BIRTHDAY TRIBUTE

Professor Meghnad Saha

His Life, Work and Philosophy. Edited by S. N. Sen. Pp. viii+176+19 plates. (Calcutta: Meghnad Saha Sixtieth Birthday Committee, Indian Association for the Cultivation of Science, 1954.) 5 rupees; 10*s.*; 1.50 dollars.

THIS account of Prof. Meghnad Saha's scientific and political career has been issued as a tribute to him in celebration of his sixtieth birthday by a committee under the chairmanship of Prof. D. S. Kothari. It emphasizes, rightly, Prof. Saha's pioneer work on thermal ionization and selective radiation pressure which established his position in the world of astrophysics more than thirty years ago and led to his election to the Royal Society. But his heart was in physics, and it was only after a considerable output of papers on purely spectroscopic problems and nuclear physics that he returned to the solar corona as a subject of study. Active interest in the propagation of electromagnetic waves in the ionosphere led later, with the development of radio-astronomy, to further work on radio-waves escaping from the sun and stars.

Meanwhile, Prof. Saha had been living a very active and successful life as a professor of physics at Allahabad and Calcutta, building up research schools in ionospheric studies and nuclear physics. He had become an active member and leader in the development of scientific societies and other activities in India. The Indian Science Congress, the United Provinces Academy of Sciences (later the National Academy of Sciences, India), the Indian Association for the Cultivation of Science and the National Institute of Science, all in turn elected him as president. Prof. Saha was also mainly instrumental in the formation in Calcutta of an Institute of Nuclear Physics for training personnel and carrying out fundamental research. He was appointed honorary director of the Institute. He was also a member of the Board, later the Council, of Scientific and Industrial Research. Through many articles, signed and unsigned, in *Science and Culture*, Prof. Saha published his views on science and its social relations.

In 1951 Prof. Saha stood for Parliament as an independent member and was elected by a large majority. In his work as a member of Parliament he has been concerned with education, industrialization, river valley projects and national planning. Throughout his life he has been a fighter for causes which he felt to be right, and it is largely due to his forthright spirit that he has risen from a humble beginning to the position of leadership that he holds to-day in the world of Indian science.

F. J. M. Stratton

FOSSIL BOTANY

An Introduction to the Study of Fossil Plants

By Prof. John Walton. Second edition. Pp. x+201. (London: Adam and Charles Black, 1953.) 30*s.* net.

THERE have been many notable advances in the field of palæobotany since the first edition of this useful text-book was published in 1940; the problem in preparing the second edition has been to make a limited selection of these for inclusion, and this the author has done chiefly from among the pteridophytes and pteridosperms of the late Palæozoic. For example, as further illustration of significant phases in the evolution of some of the chief groups of vascular plants, substantial information is included about the structure of the Lower Carboniferous horsetail cone *Protocalamostachys*, in particular of its sporangiophore; about the structure of various Carboniferous seeds, especially *Calathospermum* and *Salpingostoma* from the Scottish Calciferous Sandstone Series; and about the demonstration of heterospory in the Carboniferous fern *Stauropteris*. Space has also been found to add a brief discussion of such recent critical studies of more modern seed plants as Simpson's stratigraphical use of Tertiary pollen floras from Mull and Ardnamurchan, and Elias's work on grass fruits in studies of the evolution of the grasslands of North America during the Miocene and Pliocene—the latter of particular palæontological interest in its relationship to the evolution of the horse.

The opportunity has also been taken to revise some of the useful tables of stratigraphic correlations, and of age of geological periods, to bring them into conformity with more modern data; and the final chapter on climate and world floras has been amplified, with a broader discussion of evolutionary aspects and including such a recent theory as Hoyle's astrophysical explanation of the former occurrence of tropical floras at high latitudes.

When so many sections of the book have thus been brought up to date within the limits of the publication, it is indeed to be regretted that space could not have been found to revise the chapters on the Cordaitales, Coniferales and Cycadales; for in these groups some of the most significant of the recent additions to palæobotanical knowledge have been made through the work of Florin, Harris and others. It is to be hoped that in any future edition the account of these groups may be amplified, for the existing text-books on gymnosperms are notoriously out of date in this respect.

MYXOMATOSIS IN BRITAIN

By Dr. C. H. ANDREWES, F.R.S.

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THE deliberate introduction into Australia of myxomatosis or rabbit-plague has undoubtedly brought immense economic benefit to that country. Rabbits are a pest in Britain also, and myxomatosis has now reached these islands. Are we to expect wholesale destruction of our own wild rabbit population and corresponding economic gain ? The answer to these questions is not easy, for myxomatosis seems to be behaving very differently in South America, which is its native land, in Australia, in France and in Britain.

In South America the virus of myxomatosis infects the native rabbit or tapeti (*Sylvilagus brasiliensis*), causing a non-fatal disease and being carried by mosquitoes (*Aedes* spp.). Its existence became known when, in 1898, it infected Sanarelli's laboratory rabbits in Montevideo and almost wiped them out. Domestic rabbits are derived from wild European rabbits, *Oryctolagus cuniculus*, and, in them, in contrast to the tapetis, myxomatosis is almost uniformly fatal. Accordingly, Aragão[1] suggested that the virus could be used for exterminating wild European rabbits where these were a pest, as they decidedly are, especially in Australia.

Early attempts to follow up this idea in Australia, Britain and Scandinavia attained only limited success: the disease obtained no permanent foothold. In 1950 further attempts were made in Australia to use the infection for destroying wild rabbits. Six of seven liberations apparently came to nought; but the seventh, just when it was thought to have failed likewise, suddenly flared up over unexpectedly wide areas. Probably it was spread by mosquitoes. Since 1950 myxomatosis has spread over much of south-eastern Australia, where it is estimated to have killed four-fifths of the rabbits in 1952–53 and to have increased rural production by £50,000,000.

In 1952 a French doctor introduced the infection into his estate south of Paris. He succeeded in his object of killing off his wild rabbits; but the disease did more: it spread beyond his park and in less than two years it had covered most of France and has now reached the north of Scotland. Why the disease has been spreading so widely when previous attempts to introduce it failed, we do not know. In France, the disease was by no means generally regarded as a blessing. Possibly the economic gains were on balance greater than the losses. But the disease affected not only wild rabbits but also the tame ones in rabbitries, which are of much economic value; and the *petits chasseurs* were very vocal because their week-end sport was spoilt.

Myxomatosis reached Britain about September 1953—how, we do not know. It could have been deliberately introduced by man, carried in infected mosquitoes or in rabbit fleas which had become accidental passengers on birds. The occurrence of the early outbreaks in counties facing the Channel—Kent, Sussex and Essex—suggests a natural method of spread rather than an intentional introduction. In view of the early failures to spread the disease, it seemed likely that the disease might die out during the winter months. On the contrary, it smouldered in its original foci and new centres of infection were reported nearly every week in south-east England.

Late in 1953 an advisory committee was appointed by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland. Its first decision was to approve the attempts made by the Ministry to 'contain' the early outbreaks, to give time for the whole position to be assessed. But the virus was not to be contained; it spread despite man's efforts and with increasing momentum as summer followed spring[2]. There is no doubt that when farmers began to realize that they had much to gain from destruction of rabbits, they obtained infected animals and released them on their own properties. The bigger 'jumps' of infection in the early summer of 1954 can be traced to such introductions.

The official attitude hitherto has been to take no part in, and in fact to deprecate, intentional spreading of the disease. A major reason for this concerns an aspect of the disease not yet discussed: the disease is a very unpleasant one. Infected rabbits are of a revolting aspect; their eyelids are so swollen that their eyes are closed; their faces, the bases of their ears and often their genitalia are swollen. When they are ill they come into the open and sit about, breathing slowly and often with difficulty, for several days before they die. Letters to newspapers reporting that they are "in agony" and attempting suicide need not be literally believed; nevertheless there is a very powerful and vocal humanitarian argument against spreading the infection in order to obtain economic rewards.

In order to foretell the likely future of myxomatosis in Britain, we need to know more of its method of spread and the controlling factors here and elsewhere. Thus we can better judge whether its activity in Britain should be helped or hindered.

Method of Spread

The natural disease in South America is apparently mosquito-borne. So, too, in Australia, mosquitoes seem to play a major part. They and other biting insects seem to act only as mechanical transmitters of infection—'flying pins'. In its first year there, the killing of rabbits was mostly along river-beds only, *Culex annulirostris* being the main vector. But in 1951–52 spread occurred far away from rivers, *Anopheles annulipes*, a wide-ranging mosquito, being largely concerned[3]; this species is believed to feed on rabbits in warrens underground. The seasonal incidence and character of outbreaks in Australia are quite closely linked with rainfall and associated prevalence of different biting insects.

There is little exact information as to the method of spread of myxomatosis in France. The rapidity of spread and the frequency of attack on tame rabbits suggest that a flying insect, probably a mosquito, plays a major part.

In Britain there has been no evidence of dramatic 'jumping' of infection, as in Australia, except where man has intervened. It is thus interesting that there is, as yet, no evidence that mosquitoes are playing any major part in spreading the disease in this country[4]. The fact that there is widespread infection in wild rabbits but only a few authentic infections of tame rabbits is also evidence against participation of a winged vector. On the other hand, rabbit fleas (*Spilopsyllus cuniculi*), which do not occur in Australia, may well be acting as a vector here. I have found, as have others, that among rabbits kept free from ectoparasites, cage-to-cage infection in the laboratory has not occurred. Fleas are abundant on wild rabbits and with warmer weather congregate more on the head where myxomatous lesions chiefly occur. Though specific parasites of rabbits, they are occasionally carried on birds and presumably could in this way help in wider spread of infection[5].

Changes in Rabbit-virus Relationship

A relationship in which a parasite kills more than 99 per cent of its hosts is not likely to be stable. In associations of long standing, host and parasite become adapted to living together, as is the case with myxoma virus and the South American tapeti. An adjustment in this sense is sure to take place elsewhere. Development of inherited resistance is likely to take a long time in rabbits—even they are slowly breeding beings in comparison with a virus. There is so far little evidence that offspring of recovered rabbits are resistant. On the other hand, there have been found in Australia virus strains of lowered virulence, taking longer to kill and killing only 90 per cent instead of more than 99 per cent. Rabbits living longer remain infectious longer and the virus can therefore spread more readily, so that one with a tendency to kill more slowly has an evolutionary advantage[6]. So far there is little or no evidence of emergence of an attenuated virus in Britain, or, so far as one knows, in Europe. Indeed, the apparently more stable European strain is being used for re-introductions of virus into Australia.

Human Intervention and Myxomatosis

In Australia, even where the kill of rabbits is very high, the disease passes on, and surviving rabbits begin to breed. The new generation of rabbits will not be immune and to keep them down and, as the Australians say, to "back up the virus", other destructive measures are being used and, when needful, virus is re-introduced. Thus, myxomatosis is greatly helping Australian economy; but to take full advantage of it, scientific "backing-up" is being used on a very large scale.

In the British Isles, myxomatosis has now reached nearly every county of England and Wales and a number in Scotland and Ireland. Its incidence, however, is very patchy. In most counties one can walk for miles and see plenty of healthy rabbits and not a single diseased one. The total destruction of rabbits must be still trivial. The poor summer of 1954 may have militated against spread by 'flying pins', and a warm September might yet alter the picture. It seems likely, however, that myxomatosis, except perhaps in south-east England, is only here and there. Things might remain like this into the indefinite future, with the disease spreading naturally or otherwise from farm to farm, parish to parish and back to its starting point as new susceptible rabbits grow up. There might well be no striking effect on rabbit numbers, except indirectly as the existence of the disease affected the trapping industry and the taste of the people for rabbit-meat; these factors might leave us in many areas with more rabbits rather than less. Further, we should still have the disease with us, with local epidemics killing the rabbits in hundreds in its highly unpleasant fashion. If such should indeed be the outcome, we should have all the disadvantages of myxomatosis with no compensating economic gain. It might then be cogently argued that we should follow the Australian example, introduce the disease simultaneously into areas of convenient size and "back it up" intensively. The rabbit population might thus be drastically reduced with a resultant gain not only to our economy but also to our very natural wish to inflict the least possible suffering on the rabbits. Maximum suffering over a long period would be caused if the disease kept going spontaneously round the country like a travelling circus. Scientists did not introduce the disease into Britain, and no official or unofficial action of man can possibly stop it. What the disease will accomplish 'on its own' we cannot yet foresee.

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[1] Aragão, H. de B., *Memorias do Inst. Oswaldo Cruz*, 20, 225 (1928).

[2] Report of Advisory Committee on Myxomatosis (H.M. Stationery Office, 1954).

[3] Ratcliffe, F. N., Myers, K., Fennessy, B. V., and Calaby, J. H., *Nature*, 170, 7 (1952).

[4] Muirhead Thomson, R. C. (personal communication).

[5] Rothschild, M. (personal communication).

[6] Fenner, F., *Nature*, 172, 228 (1953)

NUCLEAR AND MESON PHYSICS

INTERNATIONAL CONFERENCE IN GLASGOW

THE International Union of Pure and Applied Physics and the United Nations Educational, Scientific and Cultural Organization sponsored a conference on nuclear and meson physics which was held in the Department of Natural Philosophy, University of Glasgow, during July 13–17, under the general chairmanship of Prof. P. I. Dee. A wide range of topics was covered, and more than one hundred papers were presented. In these circumstances it is impossible, in a short review, to do justice to, or even mention, all the contributions.

The opening session was on nuclear forces and nucleon scattering. The present state of knowledge in this field was surveyed by Prof. H. S. W. Massey, who stressed the need for more work on the very light nuclei, in addition to that on proton–proton and proton–neutron scattering, to try to gain some direct evidence on the presence or absence of many-body forces. The recent work on nucleon–nucleon scattering at Harvard and Brookhaven was described by Prof. N. F. Ramsey; the extension of proton–proton scattering experiments to high energy has shown that the apparent constancy of the total cross-section at high energies is due to a broad flat minimum in the range 200–400 MeV.

In the angular distribution of proton–deuteron scattering at 20·6 MeV., described by Dr. D. O. Caldwell, a minimum at small angles has been found, due to the interference between the Coulomb and nuclear scattering. This interference should enable data to be fitted with a unique set of phase shifts and decide between the two sets which both fit the earlier data. Work was also reported from several laboratories on the scattering of polarized nucleon beams.

An account of the present status of the meson theory of nuclear forces by M. M. Levy and R. E.

Marshak was presented by Prof. Marshak, who emphasized the different approximations used in current treatments. He made it clear that, although the present theory includes many of the observed features of nuclear forces, further developments towards a fully non-static approximation are required.

The sessions on nuclear data and nuclear models was opened with review papers: by Prof. J. A. Wheeler on nuclear models, and by Prof. S. Devons on the experimental determination of energy-levels. Prof. Wheeler dealt with the work currently in progress on different aspects of the problem and, in particular, described the work of K. A. Brueckner. This considers a test nucleon passing through an infinite nuclear medium. The wave describing the nucleon is scattered by each of the moving centres in the medium, the forward-scattering amplitudes adding coherently to the primary wave. No elementary law of interaction enters the calculations—only the phase shifts which describe the nucleon–nucleon scattering up to 100 MeV. The present experimental information, however, is not sufficiently complete to exploit this approach.

Prof. Devons emphasized the great theoretical and experimental advances of the past few years, and pointed out that in some cases theory has now outstripped experiment. He instanced the small differences in the Coulomb energy for corresponding levels of a T-multiplet (which have considerable interest, but are not always known with great accuracy) and the low-lying rotational levels of some heavy nuclei which need to be determined with the highest precision. Of great interest was his description of the measurement at the Imperial College of Science and Technology, London, of the reduction of the Doppler shift as a recoil particle passes through slowing-down materials. This method promises to fill the gap in the lifetime measurements of radiative transitions. Of the numerous interesting experimental papers read at this session, that of Dr. W. W. Buechner describing the work at the Massachusetts Institute of Technology, using a magnetic spectrograph as a particle analyser, most emphasized the great accuracy attainable with present-day techniques. A theoretical paper of particular significance was that of J. P. Elliot and B. H. Flowers, who derived the even parity, low-lying levels of mass-19 nuclei. These are assumed to arise from configurations of the form $\Sigma d^{3-x}s^{x}$ ($x = 1$, 2 or 3). By using essentially only one free parameter, the positions and spins of these levels are predicted and show good agreement with the somewhat sparse experimental data. Prof. V. F. Weisskopf closed these sessions with a stimulating and provocative summary of the present position. The problems he discussed included that of the effective mass of a nucleon inside the nucleus, and the possibility of the internucleon forces in nuclei being different from those between free nucleons.

Another aspect of low-energy nuclear physics was discussed at the session on photo-disintegration. The results of Dr. H. W. Koch on X-ray scattering were interpreted by Dr. U. Fano as showing that the giant resonance does not possess a detailed structure. A tentative theory of the giant resonances was put forward by Dr. D. H. Wilkinson. This explains the resonances in terms of single-particle transitions for the absorption process, and the anomalously large yield of high-energy particles and their angular distribution are predicted in terms of the same absorption process.

The field of beta- and gamma-ray transitions was surveyed by Dr. K. Siegbahn, who described the recent developments which enable extremely accurate measurements to be made. A most stimulating talk on the interaction in β-decay was given by Dr. C. S. Wu. The Fermi and Gamow–Teller components have approximately the same magnitude, and recoil experiments on helium-6 show that the latter is a tensor interaction. Preliminary results on neon-19 recoils suggest that the Fermi interaction is scalar, as favoured by other evidence. The more recent calculations which nullify the necessity for the pseudoscalar component have been confirmed in their conclusion by the direct measurement of the spin of radium E by K. Smith, who has obtained a value of 1.

The conference was divided into two halves: during the first two days nuclear phenomena not involving π-mesons directly were discussed, and the last two were mainly devoted to mesonic (largely π-mesonic) physics. The intervening day, July 15, was spent in a chartered steamer sailing among some of the lochs and islands of the Firth of Clyde; this not only allowed a view of some beautiful scenery, but also gave the delegates an opportunity for discussion, particularly valuable by reason of the rather tight programme.

Prof. H. A. Bethe opened the morning session on July 16 with a general survey of pion–nucleon interactions. He discussed the cross-sections for pion–proton scattering up to about 200 MeV. which are interpretable in terms of phase shifts for angular momentum states $P_{3/2}$, $P_{1/2}$ or $S_{1/2}$ and states of total isotopic spin $T = {}^3/_2$ or $T = {}^1/_2$. Of the three possible analyses into phase shifts, only one gives a resonance in the $P_{3/2}$ $T = {}^3/_2$ state, but physical reasons are given for this being the most plausible analysis. These results, including the low-energy P-wave scattering, are interpreted in terms of the pseudoscalar coupling theory of mesons to nucleons, using Tamm–Dancoff approximate methods. The more difficult interpretation of the photo-production cross-sections was also discussed. In this session, papers on experimental researches on pion–nucleon scattering and pion production up to energies of 1·5 BeV. were presented by Dr. R. H. Hildebrand (Chicago), Dr. J. Ashkin (Carnegie Institute of Technology), Dr. J. B. Platt (Rochester, N.Y.) and Dr. A. C. Helmholtz (Berkeley).

In a session on detailed meson theory, Prof. F. J. Dyson gave an account of the surmounting of difficulties, in the Tamm–Danooff mèthod, at Cornell. Other papers included two on the origin of spin orbit coupling in nuclei, while Dr. M. Cini reported the application of the variational method of Cini and Fubini to pion–nucleon scattering. This latter method gives a correct fit of the P-wave, though not the S-wave, phase shifts to the 'Glicksman set' of phase shifts, and seems capable of refinement by, for example, the introduction of a further variational parameter.

The afternoon of July 16 consisted of four simultaneous meetings of special interest. These were on β and γ transitions and mesic X-rays, detailed theory of nuclear models, field theory and photodisintegration (mentioned earlier).

Dr. J. Ashkin reported on measurements of the intensities and energies of X-rays from π-mesic atoms. Energy measurements of X-rays from *transitions* between outer shells, where the π^--meson nucleon interaction does not appear, gives a close determination of the π^- mass, while measurements of line shifts in inner shells where the nuclear interaction operates can be related to phase shifts in the meson–nucleon scattering. Dr. J. B. Platt reported work on the relative intensities of X-ray lines in order to find the attenuation resulting from nuclear capture from inner shells.

The field theory meeting was opened with a talk by Prof. W. Heisenberg on "Quantization of Non-linear Wave Equations"; it is proposed to introduce just one wave function for all matter, obeying a non-linear field equation. The equation

$$\gamma_\nu \frac{\partial\psi}{\partial x_\nu} + l^2\psi(\psi^+\psi) = 0$$

is taken as an example, and study of the likely commutation rules leads to the conclusion that the laws of quantum mechanics would be modified in a certain region of Hilbert space.

The conference ended on the afternoon of July 17 with a full meeting of all delegates, at which papers on heavy mesons and hyperons were presented. Dr. C. C. Butler opened the session with an excellent review of our present knowledge of heavy mesons and hyperons, and the conference closed on a high note with a paper by Drs. A. Pais and M. Gell-Mann on some theoretical speculations concerning the heavy particles, which included an interpretation of Λ^0 particles as particles of high intrinsic spin. The full proceedings of the conference will be published by the Pergamon Press.

E. H. Bellamy
R. G. Moorhouse

SCIENCE, ANIMALS AND HUMANITY*

By W. LANE-PETTER
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If I were a psychologist I might understand, and even be able to explain, why animals, and in particular certain animals, evoke an emotional response in human beings, so strong in some that it is beyond the reach of reason. We all know of the cat lovers who carry their devotion outside the limits of economy or hygiene; of the dogs who lay undisputed claim to the best armchair or the master's place on the hearth-rug; of the horses, canaries and other animals who receive more consideration from their owners than persons more nearly related zoologically and therefore having, one would think, better claims to affection. On the other hand, by taking some animals into domestication, or keeping others in captivity, man accepts an obligation to look after them, for they are entirely dependent on man for the necessities of their being. It makes it easier for us to do our duty towards our animals if we are fond of them.

Emotion, then, is bound to creep into any discussion of relations between animals and man, and it is a deep and often disturbing emotion. To ignore it is unrealistic, and to be ashamed of it unnecessary; but it should not be allowed to cloud our reason, any more than any other emotion. Such undisciplined feeling is often associated with a morbid preoccupation with brutality—a revealing word—in books and articles, on the cinema screen, in conversation and perhaps in real life, and the minutiæ of violence excite a thrill of disgust, guilty pleasure or any other emotion; but above all a thrill. There can be few normal people who are totally unaffected by the sight or image of injury, be it accidental, criminal or surgical; but in most of us that basic attraction–repulsion is clothed in reason or rationalization. So in a discussion of animals let us try to recognize the shadow of the brute within our souls and keep him chained, and let us be especially wary lest any moralizing we may indulge in be the brute tugging at his leash.

There exists a great gulf between those whose primary interest is in the welfare of animals, and the scientists who use animals in their work. It is a gulf of misunderstanding so wide that the leaders in each field are often not on speaking terms with one another, at least in public. "Callous torturer", says the humanitarian, and the scientist replies "sentimental crank". Yet the first may be a reasonable, intelligent and responsible person, and the second as deeply moved by cruelty as any of his fellows, for whom the obligation of humanity is so obvious that he does not bother to explain it. But of course he should explain what he is about, and the layman who criticizes him should listen to the explanations.

What Dr. J. Bronowski says of the nuclear scientist[1] has a more general application. The scientist, he says, ". . . has one special responsibility . . . of enlightenment in scientific matters . . . the responsibility of knowledge, not of power . . . to illuminate for all men the choice which his work offers them. . . . Outside his laboratory, his task is to educate us in what goes on inside it, and to give it a meaning for us. In a world in which statesmen as much as voters are ignorant of the simplest implications in science, this is a formidable responsibility . . . [the scientist] has no other choice to-day but patiently to become a teacher, in a world in which distrust and prejudice are free. . . . There is no alternative to an informed public opinion: and that can exist only where scientists speak to voters, and voters accept their responsibility, which is to listen, to weigh, and then to make their own choice".

Now this is just the reverse of the point of view that I have heard from the lips of both scientists and administrators. Let us, they have said, keep quiet about animal experiments. People do not want to hear about them, and if we direct their attention to this side of scientific activity, it will merely give stamping-ground to the anti-vivisectionists. Or, perhaps they will say, nobody bothers much about rats and mice and guinea pigs; but whatever you do, leave cats and dogs out of it; these animals to-day occupy the place in men's hearts that horses did a century ago, and we should let them lie sleeping. But is this playing fair with the voters?

We need not concern ourselves with the abolitionists who are unreservedly opposed to any sort of animal experimentation. It is possible to respect their feelings, but not their way of conducting controversy. Perhaps I may digress a little in order to show how careful one has to be in the matter of anti-vivisection propaganda. In 1948 a deputation of antivivisectionists met the Home Secretary, and cited a number of alleged cruelties. Referring to the work of Mellanby on experimental rickets[2] in puppies they quoted "animals were confined absolutely in kennels, 8 ft. 6 in. by 2 ft. 6 in., for 13 weeks. . . . These animals were most seriously attacked by mange". It seems a strange tactic to attempt to pillory work on rickets, which was at that time a major scourge, and which has now, as a result of that work, become a rarity. But on referring to the report itself we find that the purpose of prolonged confinement was to investigate the part played by exercise and confinement in the production of rickets, and that the animals so confined "grew well and kept in perfect condition". The animals attacked by mange were the subjects of an entirely separate experiment, and "because of the severity of the disease, the experiment was concluded".

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* Substance of a paper read on September 6, 1954, before Section D (Zoology) of the British Association meeting at Oxford.

The same deputation referred to some work done at Cambridge in 1931 by Florey and Webb[3], in which the effects of mustard oil on various tissues of the cat were examined. They said that the work was done under "a narcotic, chloralose", and that the experiments lasted from 3½ to 8½ hours. Now, the use of chloralose as an anæsthetic is limited to non-recovery experiments, and this fact is well known to scientists, but not apparently to their critics; and, although it was not specifically mentioned anywhere in the paper describing the experiments, the cats never felt any pain at all, for they were unconscious before the experiments started and never regained consciousness.

While the scientist's main job is to get on with his work, his opponents can spend all their time and resources on attacking him. Moreover, to answer ten words of accusation, however preposterous, may take a hundred words in reply.

Antivivisectionists have not yet succumbed to the advance of medical knowledge; but they are of no great consequence, although it is still possible for them to be a real nuisance. They should certainly not be allowed to inhibit scientists from expressing humanitarian views on animal experimentation. But what can one say when the Royal Society for the Prevention of Cruelty to Animals, the most influential body of organized animal welfare, whom we should all, I hope, wish to support and see prosper, asks "Why not endeavour to reduce the vast total of animal suffering in the laboratories? Until the animal experimental section of the scientific world shows some sign of concern in this direction, the R.S.P.C.A. would fail in its duty if it did not sound the drum of alarm"[4]. How have the scientists so come to neglect their duty of informing the public of what they are about that these questions can in all seriousness be asked?

Experiments on animals have led, and may be confidently expected in the future to lead, to great benefits to man and to animals, with all that that implies in the relief of suffering and the saving of life. The cost is the infliction of some pain on a number of animals that are neither consenting nor direct beneficiaries. Is this not, we are asked, "to do a little wrong" in order that one may be enabled "to do a great right"? Is it not the old argument of the end justifying the means?

Now these questions beg one assumption, that to inflict pain, in itself, is always wrong. But is it? Man, by entering into the arrangement of domestication, assumes the power of life and death over his animals. Civilized man also assumes the responsibility of avoiding cruelty to these same animals, and Great Britain has a good record in this respect. Pain is inseparable from life itself, and the occasional infliction of it from our dealings with each other and with our animals. But the infliction of pain is not synonymous with cruelty. The Shorter Oxford English Dictionary defines cruelty as "a disposition to inflict suffering: delight in or indifference to another's pain", and here is the real point. In the words of Lord Wright in the House of Lords on July 2, 1947, ". . . it is impossible to apply the word cruelty to efforts of the high-minded scientists who have devoted themselves to vivisection experiments for the purpose of alleviating human suffering . . ." Those who, for whatever motives, inflict pain on animals and are indifferent to the fact, are cruel, and deserve condemnation. But a word of caution is necessary here. Because a scientist, in reporting his work, does not explicitly state that he was aware of the pain he was inflicting, that he did it with reluctance and was careful to minimize it, it must not be assumed that this was not so. He has a right to be regarded as a humane person unless he gives evidence to the contrary. Moreover, as we have seen, scientific language is too often indigestible material for the layman, and technical descriptions of experimental procedures can make hair-raising reading for him. But in all the responsible examinations of alleged horrors perpetrated, in Great Britain at least, the scientist has been vindicated.

Scientists do not like being called callous blackguards, and, though individualists by training and inclination, they can show a surprising solidarity when unfairly calumnied. As Major Hume, of the Universities Federation for Animal Welfare, says, ". . . public opinion in scientific circles, which in the eighteen seventies befriended animals as a matter of course, has until recently been rendered allergic to any reference to the prevention of cruelty. Then animals enjoyed the open patronage of scientists as such, but subsequently they were largely deprived of it by the polemical intemperance of those who intended to act as their champions"[5]. One reads some personal feeling between these lines, for in some of its activities U.F.A.W. has not been immune from criticism by scientists, myself among them. But the point is well made. To-day we can state fearlessly what is generally accepted, that painful experiments should have a worth-while object and should be conducted with every effort to minimize the pain; and that pain beyond a certain level in severity or duration or a combination of both is never justifiable. To state such a principle requires that its observance be demonstrated, and this means bridging the gulf between scientists and animal protectionists.

Is the "total of animal suffering in laboratories" so "vast"? How are scientists to convince those who are open to conviction that this is a gross exaggeration? I think it very reasonable that laymen should want to satisfy themselves on this score, and understand why and how experiments, when they are painful—and most of them are not—are carried out. It is in fact one of the main functions of the Research Defence Society to explain, in language intelligible to the layman, what we all owe to animal experiments, and what safeguards exist against the unjustifiable exploitation of animals. Their journal contains some interesting accounts of the conquest of many diseases and deserves wider reading than it gets. But more, much more, needs to be done.

As a matter of fact, scientists themselves have anticipated the R.S.P.C.A. in showing "some sign of concern". As long ago as 1870 the British Association appointed a committee, which reported in 1871, "to consider the subject of Physiological Experimentation"[6]. The British Medical Association also turned its attention to the controversy at about the same time, and reported in like vein. Earlier still, the giants of the biological world, men like Charles Darwin and Thomas Huxley, had expressed their concern about the possibilities of cruelty in laboratories. All this led directly to the Act of 1876, which controls painful experiments on animals in Great Britain, and was supported by most scientists. Under this Act, which has been and still is faithfully observed, all severely painful experiments are carried out while the animal is completely under the influence of an anæsthetic; if severe and enduring pain follows on recovery, life is destroyed forthwith. What more is wanted, if we are not to abandon the most fruitful method of medical research so far devised?

Prof. Robert B. Lawson, writing about animals in pædiatric research, says "... one cannot escape feeling the intense debt due the research animal. The way in which each type of investigation requires a particular animal is particularly striking. Rats play a key role in one study—mice in another—and the dog in a third. Rarely can one take the place of the other. We are indebted to all research animals for the tremendous advances in medical science that have made this generation of children healthier, bigger, and with more promise, than ever before"[7]. In a recent symposium on the design of animal houses, the chairman, Dr. Parish, said, "It is a good thing that laboratory workers themselves wish to improve the living conditions of animals and thus repay the debt ..." Indeed, the progress that has been made in recent years in the housing, feeding, care and management of laboratory animals is quite remarkable, and owes everything to the initiative of the scientists.

It is a symptom of the times to try to make scientists the scapegoats for that which disturbs the public conscience. They are not the high priests of a secret cult, dealing in matters not to be revealed to ordinary men and women; neither are they mental acrobats and moral imbeciles. They are as good and as bad as the rest of the community, but no more indifferent to the sufferings of others than farmers or financiers.

If this tragic misunderstanding is to be got rid of, scientists must take time off to explain the mechanics and implications of their work and show that they respect the feelings, even the misgivings, of the humanitarians; and the public must modify its "Scientists—I'd like to drown the lot" attitude. An example of what mutual goodwill can achieve is to be seen in Vancouver, British Columbia, where, by friendly agreement on both sides, the local Society for Prevention of Cruelty to Animals supplies to the medical school unwanted, unclaimed animals, which would otherwise be destroyed. In a nine-point agreement, the conditions in which this surrender of unclaimed strays operates are laid down, and the medical faculty has been only too happy to abide by them. As a result of the agreement, the medical school gets the animals it must have, it allows the S.P.C.A. to visit its animal quarters, and indeed looks to that enlightened organization for advice and help in maintaining the best possible conditions for its animals. An atmosphere of co-operation exists which is a help, and a credit, to both sides.

It is worth examining this arrangement more closely. The animals supplied to the medical school may only be used for non-recovery experiments, that is, they are anæsthetized before use, and never recover consciousness; and they must be used within forty-eight hours of being handed over. All long-term experiments are done on animals obtained elsewhere.

Only dogs otherwise destined to be destroyed may be handed over, and these must not include any brought by their owners specifically for destruction, nor any bearing identification marks. The animals must be kept two days beyond the legal claiming holding period before being handed over. The S.P.C.A. inspectors may witness experiments and have access without appointment to records and to animal premises. No animal handed over by the S.P.C.A. ever suffers any pain at all; it has a painless death under anæsthesia. At the same time, the S.P.C.A. can and does satisfy itself that all the animals used are well cared for. This shows how far mutual trust and co-operation can go.

There can be no objection on humanitarian grounds to any animals, including cats and dogs, being used for non-recovery experiments. If objections are raised, they must be based either on an aversion to animal experiments on principle, whether or not they are painful; or on a profound mistrust of the scientist. The first alternative leads one into such a philosophical morass as few if any of us could escape from. I am inclined to think that the second alternative, mistrust of the scientist, is the real obstacle to co-operation. Sentiment comes into this question, and it is no use pretending we can keep sentiment out. It should not, however, be allowed to ride us. Scientists would prefer to obtain the animals essential to their work in ways which remove the danger of their being sold a stolen pup, and to have impartial people satisfy themselves about the propriety and humaneness of their work.

I would not like to leave the impression that to get scientists and humanitarians sitting around the conference table has, for the scientist, no more interest than to obtain more cats and dogs more easily. If that were one of the results, so much the better; but the issue is much larger.

To-day we have a duty to pursue medical research by all legitimate methods, and one of those methods is the use of animals. We also have a duty to be considerate in our dealings with animals, and the two duties are not incompatible. Can we not, like the British Columbians, explore the no-man's-land of misunderstanding and discover instead the common ground of humanity?

[1] *Observer*, May 9, 1954.

[2] M.R.C. Special Report No. 61 (1921)

[3] *Brit. J. Exp. Path.*, 12, 256 (1951)

[4] *The Times*, Oct. 3, 1953.

[5] "UFAW Handbook on the Care and Management of Laboratory Animals", p. 2 (1947)

[6] Report of the British Association for the Advancement of Science, lxii (1870), and 144 (1871).

[7] *N.S.M.R. Bull.* (U.S.A.), 8, No. 3, 4 (Jan–Feb., 1954).

OBITUARIES

Dr. Herman A. Spoehr

By the death on June 21 of Dr. Herman A. Spoehr, at the age of sixty-nine, plant physiology has lost one of its best known and most distinguished research workers and exponents.

Herman A. Spoehr was born in Chicago on June 18, 1885, and was educated at the University of Chicago, where he took his bachelor's degree in 1906. After working for a time in the laboratories of Emil Fischer in Berlin and L. Maquenne in Paris, he returned to Chicago, where he worked with the well-known sugar chemist, J. U. Nef, and where he took the degree of Ph.D. in 1909. In the following year he joined the staff of the Carnegie Institution's Desert Laboratory in Tucson, Arizona, where he remained for ten years. During this period he published a number of papers which established his reputation as an original and critical investigator. Among his more important publications of this period may be mentioned those dealing with the mechanism of photosynthesis. At that time the theory that formaldehyde was an intermediate product in photosynthesis was very largely accepted. Spoehr, on repeating under properly controlled conditions the experiments which were supposed to provide the evidence for this theory, was unable to find the slightest indication of formaldehyde production, and Spoehr's work was no doubt largely responsible for the ultimate abandonment of that theory. Perhaps the most important of Spoehr's publications during his time at Tucson was his monograph "The Carbohydrate Economy of the Cacti", published by the Carnegie Institution in 1919.

In 1920 Spoehr moved to the Carnegie Institution's Coastal Laboratory at Carmel, California, followed in 1929 by a move to Stanford University, which in that year took over the housing of the Division (now the Department) of Plant Biology which had been created in the previous year with Dr. Spoehr as its first chairman. While at Carmel, among other publications, he produced two of particular importance. One of these, jointly with J. M. McGee, was "Studies in Plant Respiration and Photosynthesis", published by the Carnegie Institution in 1923, the other his well-known book on photosynthesis published in 1926.

For a short time in 1930–31 Dr. Spoehr was director of the Natural Sciences Division of the Rockefeller Foundation in New York; but in the latter year he returned to Stanford to resume the chairmanship of the Division of Plant Biology. He retired officially in 1950 but continued thereafter to work in the laboratory that he had directed for so long.

Throughout his life in the Division of Plant Biology Dr. Spoehr's main scientific interests continued to lie in photosynthesis and related matters. Particular mention may be made of his successfully bringing to maturity albino maize plants, while in later years he was much interested in the question of applying the results of research in photosynthesis to increasing the food supply of the world. This led to the idea of the culture of algae on a large scale for the use of food, and by 1947 the possibility of cultivating *Chlorella* on a large scale for this purpose was taken seriously and a preliminary analysis of the problems involved was prepared by Spoehr and H. A. Milner and published in the Carnegie Institution Year Book for 1948. Although preliminary work on the subject at Stanford Research Institution was ended in 1950, it has been continued elsewhere, and the recent (1953) Carnegie Institution Publication on "Algal Culture", edited by J. S. Burlew, indicates in no uncertain way that further investigation on the problem is proceeding vigorously.

During the Second World War the laboratory of which Dr. Spoehr had charge concentrated on the study of antibiotics from chlorophyll-containing organisms.

As well as by his direct contributions to plant physiological research and literature, Dr. Spoehr served the cause of science in other ways. He was a member of the board of directors of the Forest Genetics Research Foundation, a member of the scientific committee of the Board of Managers of the New York Botanical Garden, a trustee of the California Section of the American Chemical Society, a member of the executive board of the Save-the-Redwoods League and for a time chairman of the editorial board of Annual Reviews, Inc. He was a member of the American Philosophical Society, the American Academy of Arts and Sciences, an honorary member of the Linnean Society of London and the Deutsche botanischen Gesellschaft of Berlin. He was awarded the honorary degree of doctor of science of the University of Chicago and he received from the same University one of its Distinguished Alumni Awards in 1943.

Dr. Spoehr is survived by his widow, a son Dr. Alexander Spoehr, the anthropologist and director of the Bernice P. Bishop Museum in Honolulu, a daughter, his mother and a brother.

In preparing this notice of Dr. Spoehr I have been greatly helped by information provided by Dr. J. H. C. Smith and Dr. C. S. French, the present director of the Department of Plant Biology of the Carnegie Institution of Washington.

WALTER STILES

Dr. A. M. Turing, O.B.E., F.R.S.

ALAN TURING was born on June 23, 1912, and was educated at Sherborne and King's College, Cambridge. He was made a Fellow of King's in 1934; he submitted his fellowship dissertation—a version of the central limit theorem for the normal distribution—four months after being placed as Wrangler in the Mathematical Tripos. During his first years of research he worked on a number of subjects, including the theory of numbers and quantum mechanics, and started to build a machine for computing the Riemann ζ-function, cutting the gears for it himself. His interest in computing led him to consider just what sort of processes could be carried out by a machine: he described a 'universal' machine, which, when supplied with suitable instructions, would imitate the behaviour of any other; he was thus able to give a precise definition of 'computable', and to show that there are mathematical problems the solutions of which are not computable in this sense. The paper which contains these results is typical of Turing's methods: starting from first principles, and using concrete illustrations, he builds up a general and abstract argument. Many years later he used an elaboration of the same ideas to prove the unsolvability of the word problem in semi-groups with cancellation.

In 1936 he went to Princeton for two years; he worked on group theory and logic, receiving his Ph.D. for a dissertation on "Ordinal Logics". In this he showed that when transfinite induction is used in logic for proofs and definitions, it is not the ordinal up to which induction runs that has significance, but rather the particular way in which that ordinal is described.

He was awarded the O.B.E. for the work he did during the War, and after it he was invited by the National Physical Laboratory to direct the design of an electronic digital computor (which he christened "The Automatic Computing Engine"). Although the theoretical aspects of its design were his chief concern, he was also keenly interested in its electronics; and while the final construction was in progress he turned to long-term problems, considering how machines might be made to learn by trial and error and the ways in which they could be compared with human brains.

In 1949 he was made deputy director of the Computing Laboratory at the University of Manchester, where work on an electronic computor had just started. He was elected Fellow of the Royal Society in 1951. His last work was a mathematical theory of morphogenesis; the main idea was to show how an originally uniform distribution of interacting substances may, as a result of diffusion, develop a strongly marked pattern. He had already published a version of the theory for distributions around a ring, and was at work on the case of a cylinder; using the machine to solve the appropriate differential equations, he was hoping to be able to exhibit the spiral patterns based on the Fibonacci series which are so frequently found in plants.

The marks of Turing's genius were his originality, his ability to control abstract thought by concrete illustration, and his preference for always working things out for himself. The freshness of his mind, his love of inquiry, and his relish for the comic, made him a lively and stimulating companion.

R. O. Gandy

Prof. C. R. S. Tenniswood

Charles Robert Sidney Tenniswood, professor of chemistry in Makerere College, University College of East Africa, died on May 22, following an accident in which his car skidded in the grounds of the College. At the time of his death, he was forty-seven and had been head of the Makerere Department of Chemistry for some nine years.

Charles Tenniswood graduated from King's (then Armstrong) College in the University of Durham with first-class honours in chemistry in 1927, being awarded the Freire-Morreco Medal and Prize for experimental work in the final year. The following year he was placed in the first division for the diploma in theory and practice of teaching before going on to three years of postgraduate research in organic chemistry under Prof. S. R. Clemo. His M.Sc. was awarded for a thesis entitled "Studies in the Synthesis of Bridged-Ring Compounds of the Quinuclidine Type", and he published papers on alkyl derivatives of ethyl malonate and ethyl cyanoacetate and on the lupin alkaloids.

Leaving the University of Durham in 1932, he was appointed head of the Chemistry Department of the Wandsworth Technical Institute, London, and then started a career of teaching which, except for the war years, was to last until his death. During 1941–44 he was seconded to the Ministry of Supply for work in the field of projectile development.

As a result of the De la Warr Commission in 1937, Makerere College, at Kampala in Uganda, had been planned for development to a university college serving all the territories of British East Africa; but the implementation of these proposals was delayed by the War. When Tenniswood arrived at the beginning of 1945, the level of teaching was of school standard and the teaching facilities consisted of one small and poorly equipped laboratory. At the time of his death nine years later, he had seen his first batch of degree students successful in their London B.Sc. Examination and had brought almost to completion the first of the new laboratories, which are giving East African undergraduates facilities in chemistry quite as good as they could enjoy in a British university. It was natural that senior members of the staff should have to bear a heavy burden of administration in the early days of a university. Tenniswood made invaluable contributions in this direction, with his great care for detail and unlimited energy. At the time of his death he was dean of the Faculty of Science and for several years had represented the Academic Board on the College Council. By his students he will probably be best remembered for the great enthusiasm that he brought to the teaching of chemistry, an enthusiasm which spared no pains to provide an interesting course and which infected his hearers with his own love of his subject. His many other duties had prevented him bringing to conclusion the researches that he started in East Africa. His earlier interest in plant alkaloids led him to investigate some of the many unknown active plant materials which have been used for years in native medicines.

Tenniswood's death is felt no less by his colleagues than by his students. His integrity and forthrightness were appreciated in personal dealings as well as in the many boards and committees on which he served, and he had a wide range of friends both in the College and in life outside. Growing colleges such as Makerere can ill afford to lose men of Tenniswood's loyalty and calibre, and his untimely death is keenly felt by all concerned.

Ralph F. Naylor

Dr. J. W. Fisher

Dr. J. W. Fisher, whose untimely death at the age of fifty-three was recently reported, was a member of the Royal Naval Scientific Service, having served with the Admiralty since 1939. He studied physics and mathematics in the University of London, where he obtained his Ph.D. in 1924. Having completed his postgraduate studies at Gottingen and Munich, he studied medicine and took his M.R.C.S. and L.R.C.P. and became house physician at Westminster Hospital. Before joining the Royal Naval Scientific Service he was engaged on research and exploration in Britain and in India on behalf of the Anglo-Iranian Oil Co.

While in the service of the Admiralty, Fisher's work was mainly directed to the solution of a number of highly intricate problems relating to the propagation, generation and reception of sounds in the sea. He brought to these problems a wide knowledge of basic physics and quite outstanding mathematical ability, coupled with the power of seeing the basic problem and to approximate—a gift which raises mathematics from a technique to a fine art. He held, with Stokes, that series solutions are devoid of elegance and showed great ingenuity in reducing his solutions to neat closed forms. The outstanding quality of his theoretical and experimental work was recognized when, in 1949, he was awarded special merit promotion to the rank of senior principal scientific officer by the Interdepartmental Scientific Panel.

Fisher had a gift for terse and pithy expression often combined with an amusing use of analogy based upon his medical experience. He had many interests apart from his scientific work, the most notable being an authoritative knowledge of antiques. He specialized in Chinese works of art—in particular, jade and carpets. With all this, he still found time to engage in farming on a small scale.

Men like Fisher are rare in any walk of life and his loss is much felt by his colleagues both in the Royal Naval Scientific Service and outside.

NEWS and VIEWS

Zoology at Bedford College: Prof. H. Munro Fox, F.R.S.

PROF. H. MUNRO FOX, who is just retiring from the professorship of zoology in the University of London at Bedford College, has occupied this chair since 1941; previously he had been Mason professor of zoology in the University of Birmingham from 1927 until 1941. After graduating in zoology from the University of Cambridge he joined the staff of the Imperial College of Science and Technology, London, in 1913, and after five years of war service returned there in 1919. Afterwards he was lecturer in biology at the School of Medicine, Cairo, during 1919–23. He then returned to Cambridge as a Fellow of his old college, Gonville and Caius, and also held the Balfour Studentship during 1924–27. During this period he organized and led a zoological expedition to the Suez Canal.

Prof. Fox's earlier investigations were in the field of marine biology and while in Cairo he studied the reproductive cycle of *Centrechinus setosus*, which, in the Red Sea, shows a well-marked lunar rhythm. The observations on this sea-urchin and other animals and plants showing supposed lunar periodicities were summarized in his book "Selene, or Sex and the Moon". His main interests, however, have been in the field of experimental zoology and for many years he has specialized in the study of animal pigments, more particularly the respiratory pigments of invertebrates. His researches and many publications in this field and also on respiratory movements in Polychaeta, Insecta and more recently *Daphnia*, either alone or in collaboration with his students, have opened up a very wide field of research. Prof. Fox has been the editor of *Biological Reviews* since 1926 and has taken a very active part in the promotion of international relationships among biologists. After the Second World War he visited various European universities on behalf of the Royal Society, and helped in the re-establishment of the International Union of Biological Sciences, and after being secretary of the Union for some years was president during 1950–53. He also served for five years on the Advisory Council of the Department for Scientific and Industrial Research. In 1953 he was appointed Fullerian professor of physiology in the Royal Institution.

Chemical Pathology at St. Mary's Hospital Medical School, London: Prof. A. Neuberger, F.R.S.

DR. A. NEUBERGER, of the National Institute for Medical Research, has been appointed to a University chair of chemical pathology tenable at St. Mary's Hospital Medical School, London. Dr. Neuberger, who is forty-six years of age, holds the degree of M.D. (Wurzburg) and Ph.D. (London). He held a Beit Memorial Fellowship during 1936–40 and carried out research work at University College Hospital Medical School, London, until 1939. He continued his researches in the Biochemistry Department of the University of Cambridge until 1942 and has since been a member of the scientific staff at the National Institute for Medical Research. In 1945 he was adviser to the Medical Directorate, G.H.Q., Delhi. He was awarded the Julius Mickle Fellowship of the University of London in 1946. He has been a member of the editorial board of the *Biochemical Journal* since 1947 and its chairman since 1952. Dr. Neuberger has worked on a wide range of topics in the chemistry and biochemistry of amino-acids and proteins. His earlier researches were concerned with the use of dissociation constants for structural diagnosis in the amino-acid and protein field; this method was later used by him in a study of the structure of penicillin. In the amino-acid field he has been concerned with stereochemistry, in particular that of hydroxyproline, and with metabolic and nutritional aspects. He is an expert on biochemical genetics and has a special interest in the metabolic abnormality known as alcaptonuria. Recently, he has become interested in the problem of porphyrin biogenesis and has made important contributions to our knowledge of congenital porphyria. He is also engaged in the study of the biosynthesis and metabolism of collagen.

Committee of Public Accounts: Research Expenditure

THE Committee of Public Accounts for the session 1947–48 recommended that the expenditure on the Vote for the Department of Scientific and Industrial Research, among others, should be covered by statutory authority other than the annual Appropriation Act, and, in evidence before the Committee in the following session, the Treasury promised to take the first convenient opportunity to embody the functions of the Department of Scientific and Industrial Research in a statute. No such opportunity, in the Treasury view, has yet arisen; and the Committee, in its third report for the session 1953–54 (pp. 44. London: H.M.S.O., 1954. 1*s.* 6*d.* net), expresses the opinion that, in view of the years that have elapsed since the Committee of Public Accounts first recommended legislation, and the expansion of the Department's expenditure during that period, the necessary Bill should be prepared at once, ready for immediate introduction when any opportunity presents itself. In commenting on expenditure, estimated at £213,000, on the construction of a new fishery research vessel for the Torry Research Station of the Department, the Committee points out that five other departments or grant-aided bodies are engaged on fishery research and have provided themselves with a total of twelve research vessels for various purposes, but that it was not clear how the activities of these departments and bodies and the Department of Scientific and Industrial Research are co-ordinated. The Committee is not satisfied that there is no overlap of functions and recommends further inquiry by the Treasury. There is also a comment on the cost of construction of the Mechanical Engineering Research Station at East Kilbride, for which originally £1,000,000 was provided in the 1949–50 estimates, increased to £1·5 million, provisional in 1950–51 and 1951–52, reduced to £1,264,600 in 1952–53 and increased to £2 million in 1953–54, which has now been set as an upper limit. The Committee is satisfied that the Treasury exercised close control over the constituent parts of schemes of this kind, but, though critical of the way in which estimates and ideas developed as the work proceeded, the Treasury made no comment on what may well have been the more important factor in a time of rising costs—the effect of Government retrenchment and the consequent delay in executing the scheme.

University Grants

WITHOUT advancing any fresh reasons in its third report for the session 1953–54, the Committee of Public Accounts again presses for the inspection of the books and accounts of the universities relating to expenditure of non-recurrent grants by the Comptroller and Auditor General. The Committee is unconvinced by the Treasury objections as detailed in the special report last February (see *Nature*, 173, 383; 1954), although it welcomes the appointment of a special committee of four to examine the universities' methods of contracting and of recording and controlling expenditure. Nevertheless it recommends that the matter be considered afresh by the Committee for the next session, and meanwhile it also recommends that the Comptroller and Auditor General should in future have access to the papers and records of the University Grants Committee relating to non-recurrent grants and also those which contain requests from the universities for assistance and the record of the consideration of them by that Committee. This persistent attempt to subject to close control expenditure which has been deliberately made the responsibility of a non-government institution, for reasons which are generally understood and approved, is disturbing. The proposals endanger an administrative device primarily designed to preserve the ancient freedom of British universities. Admittedly, the device will only endure so long as its value is clearly understood and approved, in Parliament and outside; but could not the Parliamentary and Scientific Committee usefully look into the question why academic freedom is subjected to this sustained attack by a committee of members of Parliament appointed primarily to ensure that the Government is not wasting public money and, secondly, to ensure that public money is not wasted by independent bodies?

Earthquake near Orléansville, Algeria

In the early hours of September 9, an earthquake occurred with an epicentre near Orléansville in Algeria. Most of the buildings in the town were damaged and many of them collapsed entirely. The Hotel Baudouin and two other hotels, the sub-prefecture, a college, two blocks of nine-story workers' flats, the hospital and the railway station were destroyed immediately. The cathedral in the market-place and the Church of Saint Reparatus dating back to the fourth century were badly damaged; and part of the jail collapsed, killing ten prisoners. Almost the only large building which escaped damage was the mosque. Nine out of every ten houses in the town were rendered uninhabitable. Telephone and telegraph communications were interrupted, gas mains were torn out, and roads and railways in the neighbourhood were rendered useless. The villages of Ponteba and Vauban were reported heavily damaged and other villages in the area were in ruins. Altogether devastation was caused over an area of some forty square miles from Ténès in the north, southwards, and from Miliana in the east, westwards. The 160-ft. wall of the Oued Fodda dam was cracked, but was quickly repaired, though a main irrigation duct was dislocated and this latter caused considerable flooding. The smaller Lamartine dam is reported to have collapsed, also causing flooding. The shock was felt in Algiers but caused no damage there. Altogether the damage is estimated at four million pounds. There were more than 1,250 killed and some 2,000 injured in the district. Orléansville was a town of about 22,000 inhabitants.

The shock was recorded at many observatories. At the Royal Observatory at Edinburgh, *eP* was registered at 01h. 09m. 15s. G.M.T. and *iS* at 01h. 12m. 52s. G.M.T. There appears to be a distinct possibility that the shock was double, and that an aftershock was recorded on the Edinburgh seismogram in the coda of the first shock. This would make the initial time of the main earthquake 01h. 04m. 49s. G.M.T. The depth of focus was normal and there were large surface waves. Algiers Observatory registered sixty-nine tremors in the twenty-four hours following the main shock, fifteen of them being strong. According to records collected by Prof. J. P. Rothé and Mme. A. Hée, of Strasbourg, earthquakes are by no means uncommon in Algeria. The line of orogenic activity stretches from Gibraltar, along the Rif in Morocco and the Little Atlas mountains in Algeria to Sicily and thence to the Apennines in Italy and to the Alps. The epicentres in Algeria lie on the principal anticlinal axes. Between the years 1790 and 1949, fifty-four earthquakes originated from a focus with epicentre some fifty kilometres to the east of Orléansville, and in the same period thirty-eight shocks occurred which had another epicentre some twenty-five kilometres north-north-west of Orléansville. The region most susceptible to earthquakes in Algeria appears to be that immediately to the south-south-west of Algiers.

Silver Jubilee of the Indian Ceramic Society

The Indian Ceramic Society was inaugurated in the Banaras Hindu University on April 15, 1928, by the late Mahamana Pandit Madan Mohan Malariya, founder of the University; the silver jubilee therefore fell last year but, for various reasons, could not be celebrated until February 1954. The celebrations included the delivery of a presidential address, the reading and discussion of papers on the ceramic raw materials of India, and the opening of the Society's new headquarters within the Glass and Ceramics Department of the University. Prof. W. E. S. Turner was the chief guest during these celebrations. In his presidential address, Dr. Atma Ram described the efforts that led to the foundation of the Society and its early struggle for recognition. While discussing future policy, Dr. Ram commented on the great progress made during the past thirty years in ceramic science and in mechanization within the industry; he thought it equally important that the general outlook on matters of organization, planning and personnel had also progressed. He emphasized the need for caution in adopting mass-production methods in a country such as India, where consumption of many of the articles that would be produced is at present low. The symposium on ceramic raw materials was organized jointly by the Society and the Central Glass and Ceramic Research Institute. Its objects were to make an appraisal of the domestic resources of the raw materials needed by the Indian ceramic industry and to examine methods for their preparation and purification.

Geophysical Conference in South Africa

A successful conference on geophysical subjects was held during July 19–22 at the University of the Witwatersrand, Johannesburg, under the auspices of the Bernard Price Institute of Geophysical Research. The field covered recent determinations of the ages of rocks and their geological implications (eight papers), geodesy (four papers), crystal structure of the earth, including seismological and gravity investigations (eleven papers), geomagnetism (four papers), the mechanical properties of rocks, including the phenomena of rock bursts (five papers), the earth's heat and its origin (five papers), the interior of the earth (four papers) and geophysical prospecting (four papers). Nearly a hundred scientific workers and interested persons from South Africa attended the conference. A number of visitors were from neighbouring British Protectorates and the Belgian Congo, and from farther afield came Dr. Francis Birch (Harvard University), Dr. Robert Stoneley (University of Cambridge) and Dr. C. J. Jaeger (Australian National University, Canberra). In addition, papers were received from M. A. Tuve and H. E. Tatel (Department of Terrestrial Magnetism, Washington, D.C.), from Prof. L. Cahen (Musée Royal du Congo Belge, Tervuren) and from the National Meteorological Service of Portugal. The papers will be published by the authors independently in various scientific journals.

Antwerp 'Zoo' Bulletins

Before the Second World War the Société Royale de Zoologie d'Anvers published a bilingual, French and Flemish, review termed *Zoo*, which was well known to visitors to the Antwerp Zoological Gardens. For financial and other reasons, this has not been restarted since the War. To some extent, it is now replaced by "Bulletins", limited to four numbers in the year, of which the first three are to hand, consisting of 24, 48 and 54 pages, respectively. They are issued by the Society under the general direction of Mr. Walter Van den bergh and the editorship of M. M. Palmans. The first number, July 1953, treats of the infection of penguins with plasmodium by Dr. J. Rodhain; the second is a description of freshwater fishes from the Belgian Congo, by Dr. Max Poll, many of which are on view in the Antwerp gardens; and the third treats of various aspects of the acclimatization of the okapi and has contributions by Dr. L. M. G. Guerden and Dr. Vendermander (Ghent), Axel Reventlow (Copenhagen) and C. S. Webb (London). They are all well illustrated by half-tone reproductions of photographs. The treatment is not fully technical but at the same time not popular, and they contain much useful information derived from actual experience. The second bulletin, that on fishes, with illustrations of thirty-four different species living in the Antwerp aquarium, shows that, apart from the scientific interest of some of them, there are a number that make attractive additions to an aquarium.

The Museums Association

The annual report of the Museums Association published in the July issue of the ***Museums Journal*** is a reminder of the growing status of these institutions and their increased usefulness to the community. For the Association, 1953–54 has been a year of exceptional activity, the beginning of a number of new ventures and marked by the continued improvement in its finances. The Handbook Panel issued its first publication and the Directory Panel is now collating the results of an extensive questionnaire. A technical certificate is now available to indicate the professional qualifications of those museum workers whose activities are in that particular field, and consideration has been given to the extension of the diploma scheme to other parts of the Commonwealth. As in previous years, the museum movement in Britain records with gratitude its great debt to the Carnegie United Kingdom Trust for its whole-hearted and liberal support.

Museum of Applied Science of Victoria: Report for 1953

In the report of the Museum of Applied Science of Victoria for the year ended June 30, 1953, it is interesting to note that the Museum intends to carry out radiocarbon (carbon-14) determinations in the near future. The few existing centres in Australia doing this work are unable to cope with all the demands, and the provision of a laboratory for this modern technique will be invaluable to Australian research workers. The acquisition of an 8-in. equatorial telescope in 1945 has resulted in a well-established and popular service to the public. With the generous assistance of a panel of honorary demonstrators from the Astronomical Society of Victoria, members of the public are able to observe the night sky.

Queen Elizabeth Forest Park

A guide to the National Forest Park, comprising Ben Lomond, Loch Ard and the Trossachs, has been compiled by Prof. John Walton, of the University of Glasgow. In commemoration of the Coronation of Her Majesty, it is fitting that this beautiful park should be named the Queen Elizabeth Forest Park. Of all the national forest parks, this is likely to be visited by the greatest number of the public; unlike the others, it is situated within easy reach of the large populations of Edinburgh, Glasgow and the industrial districts of the central valley of Scotland. Moreover, it includes part of the Trossachs, which has for many years attracted visitors in large numbers from all parts of the world.

The Forestry Commission in 1928 acquired land in the neighbourhood of Loch Ard, and with later acquisitions has brought under national ownership no less than 41,454 acres extending from Loch Venachar and the headwaters of the Forth over the summit of Ben Lomond to the shores of Loch Lomond. The area marches with the main part of the beautiful Trossachs. Plantations covering an area of more than 13,000 acres have been established, while there are nearly 20,000 acres of lochs and mountains which are available for those who find joy and recreation in exploring the wild countryside. Besides sections dealing with the geology, botany, bird and mammal life of the area, the guide contains an account of the structure and freshwater biology of Loch Lomond, Gaelic place names and their derivations, as well as an account of the Trossachs in literature. The guide also contains a useful Ordnance Survey map of the area. Guides cost 3*s*. each and can be obtained from H.M. Stationery Office.

Sea-horses in a School Laboratory

Many people regard sea-horses (*Hippocampus* sp.) as fictitious or heraldic or have heard of them only from mythological references in ancient literature. Apart from the excellent exhibit at the London Zoo, under the care of Mr. H. Vinall, and in a few seaside aquaria such as that at Plymouth, these animals are seldom seen alive in Britain. There are many laboratory difficulties in trying to maintain a stock of sea-horses; they do not acclimatize easily, refuse to eat and eventually die of starvation. Clean seawater has constantly to be procured, continuously to be aerated and maintained at a temperature of 75° F. by means of thermostatic control. The Edinburgh and East of Scotland Aquarium Society very enterprisingly showed some fine specimens at its annual exhibition in 1953 and these were later transferred to the biological department of Loretto School. Although they were never given any formal lessons on the subject, a group of fifty schoolboys were given a surprise question in an examination paper on the habits of sea-horses. Their observations have been put together in a most stimulating article by A. S. Gillespie (*School Nat. Study J.*, 49, 196; July 1954).

Protection of Plants

The thirty-fourth report of the Quebec Society for the Protection of Plants (Pub. Dept. Agriculture, Province of Quebec, May 1954; n.p.) includes, among other general matters, a number of papers presented at the annual meeting and also the papers contributed to a symposium on "Viruses and the Protection of the Plant Kingdom". These last range widely, and include studies of infection, identification, relationships of strains, the induction of mutants, host reaction, mutual adaptation in viruses and their hosts, resistance, immunization, agents of dissemination, and other topics.

Chemical and Plastic Materials Exhibition in Paris

The third Salon de la Chimie et des Matières Plastiques will be held at the Parc des Expositions, Porte de Versailles, Paris, during December 3–12. On each of the eight weekdays during this period a technical meeting will be held to discuss the following subjects: new vacuum techniques; perfumery and cosmetics; chromatography and ion exchange; applications of microscopy in chemistry; anti-fouling paints; electronic techniques in the service of chemistry; control and regulation systems in sugar refineries, and corrosion; and recent developments in plastics, and corrosion. Last year the Salon included 650 exhibitors from thirteen countries, and two hundred thousand visitors attended; this year the Salon will be even larger, and an area of just over six acres has been reserved. In all, there will be four separate but complementary exhibitions as follows: laboratory equipment (instrumentation, optical, testing, measuring, control and regulating equipment); chemical products (pure, industrial and finished products); chemical engineering (general and special plant); and plastics industry (raw materials, materials for processing, and manufactured articles). Concurrently the third session of the Chemical Engineering Conference will be held, when many of the problems encountered in the operation of modern factories will be reviewed. Further information on all these events can be obtained from the Commissariat Général, 28 rue Saint-Dominique, Paris 7°.

National Research Council of Canada: Postdoctorate Fellowships for 1954–55

The National Research Council of Canada has awarded sixty-eight postdoctorate fellowships for the year 1954–55 for research in the Council's laboratories. The fellowships, which are worth 3,000 dollars tax-free (3,500 dollars for married men), are awarded without regard to nationality to persons less than thirty-five years of age with a Ph.D. degree of a recognized university. The distribution of the awards between the various Divisions of the National Research Council is as follows: applied biology, 10; applied chemistry, 9; pure chemistry, 25; physics, 17; and radio and electrical engineering, 1. In addition, five fellowships will be held at the Prairie Regional Laboratory, Saskatoon, and one at Science Service of the Department of Agriculture.

Pesticides Group of the Society of Chemical Industry

The Society of Chemical Industry is forming a new Group—the Pesticides Group—based on the former Crop Protection Panel of the Society's Agriculture Group. The present membership of the new Group is about two hundred and forty, mainly derived from the former Panel, but with the now extended terms of reference it is hoped that the Group will be widely supported by individuals and firms with an interest in pesticides, but not necessarily in the field of agriculture. The inaugural meeting and dinner of the Group will be held on October 18. Further information can be obtained from the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

Advisory Council for Scientific and Industrial Research: New Members

The Lord President of the Council has appointed Dr. E. Ashby, president and vice-chancellor of The Queen's University, Belfast, Mr. S. Barratt, finance director of Messrs. Albright and Wilson, Ltd., Oldbury, Birmingham, Prof. E. A. G. Robinson, professor of economics, University of Cambridge, and Dr. C. Sykes, managing director of Messrs. Thomas Firth and John Brown, Ltd., Sheffield, to be members of the Advisory Council for Scientific and Industrial Research in succession to Prof. R. S. Edwards, Lord Halsbury, Sir Henry Hinchliffe and Mr. A. H. Wilson, who retire from the Council on September 30. Sir Hugh Beaver is to succeed Sir Ian Heilbron as chairman of the Advisory Council on October 1. The other present members of the Council who continue to serve after September 30 are: Sir Wallace Akers, J. Crawford, Prof. T. R. C. Fox, W. L. Heywood, Sir Philip Johnson, Sir Eric Rideal, Sir George Thomson and Sir Ben Lockspeiser (secretary).

Announcements

A course of twelve lectures and demonstrations on the theory of photoelasticity and the practical application of photoelastic methods to the investigation of two-dimensional stress distributions will be given in the Faculty of Engineering, University College, London, on successive Mondays (2–3 p.m.), commencing on October 11. A course of twelve lectures and demonstrations on recent developments in the photoelastic investigation of three-dimensional stress problems will similarly be given on Mondays, commencing January 31, 1955. The fee for each course is 7½ guineas, or 14 guineas for both (free to students of University College). Further information can be obtained from the Secretary of the College, Gower Street, London, W.C.1.

The Bone and Tooth Society will hold a symposium on "Vitamin D and Bone" on September 30 at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1, at 5 p.m. Sir Edward Mellanby will speak on "Vitamin D and Nutrition" and Dr. E. Kodicek on "Balance Studies of Vitamin D in the Rat". There will also be a joint contribution from Dr. J. Anderson, Dr. C. E. Dent and Dr. B. Senior on "Vitamin D and Phosphate Excretion". Further information can be obtained from the Secretary, Bone and Tooth Society, Biochemistry Department, Institute of Orthopaedics, Royal National Orthopaedic Hospital, Brockley Hill, Stanmore, Middlesex.

SIXTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

AT the Sixth Commonwealth Entomological Conference, held in London during July 7–16, there were fifty-five delegates, a greater number than ever before, and these included representatives from nearly all the countries of the British Commonwealth. The open meetings attracted a large attendance of entomologists from Britain and overseas, and a wide field of subjects was discussed.

The principal advances in economic entomology continue to be in the development and application of synthetic insecticides and in the study of problems arising from their use. Dr. H. G. H. Kearns (University of Bristol Fruit Research Station) reviewed the synthetic insecticides used on field crops and the methods of applying them. It is more difficult to treat field crops than plantation or orchard crops, and the margin of profit limits what can be done. These considerations apply particularly to peasant-grown crops, for which dusting, though an inefficient way of using toxic materials, has the advantage of requiring no water and of permitting the use of simple equipment.

The application of insecticides from aircraft was dealt with first by Mr. D. Yeo (Colonial Insecticides Research Unit, Tanganyika), with particular reference to tsetse fly. Methods using residual deposits are not economic against species spread through savannah woodland; but in large-scale experiments using 'space sprays' that deposit toxic droplets directly on the fly kills approaching 100 per cent have been reached. The behaviour of droplets of such a size (about 50 μ) that they neither impact on the canopy nor fail to settle is greatly affected by atmospheric turbulence: application is thus restricted to brief periods around dawn and dusk, when conditions are still, and this renders the use of aircraft uneconomic. Dr. R. C. Rainey (Desert Locust Survey) discussed developments in spraying flying locust swarms from aircraft. Methods of graphical analysis of the factors involved, together with laboratory indications that locusts are far more susceptible to insecticide when flying than when resting, have provided the background to aerial attacks on swarms recently invading East Africa. By bringing together data from many sources, estimates of efficiencies and costs have been obtained which suggest that the method is not seriously more expensive than hopper-baiting, to which it is complementary, making it possible to attack locusts throughout their life-cycle.

Dr. A. M. Massee (East Malling Research Station) illustrated the effect of insecticides on the balance of animal populations by the history of certain orchard pests. The mite *Metatetranychus ulmi* became a serious pest after the adoption of tar–oil washes, which are non-toxic to its winter eggs but killed many of its predators that hibernate on the tree, and the use of DDT and organo-phosphorus compounds made matters worse. DDT also favours woolly aphis, *Eriosoma lanigerum*, by destroying its parasite, *Aphelinus mali*; on the other hand, it has virtually eliminated the apple capsid, *Plesiocoris rugicollis*, which had become an important pest under the previous spray programme. Spider mites can now be controlled by summer ovicides that are relatively harmless to beneficial insects and mites; this advance underlines the need for more selective rather than more toxic insecticides.

In opening the discussion on the development of resistance to insecticides, Dr. J. R. Busvine (London School of Hygiene and Tropical Medicine) said that authentic cases, among which pests of medical importance preponderate, are mostly of recent occurrence, and it is not clear whether this results from a more widespread use of insecticides or from the way the modern ones act. The possibility and speed of development of resistance depend on the frequency of occurrence and effectiveness of resistant genes in the original population, the intensity of selection and the rate of reproduction. Little is known of the mode of action of resistance: one mechanism appears to be the conversion of toxic to innocuous compounds; but another one, differently inherited, is required to explain resistance to 'knock down'.

Dr. I. Thomas (Plant Pathology Laboratory, Harpenden) opened the discussion on the estimation of losses from pests by referring to early work based on mechanical simulation of damage, and then outlined the methods used in Britain by the National Agricultural Advisory Service, under the guidance of the Pest Assessment Committee. He emphasized that pest damage is only one of several factors affecting crop yields and that, especially in under-developed countries, it may not be the limiting one. His colleague, Mr. A. H. Strickland, described in more detail the use of insecticides to obtain differences in pest density on experimental plots. Regressions of yield on infestation thus obtained for each district can be integrated with rapid district-wide assessments of infestation to provide valid estimates or even forecasts of yield losses. A subsidiary development is the collation of pest densities with ecological features, thus enabling situations associated with high infestations to be defined and avoided. Mr. Q. A. Geering (Cotton Research Station, Uganda) described a method used in Uganda for studying losses caused by cotton mirids. This utilizes single-row plots from which the pest is repelled by an insecticide, and is valuable in the case of mobile insects, for which ordinary plot methods break down. The results show how a plant which flowers over a considerable period can ultimately compensate for severe early damage, the real loss being in time rather than in yield.

Dr. W. R. Thompson (director of the Commonwealth Institute of Biological Control) outlined recent attempts to control two scale insects accidentally imported into Bermuda that have attacked the dominant shade tree there, a species of cedar that is unique to the island and, perhaps for that reason, highly susceptible to scale attack. Although some one and a half million individuals of forty species predatory or parasitic on scales were introduced, only two species, both Coccinellids, have become established. It appears that predators, as well as parasites, may have highly specific host-relationships. The Coccinellids now show signs of holding scale infestations below a level lethal to the surviving trees; but the lack of more striking success in a biological control operation on an island is surprising and emphasizes the need for further research if the results of such experiments are to be understood.

The principles underlying the biological control of weeds were discussed by Mr. J. R. Williams in a paper read by Dr. R. Mamet, both of the Department of Agriculture, Mauritius, where spectacular control of the introduced weed *Cordia macrostachya* has been effected by the leaf beetle, *Schematiza cordiae*. Essentially they involve exhaustive tests to show that the insect introduced is restricted to the weed to be controlled; the danger of the evolution of strains adapted to other, desirable plants after the elimination of the undesirable one seems slight, because the period during which intense selection of such strains would operate, following the rapid collapse of the weed population, would perforce be short.

In the discussion on pests of tropical cereal crops, both the opening speakers stressed the need for special research, and the Conference endorsed this view. Dr. H. F. Barnes (Rothamsted Experimental Station) reviewed recently acquired records of the occurrence of certain important grain midges, and pointed out that the existence of biological races necessitates experimentation to show whether sorghum midge, which is a particularly serious pest, is a single species being spread with seed or a complex of species that have arisen independently by convergent evolution. Mr. J. Bowden (Department of Agriculture, Gold Coast) said that damage by stem-borers had been insufficiently appreciated and investigated because of the preoccupation of entomologists with cash crops. The two needs are critical taxonomic and biological studies of the groups concerned, and standardized ways of assessing infestation and damage; the methods developed in the Gold Coast, though simple, seem adequate.

Mr. G. V. B. Herford (director of the Pest Infestation Laboratory) spoke of the increasing realization of the magnitude of problems of stored-product pests, particularly those of the Colonial territories, where a number of research and advisory units, with which close liaison is being maintained, are now engaged. Notable technical developments include the extended use of the fumigation of bagged produce under gas-proof sheets, and greater provision for bulk storage of grain, either in silos utilizing circulatory fumigation or in sealed underground pits.

Dr. R. C. Fisher (Forest Products Research Laboratory, Princes Risborough) began the discussion on problems of forest entomology, and referred to another example of the establishment in a tropical region of a unit linked with a research institute in Britain, namely, the team studying bark beetles in West Africa. In this investigation and in those carried out at the Forest Products Research Laboratory, the emphasis is on the study of the biology of the insect and the relation of its attack to the history and condition of its host timber. Dr. F. T. Bird (Division of Forest Biology, Canada) gave an account of the use of virus diseases of European origin against two introduced sawflies. The virus, which has maintained an extreme virulence, has been artificially disseminated and gives rise to epizootics in succeeding years, being transmitted from year to year via the egg. The mortality is dependent on the population density and habits of the sawflies, and at low densities is greater in the spruce sawfly, the eggs of which are laid singly and whose larvæ feed singly.

Mr. W. V. Harris, who opened the discussion on termites, outlined the programme and progress of the Colonial Office Termite Research Unit, of which he is in charge. He mentioned some interesting points that have already emerged from the rapidly accumulating data on termite distribution and ecology in East Africa, and directed attention to the dispersal of injurious dry-wood species that is taking place around the tropics.

Mr. L. G. Putnam (Division of Entomology, Canada), in a paper read by Mr. A. B. Baird, discussed developments in grasshopper research and control in Canada. Grasshoppers, unlike locusts, are not strictly gregarious, and do not normally undertake long flights. Outbreak centres thus do not exist: overall abundance appears to depend on weather factors, now being analysed, and as the insects are univoltine and lay their eggs, which overwinter, in or adjacent to stubble, the intensity of damage is determined by the degree of juxtaposition of successive crops. Dr. B. P. Uvarov (director of the Anti-Locust Research Centre) dealt with the more complex dynamics of locust plagues, involving not only fluctuations in numbers but also changes in the extent of the populated area and qualitative differences between solitary and swarming populations. Quantitative studies of numerical fluctuations and of their causes, especially biological ones, are now being pressed forward. A connexion has been demonstrated between large-scale swarm-displacements and movements of air masses, and the more mysterious movements that solitary adults are known to make are being studied. Recent work suggests that gregarious behaviour arises from conditioning, and persists even though the conditioning factors no longer operate.

Dr. C. H. N. Jackson (Tsetse Research Laboratory, Tanganyika) discussed the principal methods that have been used for controlling tsetse. These mostly depend on the selective destruction of some essential feature of the fly's environment, such as the vegetation characterizing the favoured breeding site or affording protection against desiccation, or the animals that constitute the food supply or a principal element in it. Insecticides are effective, though rather expensive; their use leaves the environment unaltered and discloses the interesting likelihood that fly populations are unable to recover after reduction below a certain level. Some results of the empirical control methods have been explained by research on tsetse physiology and behaviour, but much more of such work is needed.

Dr. W. J. Hall (director of the Commonwealth Institute of Entomology), in opening a discussion on the supply and training of taxonomists, said that the existing provisions for taxonomic research and for the identification of insects and mites of economic importance are inadequate. Substantial increases in staff are needed in organizations connected with these activities, which are interdependent. A number of other suggestions for improving the situation were discussed, and a committee was set up to make recommendations.

A full report of the proceedings, including the resolutions adopted by the Conference, will be published later in the year by the Commonwealth Institute of Entomology, together with reviews of the progress of economic entomology in the Commonwealth countries since 1948.

During the Conference, delegates visited Rothamsted Experimental Station, the Silwood Park Field Station of the Imperial College of Science and Technology, London, and the Pest Infestation Laboratory of the Department of Scientific and Industrial Research. These visits, together with certain social occasions, provided the opportunity for informal discussion between entomologists from many widely separated countries that is so valuable a feature of these Conferences.

COMPARATIVE ENDOCRINOLOGY OF VERTEBRATES

An international symposium on the comparative endocrinology of vertebrates was held in the Zoology Department, University of Liverpool, during July 12–16. It was made possible by the generous financial support of the Rockefeller Foundation and the United States National Science Foundation. The Derby professor of zoology, Prof. R. J. Pumphrey, on behalf of the University, officially welcomed the participants, who numbered about seventy-five. The symposium was divided into two parts, the first entitled "The Comparative Physiology of Reproduction" being under the chairmanship of Prof. S. Zuckerman; for the second part, on "The Hormonal Control of Water and Salt-electrolyte Metabolism in Vertebrates", Dr. S. J. Folley took the chair.

The first two days were devoted to a comparative survey of reproduction, starting with a paper on fish by Prof. W. S. Hoar (Vancouver), who, even though confining his survey to the teleosts, surprised many of his audience with the wide variety of reproductive patterns ranging from oviparity to viviparity met with in the bony fish. In discussion of this paper, Dr. A. S. Parkes raised the interesting question of how the sperm penetrates into the ovarian follicles in those forms in which intrafollicular fertilization occurs. This question could not be answered.

Prof. G. J. van Oordt (Utrecht) dealt with the male amphibian, his paper describing an experimental analysis of seasonal fluctuations in spermatogenesis in frogs which emphasized the part played by variations in sensitivity of the seminiferous tubules to pituitary gonadotrophins. In the discussion, Dr. H. Tuchman-Duplessis referred to experiments on the newt which suggested that cyclic variations in pituitary gonadotrophic activity may be another factor involved in seasonal changes in spermatogenesis in amphibia. Dr. C. L. Smith (Liverpool) in surveying reproduction in female amphibia discussed the role of exteroceptive factors such as rainfall and temperature in controlling pituitary activity via the hypothalamus. He described experiments on the relation between thyroid activity and the sympathetic system which might bear upon the possible participation of an adrenergic component in the functional pathway between the hypothalamus and the hypophysis.

Reptiles, which have been comparatively little studied by endocrinologists, were surveyed under four heads, Sauria, Ophidia, Crocodilia and Chelonia, by Dr. R. Kehl (Algiers) in a joint paper with C. Combescot. Much of the paper was taken up with a description of Dr. Kehl's own work on the Algerian saurians, *Uromastix* and *Acanthodactylus*, which is providing much needed additional information about this class. Dr. M. R. Miller (California), in the discussion, described Californian reptiles in which the male interstitial cells show no evidence of endocrine activity. The meeting entered upon less exotic ground with a stimulating survey by Dr. A. J. Marshall (London) of reproduction in male birds, which included some slides illustrating his own observations on the periodic appearance of cholesterol-positive lipids in the testes. His references to the work of K. G. Wingstrand and particularly that of J. Benoit and I. Assenmacher, which suggests that the gonadotrophic function of the pituitary in birds is stimulated by a chemotransmitter of neurosecretory origin passing down the pituitary portal vessels, followed by an all-too-brief exposition by Prof. Benoit himself of his elegant experiments, aroused much interest. This prompted Prof. Zuckerman, who earlier as chairman had eschewed controversy by virtue of his office, to express scepticism as to the completeness of the experimental evidence for the involvement of the pituitary portal vessels in the hypothalamic control of pituitary function as postulated by Benoit for birds and by G. W. Harris for mammals. Reproduction in female birds was surveyed by Dr. W. R. Breneman (Indiana), who, in the course of his exposition, described cytological work carried out by his colleague, F. Payne, on the avian pituitary in various reproductive phases. Evidence that the avian ovary produces progesterone and androgen as well as œstrogen was presented. This paper gave rise to discussion on, among other topics, the mechanism which determines the number of eggs in a clutch. This is probably neurogenic, and it seems possible that it may be more or less analogous to the suckling stimulus in mammals which, if intense enough, can stop the ovarian cycles. This theory involves the idea that the brood spots of birds are homologous with the mammæ of mammals and so may be sensitive to prolactin, as may be the ventral glands in the Chinese swifts said to secrete the edible birds' nest cement, prized by gourmets as an ingredient of soup.

Prof. Zuckerman at this point exchanged the role of chairman for that of lecturer and, with characteristic scholarship, surveyed the mammals in a joint paper with P. Eckstein. His main thesis in reviewing the manifold reproductive patterns found in this class was that many of these variations may not be differences in kind so much as components of a continuous spectrum. In discussing this paper, Dr. S. J. Folley cited the domestic cow as a probable example of a form from which a primitive breeding season has been eliminated by selective breeding. This was followed by diverting exchanges between Prof. Zuckerman and Dr. Parkes, who pleaded for the simple view of natural phenomena. Dr. L. Harrison Matthews (London) then undertook a wide survey of reproductive processes in vertebrates in a paper the topic of which was the evolution of viviparity. The discussion on this paper was notable for an impressive and scholarly contribution by Prof. E. C. Amoroso in which, after considering the adaptations which viviparity has necessitated, he drew a penetrating parallel between the increasing complexity of the endocrine function of the placenta and the lengthening of pregnancy. The comparative survey was concluded by a paper by Dr. E. Witschi (Iowa) on vertebrate gonadotrophins which was mainly occupied by a consideration of results obtained with an assay technique based on plumage changes in the weaver finch. He concluded from his results that the luteinizing and interstitial-cell-stimulating hormones are separate and distinct pituitary hormones, a conclusion which, however, did not command the support of two of his compatriots, Drs. R. O. Greep and J. H. Leathem.

The third day of the symposium was occupied by papers on the effects of sex hormones in vertebrates. Dr. J. M. Dodd (St. Andrews) began with a survey of the position in fish and lower chordates, in the course of which it became evident that his results lead him to differ somewhat from the views of D. B. Carlisle on the endocrine function of the sub-neural gland in ascidians which some regard as a primitive pituitary. Dr. Carlisle intervened in the discussion to clarify his position. Dr. L. Gallien (Paris) described experiments on the effects of sex hormones on sexual differentiation of the larvæ of amphibia. It is possible to achieve total sex inversion in amphibians by administration of the appropriate (mammalian) sex hormone at an early enough stage, showing that the development of the gonocytes is controlled not by genes but by endocrine factors arising out of the competing influences of the gonadal cortex and medulla. Dr. R. M. Fraps (Beltsville), in dealing with birds, described interesting experiments on the mechanism of ovulation in the domestic hen which indicate that the secretion of ovulating gonadotrophin (LH) by the pituitary is called forth by a progestogen (progesterone itself ?) secreted by the follicle next due to ovulate. The secretion of the progestational hormone is probably evoked by pituitary luteotrophin (prolactin). In the discussion on this paper Prof. Benoit described among other things the masculinizing effect of cortisone on ducks.

Dr. J. H. Leathem (Rutgers), to whom the paper on mammals was entrusted, discussed important species differences in the effects of steroids on the reproductive system of both male and female. Dr. T. Mann, commenting on this paper, illustrated this point by references to the marked differences between various species of mammal as regards the respective sites of origin of the fructose and citric acid found in the seminal plasma. Dr. A. Jost (Paris) concluded this part of the symposium with a paper describing his investigations on the effects of sex hormones on sexual differentiation in the fœtus, which show that this is not a continuous process ; rather, there occurs a critical period of testicular activity during which the character of the sexual structures is determined for life. Experiments involving hypophysectomy by the rather drastic procedure of decapitation (which, incidentally, is not fatal to the fœtus) indicate a gonadotrophic function for the fœtal pituitary. His admiration for the elegance of Dr. Jost's experiments tempted the chairman into a gentle tilt against the chemists, who, however, found a champion in Dr. Folley. In a masterly summing-up of this part of the proceedings, Prof. Zuckerman referred to the unique character of the meeting thus far, so broad and all-embracing had been the field covered. He reminded his audience that despite the astonishing variety of the reproductive patterns encountered even within one class, the underlying mechanisms seem nevertheless basically the same all through. It was good to hear Prof. Zuckerman predict that endocrinology will soon emerge from the "ACTH–cortisone era".

In opening the second part of the symposium, the chairman, Dr. Folley, referred to the evolution of devices for conserving water so as to preserve the aquatic environment necessary for the aqueous cell chemistry which is the basis of life. In considering the role of the endocrine system he mentioned recent achievements such as the discovery of aldosterone and the synthesis of the oxytocic polypeptide which can only serve to encourage further efforts in this field. The first paper, given by Prof. E. J. Conway (Dublin), began with a fundamental treatment of ionic equilibria in isolated muscle tissue before proceeding to consider the application of these principles in studies involving the adrenal cortex. It was interesting to learn that adrenal corticoids can influence ionic transport through the cell membrane of the yeast cell. Prof. H. Heller (Bristol) in a paper on mammals described the various physiological stimuli (dehydration, stimulation of vagal afferents, suckling, etc.) which cause secretion of the pressor-antidiuretic hormone. An old adage of the Hogben school, to the effect that when one measures hormone excretion in the urine one may be merely studying kidney physiology, came to mind in connexion with the mention of findings which suggest that the kidney may convert pressor-antidiuretic hormone into a less biologically active form prior to excretion. In comment upon a point raised by Prof. Heller's paper, Dr. Folley referred to the careful experiments of Mrs. M. H. I. Dodd at Shinfield which indicate that neither the lactating state itself nor the application of the milking stimulus has any detectable effect on the amounts of pressor-antidiuretic hormone and oxytocin in the posterior lobe of the goat. He also pointed out that evidence of differential secretion of the two posterior lobe principles has been provided by the work of G. Peeters, of Ghent, who showed that suckling antidiuresis in water-loaded cows could be inhibited by mild fright, while the milk-ejection reflex (believed to involve oxytocin secretion) was not affected. An interesting contribution to the discussion came from Dr. F. G. Hofmann, who described a creature of the American desert, the kangaroo rat, which is geared to maximum water conservation and shows a great impediment to water excretion, yet its response to pressor-antidiuretic hormone is equal to that of the ordinary rat.

A paper on amphibia was read by Dr. W. H. Sawyer (New York). He emphasized the key position of this class which, situated as it is between water and dry land, may provide the best experimental medium for elucidating the basic principles of salt and water balance. Dr. Sawyer visualized the neurohypophysis as playing the primary part in regulating water balance and the adrenals as having precedence in regulating salt metabolism. He felt that, for amphibia as for mammals, the respective roles of the two glands are complementary rather than antagonistic as so often regarded. In the ensuing discussion, Dr. C. Barker Jørgensen described experiments, partly with K. G. Wingstrand, on section of the supraopticohypophysial tract in *Rana temporaria* which resulted in a decrease of neurosecretory material but did not affect the rate of water uptake. Then Dr. V. Capraro (Milan) read a joint paper with M. L. Garampi describing experiments on effects of posterior-pituitary extracts on the rate of water flow through the isolated frog skin which indicate that mechanisms more complicated than simple changes in pore size are involved. As pointed out by Prof. Pumphrey, such results are likely to depend to an important degree on the season in which the frogs are taken, since the winter frog is physiologically a very different creature from the summer frog.

In the final session the first paper was by Prof. M. Fontaine (Paris), who gave an excellent general survey of the endocrine control of water and salt metabolism in fish. He was followed by Dr. D. C. W. Smith (St. Andrews) with an admirable account of some of the interesting work in progress at the Gatty Marine Laboratory on the relation between the endocrines and salinity tolerance in Salmonidæ. The thyroid hormone and pituitary somatotrophin seem to be of importance here. The last paper was given by Dr. I. Chester Jones (Liverpool), who in refreshing style surveyed the role of the adrenal cortex in salt and water metabolism in vertebrates. In the discussion, observations on water diuresis in patients with adrenal insufficiency were described by Dr. A. Slessor, while Dr. M. Ginsburg described experiments on the relation between the adrenals and the rate of disappearance of injected pressor-antidiuretic hormone from the blood in rats.

In the course of both parts of the symposium there were references from time to time to a dictum attributed to a distinguished zoologist not present at the meeting, to the effect that it is not the hormones themselves which evolve but rather the uses to which they are put. The chairman briefly returned to this concept in his final summing-up. He regarded it as inherently improbable and cited a number of facts which suggest that hormones are suitable material upon which the evolutionary process can work. This prompts the thought that if a sequel to this symposium is organized in a few years time—and in view of the evident success of the present one it is to be hoped that this will be the case—then perhaps a suitable theme will be "The Evolution of the Endocrine System".

If the above suggestion is acted upon, it would please many if the sequel were held under the same auspices, for the atmosphere of this symposium was extraordinarily pleasant and all the arrangements reflected great credit upon the originator and organizer, Dr. I. Chester Jones. This was acknowledged in a graceful speech at the end by Prof. Benoit, as was the pleasant hospitality accorded to the participants in functions arranged by the Merseyside Civic Society, the University of Liverpool and Prof. Pumphrey.

By arrangement with the Society for Endocrinology, the proceedings will be published as soon as possible in two volumes (Nos. 4 and 5) of the recently established series of *Memoirs* of that Society, the Royal Society having made a generous grant towards the expenses of publication.

S. J. FOLLEY

PHYSIOLOGY IN HUNGARY

THE twentieth (anniversary) annual conference of the Hungarian Physiological Society was held during July 8–10 in Budapest, under the presidency of Prof. Brunó Straub, and to mark the occasion the Hungarian National Academy of Sciences invited a number of guests from other countries to attend the meetings and to participate in the discussions. The programme, which contained 128 communications, demonstrated both the high quality of work in progress in the fields of physiology, biochemistry and pharmacology, and also the remarkable number and keenness of the younger generation of Hungarian scientific workers. Besides these papers, which were divided into three concurrent sections, there were plenary sessions, the first being devoted to a general report by Prof. G. Romhányi (University of Pécs) on the most recent discoveries relating to biological structure and function, and the others to lectures and communications by the foreign visitors.

From neighbouring countries came, among others, the Polish biochemists and physiologists, W. Niemerko (now director of the Nencki Institute, soon to return from Lódz to new quarters in Warsaw) and W. Missiuro; several Czechoslovak guests, including Dr. E. Gutmann (who at one time worked in Oxford); the Rumanian medical physiologists, Danielopulo and Julius Nitzulescu; and Prof. Gotséeff, of Bulgaria (one of the pupils of the late Sir Joseph Barcroft). The U.S.S.R. sent Prof. P. S. Kupalov (a former colleague in years gone by of Prof. A. V. Hill), Prof. S. C. Koschtojanz, the comparative physiologist, with the neurologists R. Kavetsky and A. Vorobyov. From the United Kingdom came the present writers, and from Germany the biophysicist Prof. Havermann (Berlin).

For more than twenty-five years, especially since the fundamental work of Szent-Gyorgyi and Straub in 1941 on the relations of actin and myosin, Hungarian physiology and biochemistry have been renowned for interest in the mechanism of muscular contraction. This was particularly in evidence at the present meetings, and for reasons of personal interest we shall report upon it a little more fully. Subjects which came under lively discussion included the effects of various extractants upon the appearance of muscle fibrils under the polarizing and electron microscopes; the early rapid phase of volume diminution accompanying the action current; the binding of metallic ions (especially Ca^{++} and Mg^{++}) by actin and myosin; and comparison of these proteins with others in this respect. The binding of Ca^{++} by muscle mitochondria was also reported upon. Interesting discussions were evoked by new investigations of the bound nucleotides in muscle and other cells, not only by Hungarian workers but also by Niemerko from Poland. A further topic was the cholinesterase activity of the mero-myosins prepared by tryptic hydrolysis; all of it was found to be in the L-mero-myosin just as all the adenosine triphosphatase activity is in the H-meromyosin. Among the workers presenting these papers were, with their many collaborators, E. Ernst, F. Guba, T. Erdős, G. Feuer, E. Biró, M. Bárányi and E. Varga.

Dr. I. Banga described some recent developments of her work on elastin, particularly in relation to the dependence of its elasticity on provision of water. Since elastin itself cannot bind water, the presence in the neighbourhood of water-binding collagen is essential. Dr. Banga and her husband, Prof. Joseph Baló, who directs one of the institutes of pathology in the University of Budapest, are much concerned with problems such as those of arterio-sclerosis.

Prof. Straub, while maintaining his interest in actin, has turned his attention also to protein synthesis. Papers from his laboratory included those on penicillinase synthesis in *B. cereus*, and on amylase synthesis in pancreas homogenates, in the presence of adenosine triphosphate. Interesting effects of ions on glutamine synthesis were also reported.

At the conclusion of the conference, the foreign visitors, together with some of their Magyar hosts, made excursions to the provinces to see the Freshwater Biological Institute on the shores of Lake Balaton, and the Universities of Pécs and Debrecen. The Biological Station at Tihány, where in the past several British investigators have worked, is in good condition, and in many ways well equipped, especially with a fine library. Under the direction of Dr. Bela Entz and Mr. I. Konok, work is proceeding on the hydrobiology of the lake with reference to the fisheries, and on the comparative physiology of invertebrates, including insect hormones. There is space for about twenty workers, and the collecting facilities include a good motor-cruiser.

The University of Pécs was first founded in A.D. 1367; but ceased to exist when the great majority of its students were killed in resisting the advance of the Turks—it was not re-founded until the present century. The town lies all on the slopes of a pleasant range of hills, and still has two mosques and a minaret among its architectural remains. The University consists primarily of the Faculties of Medicine and Law. Scientifically, it occupies a special position, as nearly all its professors are Academicians, and the National Academy of Sciences takes a particular interest in its progress. In the Department of Physiology, headed by Prof. E. Ernst, visitors were able to see ingenious apparatus for measurement of rapid volume changes using a piezo-electric quartz membrane, and micro-calorimeters for recording heat-production of muscles without contact between the tissue and the thermo-couples. One of the chairs of pathology is held by Prof. C. Donhoffer (a pupil of the late J. J. R. McLeod at Aberdeen); under his leadership interesting work in nutritional science is proceeding, especially on the effects of many different factors on the selection and intake of food by the rat. In the Department of Neuro-physiology (Prof. K. Lissák) much work on conditioned reflexes is under way; this was naturally of great interest to the Russian and Polish specialists. The Institute of Anatomy and Embryology, under Prof. J. Szent-Agothay, was also full of activity, mainly on three lines: neuro-hormonal correlations studied by lesions of the central nervous system; a new approach to 'neuro-taxis' in the study of the means whereby outgrowing axons find their way to their presumptive connexions in ganglia or central nervous system; and developmental neuro-anatomy. Here Dr. G. Székely has obtained results of much interest by homoplastic heterotopic eye transplantations in the newt, giving reversed reflex reactions to prey after innervation. Learning to overcome this is possible with half an eye but never with a whole one. Lastly, in the Department of Histopathology (Prof. G. Romhányi) work is well advanced on the study of artificial birefringent fibrils of polymerized deoxyribonucleic acid.

Throughout the conference, Magyar hospitality was at its most charming, and the visitors carried away a deep impression of the vitality of Hungarian physiology and biochemistry.

JOSEPH NEEDHAM
DOROTHY M. NEEDHAM

CROSSED LAMELLAR STRUCTURE IN HIGHER PLANTS

A. B. WARDROP has directed attention to the existence of crossed lamellar structures in the cell walls of higher plants, such structures having hitherto been known with certainty to occur in some green algæ (*Australian J. Bot.*, **2**, 2, 154; 1954). When a number of higher plants in which it was considered that this structure might be present were examined, it was demonstrated in the phloem fibres of *Vinca major* and the tracheidal elements of the aerial root of *Alstonia spathulata*. In the latter, two types of crossed structure are recognized: in one, bands of laterally associated micro-fibrils c. 0·5 μ wide intersect at variable angles, whereas, in the other, lateral association is complete, forming a crossed lamellar structure which approaches most nearly that occurring in the algæ. In the outer layer of the secondary wall of wood fibres of *Eucalyptus elaeophora* and *E. regnans* there is inconclusive evidence of a crossed structure similar to that observed in the cell walls of some vessels, which consists of a loosely formed meshwork of aggregates of microfibrils. This structure is considered to be distinct from the crossed lamellar and cross-banded structures. The paper is illustrated by a number of electron micrographs.

The same author has also reported on the mechanism of the surface growth involved in the differentiation of fibres and tracheids (*ibid.*, p. 165). An electron microscopic investigation was made of the differentiating xylem elements of *Pinus radiata*, *Eucalyptus elaeophora* and *Ulmus* sp. In the tips of fibres and tracheids there is a tendency for the microfibrils of cellulose to be oriented in the direction of growth. It is considered that this orientation can be disturbed by subsequent dimensional changes in the cell. The thin areas of the differentiating cells which are involved in the so-called 'mosaic growth' have been compared with the regions of the cell wall penetrated by plasmodesmata in the storage parenchyma of potato tubers. The suggestion is made that the thin areas are regions of the cell wall penetrated by plasmodesmata, or are developing primary pit fields. The implications of this concept, with respect to intercellular readjustment and to the differences between fibres and tracheids in extension growth, are discussed.

FORESTRY IN JAMAICA

ANNUAL REPORT FOR 1952–53

IN the annual report of the Forest Department of Jamaica for the year ending March 1953*, allusion is made to the devastation caused by the great hurricane of 1951 and the rehabilitation work, forestry and planting carried out in 1952. Jamaica's forest policy is outlined in the report as follows: protection and development of the Island's natural forest resources, that is, existing forest reserves and future extension thereof; afforestation of suitable accessible areas with the view of increasing timber production and eventually making the Island self-supporting; encouragement of afforestation and sound forest management on private lands; and research work on sylvicultural and utilization problems.

It is obvious that considerable progress has been made by the Department, as a working plan for the production reserves has been drawn up and is being worked. It provides for three working circles—plantation, improvement and natural forest. The provisions are very similar to the earlier type of working plans drawn up in India and Burma during the latter part of the nineteenth century. However, there is a serious trouble, one which was also experienced in parts of India during the early days of the Department there. The general position regarding forest reserve boundaries, says the Conservator of Forests, continues to deteriorate and is directly attributable to land hunger of an ever-increasing population. Villagers deliberately remove the boundary stones and, when prosecuted, challenge the accuracy of the original survey, thus requiring a new survey to be made. The policy of the Department is naturally to give up any suitable land for agriculture, but such sites are now unfortunately very few and far between.

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* Forest Department, Kingston, Jamaica, B.W.I. Annual Report for the Year ended 31st March, 1953. Pp. 12. (Kingston, Jamaica: Forest Department, 1953.)

Artificial regeneration has been making considerable strides. The most popular species is mahoe (*Hibiscus elatus*); but the use of *Pinus patula* and *Eucalyptus saligna* has again been partly increased and formed approximately one-third of the area of 620 acres planted during the year. The total area of plantations formed by the Department amounts to 6,348 acres. The general planting programme has now a fairly constant pattern: above 3,000 ft. *Pinus patula* is planted on the grassland areas and *Eucalyptus saligna* on the old cultivation areas; in the middle-elevation areas, mahoe and broadleaf (*Terminalia latifolia*) are put on the sites of better soil and *Eucalyptus* species, *Pinus patula* and *Grevillea robusta* on the impoverished sites; in the coastal region mahoe is used in the drier localities and teak on alluvial flats.

INDUSTRIAL RESEARCH ASSOCIATIONS IN GREAT BRITAIN

ADDRESSING a meeting of the Parliamentary and Scientific Committee on July 13, Mr. G. L. Bailey, immediate past chairman of the Committee of Directors of Research Associations, said that the total income of the forty-one research associations in Britain to-day amounts to about £4·5 million, of which about £3 million comes from industry. The general object of the research associations is to encourage the use of scientific knowledge by industry, including both the acquisition of scientific knowledge and its application. More money is spent on research than on its application, and in his address Mr. Bailey concerned himself mainly with what is done to secure the application of research results in industry, although he instanced the work by Dr. A. J. P. Martin and Dr. R. L. M. Synge on partition chromatography and the new anti-corrosive composition formulated by the British Iron and Steel Research Association as outstanding examples of important achievements in pure research that are to the credit of a research association; the former arose out of a search for methods of analysis suitable for elucidating the chemical composition of wool, and the latter from a long-range detailed study of the corrosion of steel and its prevention.

Much of the research programme of the associations, said Mr. Bailey, is concerned with the development of new materials for a particular purpose or of new processes, and there are also smaller investigations and those relating to methods of testing or evaluation. Apart from the issue of reports or of scientific papers, the associations usually spend 15–20 per cent of their liaison service income on consultations originating in a direct approach from a member firm or arising out of a visit by a liaison officer for a general discussion. Such liaison work, moreover, is now tending to intensify application work at the expense of long-range research generally.

Dr. S. Whitehead, the chairman of the Committee of Directors of Research Associations, who followed Mr. Bailey, referred first to co-operation with universities and technical colleges, to which institutions the research associations make grants amounting to about £80,000 annually, their policy being usually to seek to interest universities in the inadequately explored portions of fundamental science on which industries are based. The research associations also bear much of the responsibility for scientific representation of their industries abroad, and government departments make great use of them on specialized projects. Mostly Dr. Whitehead's address was concerned with the question of development. Apart from their success in persuading individual members to undertake development, the research associations have sought to foster the group method of sharing the cost of development. During and since the Second World War the Government has successfully used the method of research or development contracts, and research associations have also found the National Research Development Corporation very helpful. The Coal Utilization and the Electrical Research Associations and the Shirley Institute, however, have also formed development companies, and this has two main advantages: the negotiation of commercial agreements and the technical problems of commercial application require a different type of staff and management; and, apart from some convenience over taxation, the development company hopes to make profits, and its finances can be more easily kept separate from that of its non-profit-making parent. Shirley Developments, Ltd., is concentrating at first on the commercial development and exploitation of instruments, devices and machines developed at the Shirley Institute, whereas Electrical Research Association Patents, Ltd., has largely confined itself to the granting of licences on important patents. Dr. Whitehead claimed that the research associations are at least as good as the best industrial research departments in the number of projects exploited, and that they are actively pursuing all the methods by which scientific discovery can be most rapidly, generally and fruitfully applied.

At the meeting, Sir Reginald Rootes limited his remarks to research in the motor industry, on the basis of which he maintained that the Motor Industry Research Association has fostered co-operation and done much to enable the British industry to keep abreast of its competitors; it provides buildings, research equipment and facilities on its proving-ground that are more comprehensive than those which individual manufacturers could afford. He also stressed the importance of adequate financial reserves and of research associations being able to plan their work for some years ahead.

SUB-GRAIN BOUNDARY CORROSION IN HIGH-PURITY ALUMINIUM

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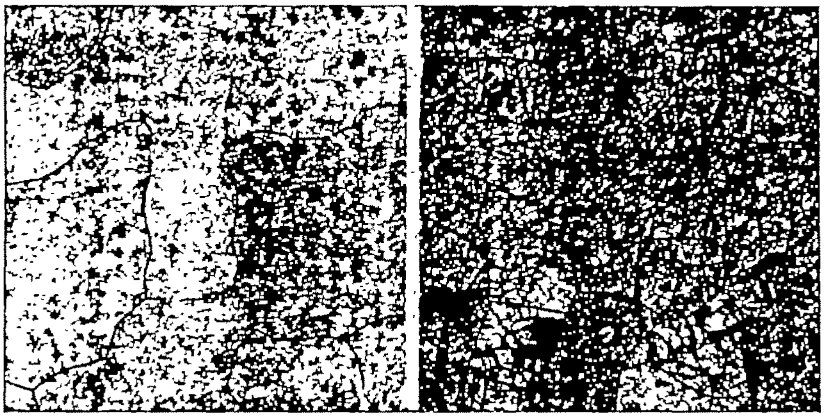
PREVIOUS observations of the intergranular corrosion of high-purity aluminium in hydrochloric acid have involved the general high-angle grain boundaries, and only superficial attack of the low-angle and sub-grain boundaries has been noted, except after prolonged anodic treatment[1]. We have observed that the sub-grain boundaries (as well as the low-angle grain boundaries) of properly heat-treated specimens are particularly susceptible to



Figs. 1 and 2. Effect of quenching-rate on attack of the sub-grain and low-angle grain boundaries after four days in solution. Annealing temperature 600° C. (1) rapid water quench; (2) inefficient quench obtained by sealing the specimen in a glass tube and quenching in liquid nitrogen. (× 8)

corrosion in 7 per cent hydrochloric acid containing about 0·5 part per million of copper (added as cupric chloride). The attack noted after several days exposure is deep and selective, so that entire sub-grains become undermined and fall out of the specimen (Fig. 2). Although the corrosion of the sub-boundaries in this solution is still somewhat slower than that of the high-angle grain boundaries and increases in a general way with increasing orientation difference, the behaviour is distinctly different from that observed when the metallic impurity content of the acid is low; in this case, the acid strength must be increased to 20 per cent to obtain comparable rates of corrosion for high-angle boundaries (penetrations of order 1 mm. a week) and the relative dependence of the susceptibility to corrosion on orientation is then very strong[1] regardless of the heat treatment[2], and the sub-grain boundaries are only superficially attacked even after prolonged exposure.

Corrosion of sub-grain boundaries in 7 per cent hydrochloric acid containing 0·5 p.p.m. copper has been observed so far in aluminium ranging in purity from 99·97 to 99·996 per cent. The susceptibility to corrosion is dependent on heat treatment; it is minimized by a rapid quench and favoured by an inefficient quench from the annealing temperature. The latter was conveniently achieved by sealing the specimen in a glass tube and quenching in liquid nitrogen. The strong influence of heat treatment is illustrated in Figs. 1 and 2. In this lot of 99·98 per cent aluminium, annealing of the material as supplied (hard-rolled) produced large grains in which the principal sub-structure was coarse and easily observed. In specimens such as that shown in Fig. 2, the small-angle boundaries that are attacked after proper heat treatment correspond to orientation differences from several degrees to at least as low as 10 min.

The variation of the susceptibility of sub-boundaries to corrosion with the rate of cooling from the annealing temperature is presumed to involve the tendency of certain impurity (that is, solute) atoms to concentrate near these boundaries, as postulated by Lacombe and Berghezan[3] for the susceptibility to etching of sub-boundaries in aluminium–zinc alloys produced by ageing air-cooled specimens at room temperature. An appreciable concentration of solute atoms adjacent to the sub-boundaries cannot be produced in material of relatively high purity cooled from a high temperature at a relatively high rate unless these atoms are strongly attracted. The attraction of a solute atom to the region adjacent to a sub-boundary that can result from a difference of atomic size and an interaction with the stress field of the edge components of the dislocations composing the sub-boundary does not appear to be sufficiently great, as estimated from the treatment of Cottrell[4] for an isolated edge dislocation, to account by itself for the observed effects. It is hoped that further study of the influence of composition and heat treatment will provide additional information on this point.

The 7 per cent hydrochloric acid corroding agent containing copper is valuable as an etch fluid for revealing the sub-structure of properly heat-treated specimens. We have made some observations of sub-structures produced by bending single crystals or coarse-grained specimens (prepared by the strain-recrystallization method) and annealing at high temperatures. In general, boundaries running in all directions are observed even where constraints due to neighbouring grains are absent. An example is given in Fig. 3. This shows the sub-boundaries produced in two grains of a coarse-grained specimen, in which the lower grain covers the width of the specimen, together with the subdivided Laue spot obtained in a back-reflexion photograph taken in the lower grain. The axis of bending is parallel to the bottom edge of the figure. When the principal sub-boundaries run more or less parallel to the axis of bending, as in the lower grain, the difference of orientation across a sub-boundary is roughly as expected from the bend radius and the mean spacing of the sub-boundaries.

To date, it has been verified by X-ray measurements that boundaries where the difference of orientation is as small as 5 min. are susceptible to corrosion in this solution; this does not appear to be the lower limit. Corrosion of sub-boundaries in a generally similar manner has been obtained by substituting 100 p.p.m. iron for the copper added to the acid and also by anodic treatment (similar to that used by Lacombe and Yannaquis[1]) in 7 per cent

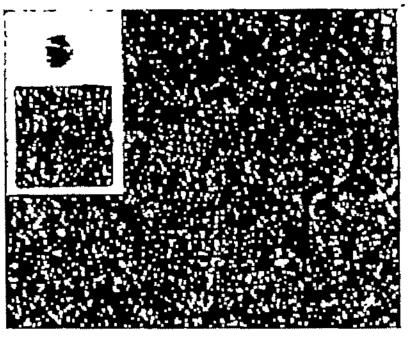


Fig. 3. Sub-boundaries in two grains revealed after four days in solution. Convex surface of coarse-grained sheet bent to a 20-cm. radius at room temperature and annealed at 645° C. The grain boundary is indicated by arrows. (× 8.) Inset shows a back-reflexion Laue spot (× 1½) together with the region of the lower grain (× 8) in which the X-ray photograph was taken. Specimen to film distance, 9 cm.; diameter of irradiated area, 1·5 mm.

hydrochloric acid without additions at current densities in the neighbourhood of 10 m.amp./dm.[2]. With these methods also, the sub-boundaries are strongly attacked only after the proper heat treatment. The minimum difference of orientation, however, is slightly larger than is required when acid with added copper is used as the corroding agent. All these methods are capable of revealing boundaries for which the difference in orientation is smaller than that at which the aqua regia plus hydrofluoric acid etch fluid[5,6] is effective. By using several of the available techniques, it is possible to obtain some information concerning the magnitudes of the differences of orientation at the various sub-boundaries of a specimen. [April 29.

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[2] Metzger, M., and Intrater, J., "Intergranular Corrosion of High-Purity Aluminium in Hydrochloric Acid" (to be issued by the National Advisory Committee for Aeronautics).

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[6] Gervais, A. M., Norton, J. T., and Grant, N. J., *J. Met.*, 5, 1166 (1953).

STRUCTURES OF MOLECULES AND CRYSTALS OF FLUOROCARBONS

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POLYTETRAFLUOROETHYLENE[1] appears to be a chain polymer $(\text{—}CF_2\text{—})_n$ of very high molecular weight, of the order of half a million[2]. The powdered material, as produced in the polymerization reaction, is highly crystalline below 20° C. The 'melting point'—the first-order transition from a partly crystalline to a completely amorphous structure—is about 330° C.[3,4], very much higher than that of the corresponding hydrocarbon polymer—132° C.[5], 136·5° C.[6]; but at 20° C. the fluorocarbon polymer shows another first-order transition involving a 1 per cent change of density, which is shown by X-ray diffraction patterns[4] to be due to a partial disordering of the crystalline regions. The occurrence of a reversible first-order transition involving disordering at a temperature so far below the 'melting point' (actually about half the absolute 'melting point') is unique among polymers, and directs increased attention to the structure of the molecules and of the crystals, both below and above the 20° C. transition.

It is also interesting that on closer examination the room-temperature transition has been found to be composite: although most of the change of density occurs at 20° C., there is an additional smaller change at 30° C.[7,8].

X-ray diffraction photographs of drawn fibres show that below 20° C. (Fig. 1*a*) the pattern is a typical 'fibre diagram' of a crystalline polymer in which the crystals are oriented with the chain direction of the molecules approximately parallel to the direction of drawing. The chain repeat-distance, calculated from layer-line spacings, is 16·8 A.; equatorial reflexions fit a pseudo-hexagonal projected cell-base with $a = b = 5{\cdot}54$ A. and $\gamma = 119{\cdot}5°$. The other unit cell parameters are still in doubt; but the general features of the diffraction pattern give very definite indications of the molecular configuration. The distance 5·54 A. and the very great strength of the 100 reflexion indicate a simple packing of rod-like molecules. A fully extended chain of singly linked carbon atoms has a plane zigzag character (as in polythene[9] and many other chain molecules); but in the fluorocarbon polymer the long-chain repeat-distance indicates some departure from a simple plane zigzag. The essential zigzag character is, however, revealed by the very strong near-meridian reflexions on the 6th and 7th layer lines, which indicate a sub-period between one-sixth and one-seventh of the true period, namely, 16·8/6·5 = 2·6 A., which is about the span of one zigzag of a carbon chain. That there are indeed 6½ zigzags in the chain repeat is confirmed by diffraction photographs taken with the fibre axis oscillating at appropriate angles to the X-ray beam; such photographs show one, and only one, reflexion from a plane perpendicular to the chain axis, and this (an extremely strong one) has a Bragg spacing of 1·294 A., one-thirteenth of the full chain repeat. The fact that there is only one such reflexion indicates that the CF_2 groups are equally spaced along the chain, and this suggests a regular helix; and the (at first sight) curious number of 6½ zigzags in the repeating unit receives a simple explanation if we imagine a plane zigzag twisted 180° in 16·8 A. or 13 chain atoms. A full 360° twist of the chain occurs in 33·6 A., 13 zigzags or 26 chain atoms, but the actual period is half this, because a zigzag consists of two lines of atoms, and a half twist brings the fourteenth atom on the second line directly above the first atom on the first line (Fig. 2). There are other ways of describing this helix; thus successive carbon atoms lie on a helix of six turns in 16·8 A.; but the first description (of the twisted zigzag) is stereochemically the most appropriate, as it refers to the bond structure.

Confirmation of this 13-atom helix is indicated by a group of fairly strong reflexions near the equator, on the second layer, with spacings 2·0–2·4 A., from planes inclined 15–20° to the chain axis; fluorine atoms attached to such a helical carbon chain fall approximately on planes having this spacing and orientation—in other words, the molecular transform has a maximum in this region.

Calculations of layer-line intensities for various types of helical (twisted zigzag) chains, made by the Bessel function method[13], show that the helix described above is the only one which will account for the observed intensities, and give the radius of the fluorine helix as 1·64 A. (± 0·05) and that of the carbon helix as approximately 0·42 A.

When the temperature is raised to 25° C., the diffraction pattern changes profoundly (Fig. 1*b*): equatorial reflexions, and those on the 6th and 7th layer lines, remain sharp (in fact, become actually sharper); but all those on intermediate layer lines become very diffuse, groups of reflexions being converted into broad areas of diffuse scattering. This last fact—that the areas of diffuse scattering are in the same places as previous groups of sharp reflexions—shows that the molecular configuration is unchanged; and this is confirmed by the spacing of the 13th order of the chain period, which remains precisely the same as it was below 20° C. (1·294 A.). We have found no evidence of an increase of chain period reported by others[10]. The disordering, therefore, affects only the positions of the molecules, not their configuration. The lateral spacings are slightly

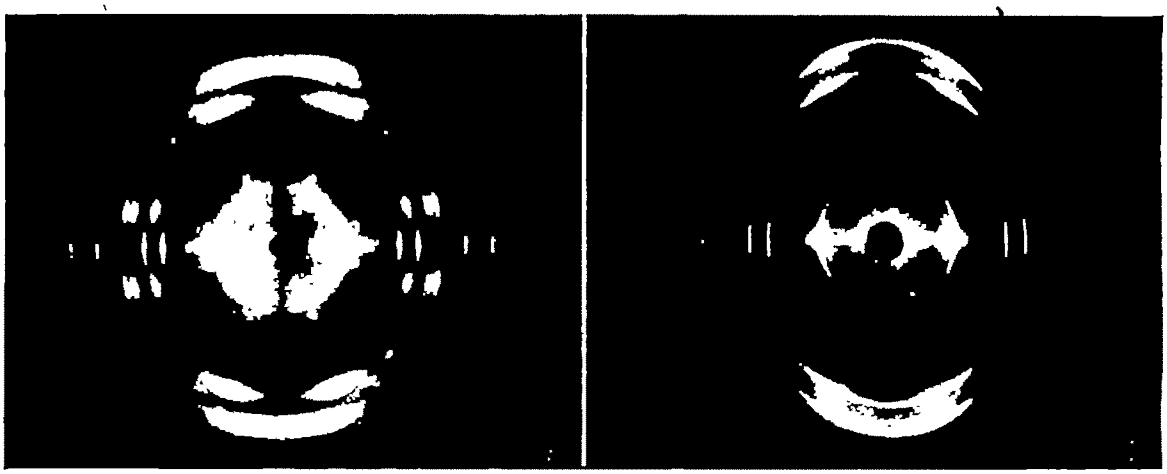

Fig. 1. X-Ray diffraction photographs of polytetrafluoroethylene : (a) at 10° C. ; (b) at 25° C.

increased (the projected cell-base is hexagonal with $a = 5 \cdot 61$ A. and $\gamma = 120°$), but the sharpness of the equatorial reflexions shows that the side-by-side packing is highly regular. The disorder must therefore consist of a variable displacement of the molecules along their chain axes, or a variable rotation about their chain axes. The fact that the 6th and 7th layer-line reflexions are sharp shows that any longitudinal displacement can only be in steps equal to the zigzag span. Variable rotation about the chain axes without longitudinal displacement would, of course, keep all the CF_2 groups on the same levels, and ensure the sharpness of the 6th and 7th layer reflexions. It does not appear to be possible to distinguish between the two alternative types of disorder, which in the polymer lead to precisely the same semi-disordered crystal structure.

At 35° C. (that is, above the subsidiary transition at 30° C.) the equatorial reflexions remain sharp, but the 6th and 7th layer reflexions become diffuse or disappear ; this means that CF_2 groups are no longer on exactly the same levels. The molecular interpretation of the two transitions suggested by these facts is therefore that the main 20° C. transition is due either to rotation around the chain axes or longitudinal displacement in precise steps equal to the zigzag span, while the subsidiary 30° C. transition is due to longitudinal displacements which are not in precise steps. Up to 150° C. the strong 6th and 7th layer reflexions become more and more diffuse as the temperature rises, while the equatorial reflexions remain sharp ; evidently the longitudinal displacements become more and more random.

Crystals of perfluorooctane, $C_{16}F_{34}$, which are flakes of hexagonal outline, have been examined by the same methods. A crystal rotated around the normal to the flake gives, at room temperature, an X-ray diffraction pattern which is strikingly similar to that of the high-polymer fibre well above 30° C. : there are sharp equatorial reflexions which fit a hexagonal projected cell-base, and elsewhere, very diffuse scattering having the same pattern as in the high polymer. Evidently the molecules have essentially the same helical configuration as those of the high polymer. The pattern differs from that of the high polymer, however, in showing meridian reflexions which are successive orders of a spacing of 23·1 A., representing the limited length of the molecules. Oscillation photographs show that the higher orders of this chain spacing are appreciably broadened ; there is evidently some disorder in the direction of the chain axes.

The diffraction pattern changes to the sharp pattern of an ordinary fully-ordered crystal only at very low temperatures : the transition temperature is about −170° C. The behaviour of this fluorocarbon is thus similar to that of the high polymer, except that the transition temperature is even lower (at less than one-third the absolute melting point). It may eventually be possible, from the X-ray diffraction patterns of perfluorooctane, to distinguish between rotations and translations of the molecules in the crystals.

Two very interesting questions arise from these conclusions. In the first place, why is it that the fluorocarbon molecules have a helical chain with a

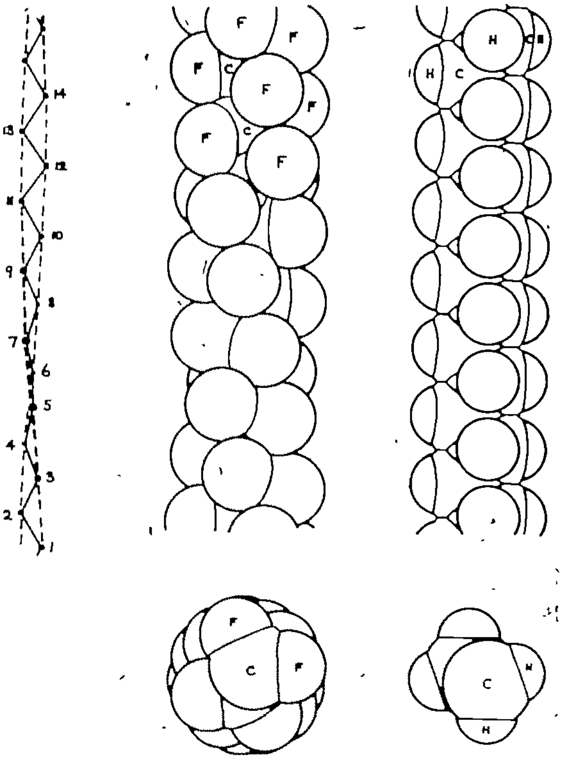

Fig. 2. Left : twisted zigzag chain found in fluorocarbons. Centre : fluorocarbon molecule (side and end views). Right : hydrocarbon molecule

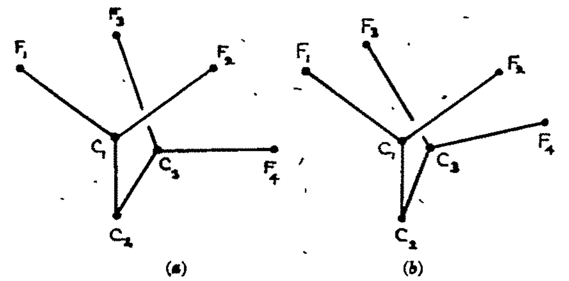

Fig. 3. (a) Configuration giving equal F—F distances ($F_1F_3 = F_3F_4$); (b) configuration actually found

13-atom repeating unit, while the corresponding hydrocarbon molecules have a plane zigzag carbon chain? And secondly, why are fluorocarbon crystals disordered so far below their melting points?

In the plane zigzag chain found in the hydrocarbons[9], the span of the zigzag is 2·539 A. Hydrogen atoms attached to next-but-one carbon atoms are also at this distance from each other. Since the van der Waals radius of hydrogen is 1·1–1·2 A., there is ample room for these atoms—in fact, they are not in contact but separated by a gap (see Fig. 2); but the van der Waals radius of fluorine is 1·35 A.; double this figure is 2·70 A., so that fluorine atoms attached to a plane zigzag carbon chain would be overcrowded. The helical structure is presumably due to rotation around the chain-bonds which takes place to increase the distance between the fluorine atoms. It is interesting to find, however, that although satisfactory distances between fluorine atoms could be attained by a rotation which would bring one fluorine atom (F_3 in Fig. 3a) equidistant from the two (F_1 and F_4) on the next-but-one carbon atom, this is not what actually happens; instead, a smaller rotation occurs (giving unequal F—F distances), and the remainder of the required increase of the shortest distance is provided by an increase of the zigzag span from 2·539 A. (the figure for hydrocarbons) to 2·595 A., an increase which is presumably due to an opening of the $\underset{C\qquad C}{\overset{C}{\diagup\;\diagdown}}$ bond angle (to 116°), since this is much easier than stretching the C—C bonds. The limitation of the rotation may be due to repulsion between fluorine atoms and next-but-one chain carbon atoms (F_3 and C_1 in Fig. 3b) or to a bond-orientation effect (as distinct from atom repulsions) which favours staggered configurations of which the plane zigzag chain is the simplest example[11].

The order–disorder transition which occurs at room temperature in the high polymer is evidently not a phenomenon peculiar to the polymer, for the same type of transition is found in perfluorooctane, again at a temperature far below the absolute melting point; it is evidently due to some feature of the structure of a fluorocarbon chain. The transition may be analogous to the change that occurs[12] in paraffin hydrocarbons from C_{21} to C_{27} (but not in the high polymer[13]) a few degrees below the melting point, a change that is thought to be due to the onset of rotation of the molecules about their long axes (though the only evidence is the change to hexagonal symmetry). In the fluorocarbons we have much more definite evidence for disorder, and, above all, the transition occurs far below the melting point. Molecular models show that the fluorocarbon chain is more 'streamlined' than the hydrocarbon chain (see Fig. 2) in the sense that the general shape is more nearly cylindrical and the projections and depressions in the profile are smaller in relation to the cross-sectional area of the molecule. The close approach to cylindrical shape may be the simple explanation of the existence of disordered crystals at such low temperatures. Both rotations around the chain axis and longitudinal translations would be facilitated by such a streamlined shape.

Many crystals composed of molecules of approximately spherical or cylindrical shape suffer transitions which appear to be due to the onset of molecular rotation[14-19]. For some spherical molecules (camphor and certain derivatives) and flat cylindrical molecules, the transition temperature is far below the melting point[14,16]; but for long-chain molecules (aliphatic hydrocarbons, acids and alcohols) molecular rotation usually occurs (if at all) only a few degrees below the melting point[12,18]. The fluorocarbons are quite exceptional among chain compounds in showing evidence of disorder very far below their melting points. The controlling factor is probably the size of the projections and depressions in the profile, in relation to the diameter of the molecule: camphor and its derivatives have a predominantly hydrocarbon surface, characterized by projections and depressions of similar size to those in chain hydrocarbons, but owing to the greater diameter of the cage-like camphor molecule, the projections and depressions are relatively smaller. Among slender chain molecules it is only the fluorocarbon surface which is sufficiently smooth to permit rotation at very low temperatures.

Polytetrafluoroethylene has other exceptional properties; in particular, its coefficient of friction is remarkably low—much lower than that of polythene—and indeed it appears to be unique among plastics in this respect[21,22]. It seems possible that this also is connected with the disorder transition at room temperature, and is in fact due to the same feature of the molecular structure—the smooth profile of the molecule, which permits easy slip of one molecule past another and easy gliding on the crystal planes which are parallel to the chain axes.

We wish to thank Dr. R. N. Haszeldine for providing a specimen of perfluorooctane. [July 12.

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LETTERS TO THE EDITORS

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Pentamethonium as an Adjuvant to Atropine in the Therapy of Paraoxon Poisoning

Paton and Perry[1] demonstrated a competitive antagonism between acetyl choline and pentamethyline *bis*-trimethyl ammonium dibromide (pentamethonium), at ganglia, and this suggested that pentamethonium might be of value in treating poisoning with anticholinesterases such as diethyl 4-nitrophenyl phosphate (paraoxon). Douglas and Matthews[2] used pentamethonium in cats poisoned with tetraethyl pyrophosphate (TEPP), and showed that it improved the contractile power of the diaphragm. We now have evidence that pentamethonium bromide significantly increases survival of fully atropinized animals—mice, rabbits and cats—poisoned with paraoxon.

Table 1. LD50 Values for Female Mice given Intravenous Injections of Paraoxon Alone and Together with Antagonists

Treatment	No. of mice injected	LD50 paraoxon (mgm./kgm.)	95 per cent fiducial limits	Slope
Paraoxon alone	101	0·48	0·46–0·49	22·54 ± 3·43
„ + 1 mgm./kgm. atropine	55	0·56	0·55–0·57	44·74 ± 8·35
„ + 5 „ „	122	0·67	0·62–0·91	11·90 ± 1·92
„ + 10 „ „	110	0·89	0·82–0·97	7·78 ± 1·63
„ + 20 „ „	50	1·00	0·88–1·13	7·51 ± 1·82
„ + 30 „ „	60	0·94	0·86–1·03	10·23 ± 2·58
„ + 10 „ „ + 10 mgm./kgm. pentamethonium	130	2·28	1·86–2·80	2·62 ± 0·47

In mice a quantitative expression of the therapeutic potency of pentamethonium was obtained by plotting dose-effect curves for the intravenous injection of: (1) paraoxon alone, (2) paraoxon plus various doses of atropine, and (3) paraoxon plus a full dose of atropine (10 mgm./kgm.) plus pentamethonium. The LD50 value for each treatment was calculated by the probit method and these, along with their 95 per cent fiducial limits and the slopes, are given in Table 1. For the test with pentamethonium, a dose of 10 mgm./kgm. of atropine was selected. This was not the optimum of the doses of atropine tested; but the difference in protection afforded by 5, 10, 20 and 30 mgm./kgm. of atropine was insignificant. Adding pentamethonium to the atropine increased the LD50 over the highest figure obtained with atropine alone 2½ times. As the protective action improved, the slope of the regression line became flatter, and when pentamethonium was injected, survival occurred in a high proportion of mice given more than 4 mgm./kgm. of paraoxon.

Experiments with rabbits and cats anæsthetized with a chloralose – urethane mixture gave similar results. Sufficient paraoxon was injected into these animals to cause severe respiratory depression in spite of a full dose of atropine given simultaneously. To some nothing more was given, and these all died within thirty minutes. To others additional atropine was given intravenously, and these too died. To others again pentamethonium was given intravenously and these all recovered within the limits of an acute experiment (see Table 2).

Table 2. Effect of Pentamethonium on Survival of Cats and Rabbits

	Dose of paraoxon (mgm./kgm.)	No. of experiments	Pentamethonium	Result
Cat	1·75	3	No	Died
Cat	1·75	3	Yes	Recovered
Cat	2·0	2	Yes	Recovered
Rabbit	1·0	3	No	Died
Rabbit	1·0	3	Yes	Recovered

An explanation of the beneficial effect of pentamethonium in these two species was forthcoming in the shape of an immediate increase in the respiratory volume. Its effect on the blood pressure, as is well known, was to lower it; but following an initial fall, a slow but steady rise set in. The respiratory volume, on the other hand, rose steeply in all experiments, reaching a peak within one minute of the injection. A limited fall then took place, and it was not until 15–20 min. later that it began to rise again.

Fig. 1 shows the respiratory volume in three typical experiments with the cat, plotted as a percentage of the average volume measured for 30 min. or more before injection of the drugs. The same initial dose of paraoxon and atropine was given to all three, and the effect on the respiratory volume of injecting pentamethonium or further atropine can be compared with that of no treatment at all. It will be seen that further atropine, so far from im-

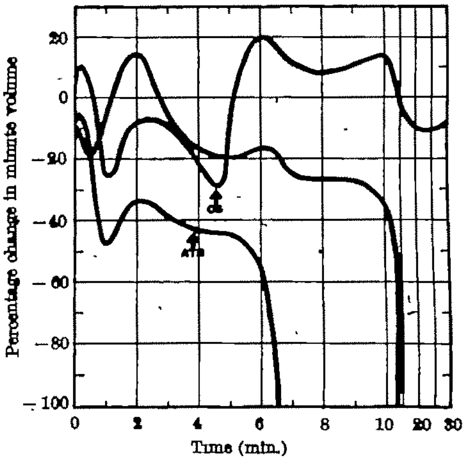

Fig. 1. Effect of pentamethonium on the respiratory minute volume of the cat. In all three experiments paraoxon (1·75 mgm./kgm.) together with atropine sulphate (2·0 mgm./kgm.) was injected intravenously at zero time. The arrows denote the time at which pentamethonium bromide (C5) (10 mgm./kgm.) was injected intravenously in one experiment, and atropine sulphate (2·0 mgm./kgm.) in another

proving the animal's condition, actually precipitated respiratory arrest.

C. A. DE CANDOLE
M. K. MCPHAIL

Suffield Experimental Station,
Ralston, Alberta,
Canada. April 28.

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Excretion in Human Urine of an Unknown Amino-acid derived from Dates

IN the course of an investigation with the aid of paper chromatography of the genetics of amino-acid excretion in man, it was observed that some individuals excreted large quantities of an unknown ninhydrin-positive substance. Upon inquiry concerning the diet of these individuals, it was found that dates had been eaten in all cases. Seven individuals were selected who had not eaten dates for at least a month, and chromatograms of their urine were prepared. In no case was the 'date spot' observed. These seven individuals were then fed eight to ten dates in the evening, and the following morning a sample of their urine was collected. Another urine sample was obtained the following morning. In every case the chromatograms of the first urine specimen showed quite clearly the 'date spot'. The chromatograms of the urine specimens produced on the second day after eating dates showed only a trace of this spot, or failed to show it altogether.

The unknown substance which produces the 'date spot' moves on the two-dimensional chromatograms in phenol–lutidine solvents to a location almost identical with that of α-amino-*n*-butyric acid. However, in butanol–acetic (4 : 1 : 1) solvent, this substance moves much less than α-amino-*n*-butyric acid, its R_F being about 0·25. The colour of the spot after developing with ninhydrin and heating also differentiates it from α-amino-*n*-butyric acid. The 'date spot' is clear blue, resembling somewhat the colour given on similar chromatograms by aspartic acid, rather than the violet or purple given by most other amino-acids. This blue becomes gradually more purple after standing for several days.

We have also investigated the occurrence of this substance in the date, and find that it is present in the free form and does not appear to increase in amount after acid hydrolysis. This suggests that the substance is an amino-acid and not a peptide. A copper complex test has also been run indicating that the substance is an α-amino-acid.

It is interesting that the amino-acid under consideration is excreted apparently unchanged, since from superficial appearances its excretion appears to be quantitative. This is a rather unusual situation for amino-acid metabolism in the human body; but we have no positive proof that the excretion is strictly quantitative.

This work was carried out by one of us (S. G.) during the tenure of a U.S. Public Health Service postdoctoral fellowship.

STANLEY GARTLER
TH. DOBZHANSKY

Institute for the Study of Human Variation,
Columbia University,
New York City. June 8.

A Peculiar Nutritional Dermatitis in Pigs

IN the course of our advisory duties, we have frequently encountered a number of cases of a peculiar dermatitis in pigs. The condition develops in pigs of about 10–12 weeks of age and is characterized initially by the development of red blotches under the skin of the hocks, spreading up the hind legs into the groin and over the belly and eventually over the back and ears. The dermatitis is accompanied by an acute irritation; the pigs become very uncomfortable and rub continually against the sides of the sties. This rubbing usually breaks the skin, resulting in the formation of extensive scabs. Appetite is adversely affected and the pigs make little or no live-weight gain. Natural recovery is very slow, and as a result of the condition, the pigs may take several weeks longer to reach the bacon factory.

The condition develops on both home-mixed and proprietary rations, with or without added antibiotics, and cannot be controlled by normal oily or powder dressings, dipping, bathing or spraying with insecticide preparations. It has only been found when pigs are dry-fed, even though drinking water is freely available.

The dermatitis can be quickly controlled and finally obviated by changing the affected pigs to wet-feeding. The inclusion of fodder beet or potatoes in the diet results in a marked improvement; but the recovery is not so dramatic as that which occurs when a wet-feeding practice is employed. On wet-feeding, appetite is quickly regained, the scabs slowly disappear and the pigs begin to put on weight again.

There is as yet no evidence of the fundamental cause of the condition or a valid explanation of the mechanism of the empirical cure; but we are putting these observations on record in the hope that they will be of value to others who may have encountered the condition, which would appear to be of more widespread occurrence than has hitherto been recognized.

Thanks are due to Col. J. E. B. Freeman, Buxhall Vale, Stowmarket, for allowing us facilities for experiments and for his careful observations.

G. THOMAS
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National Agricultural Advisory Service,
Eastern Province, Anstey Hall,
Trumpington, Cambridge. July 31.

Action of Squalene upon Carcinogenic Hydrocarbons

SQUALENE is an unsaturated triterpenoid hydrocarbon which was originally isolated from the liver oil of the shark[1]. Among its other occurrences, it was found to be present in the fat from ovarian dermoid cysts[2]. In an investigation on the role of sebum in carcinogenesis, squalene was found to be present in horse smegma and in human ear wax and hair oil[3,4]. MacKenna and co-workers found it in skin surface sebum[5].

The possible role of squalene as a protective agent in sebum is under investigation in this laboratory. It has already been shown to be fungistatic *in vitro* against certain dermatophytes[6]. This appears to be related to rapid peroxide formation which occurs when squalene is exposed to air.

Squalene was purified by passage through alumina. 3-Methylcholanthrene, 7,12-dimethylbenz[*a*]anthracene and benzo[*a*]pyrene (from Eastman Organic Chemicals) were purified before use. 100-mgm. samples of freshly purified squalene containing 500 μgm. of carcinogen were exposed at 37° C. in 35 c.c. round-bottomed centrifuge bottles. After the desired time interval, 10 c.c. of methanol was added and then 3 c.c. of cold 1 *N* sodium hydroxide. The mixture was then extracted six times with 5-c.c. portions of petroleum ether. The solvent was removed by evaporation under reduced pressure. Aliquots were taken for fluorometric determination of the hydrocarbon content and for squalene determination[4].

This procedure permitted a quantitative recovery of squalene and each of the hydrocarbons when the extraction procedure was carried out immediately. Complete, or nearly complete, recovery of the hydrocarbons was obtained when mineral oil replaced squalene and the period of exposure at 37° C. was as long as one month.

Only 7 per cent of 7,12-dimethylbenz[*a*]anthracene could be recovered after exposure to squalene for one week at 37° C. Nothing could be recovered after the second week. In the case of 3-methylcholanthrene 30 per cent remained after the first week and only traces were found afterwards. The possible presence of a fluorescence-quenching substance was ruled out. On the other hand, even after five weeks of exposure, 92 per cent of benzo[*a*]pyrene was recoverable. This substance exerted a profound antioxidant activity, for squalene could still be recovered in nearly theoretical amounts. During this period squalene alone was almost completely oxidized. 7,12-Dimethylbenz[*a*]anthracene exerted almost no antioxidant effect although 3-methylcholanthrene was somewhat inhibitory.

Bernheim *et al.*[7] demonstrated that carcinogens inhibit fatty-acid oxidation in the epidermis of the mouse and suggest that carcinogens, by inhibiting peroxide formation, may produce conditions favourable for growth. The observation with benzo[*a*]pyrene is in conformity with the suggestion of these workers. Mueller *et al.*[8] reported some time ago that benzo[*a*]pyrene and 3-methylcholanthrene are destroyed in oxidizing unsaturated fatty acids. It remains to be seen whether the products of the reaction of 3-methylcholanthrene and 7,12-dimethylbenz[*a*]anthracene with squalene are still carcinogenic and whether this reaction is related to the role of squalene in sebum.

This project was supported by Grant *C*-2012 of the National Cancer Institute, U.S. Public Health Service.

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Cortisone in Relation to Infection and Tumour Growth

Nicol, Helmy and Abou-Zikry[1] showed that œstrogens stimulate the reticulo-endothelial macrophages in the spleen, liver, and lymph nodes, and that prolonged œstrogen treatment or stimulation by large doses of œstrogen appears to lead to mobilization of the macrophages in these organs. The reticulo-endothelial system is an important defence mechanism against malignant tumours in general[2,3], and its stimulation therefore probably increases the general defence of the body against tumour growth.

In view of the recent reports that patients being treated with cortisone are more susceptible to infection, and that cortisone enhances the spread of transplanted tumours in animals, it seemed desirable to study the effect of this hormone on the reticulo-endothelial system.

Seventeen male guinea pigs aged about one year were used for the present investigation. The reticulo-endothelial macrophages were studied by giving all the animals one daily injection of trypan blue subcutaneously for the last six days prior to being killed by chloroform. The dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. Seven of the animals were given dye only and were used as controls. The ten remaining animals each received 5–10 mgm. of cortisone (Roussel Laboratories, Ltd.) intramuscularly once daily for one to four weeks in addition to the dye. Specimens were taken from the spleen, liver and lymph nodes and fixed in Heidenhain's 'Susa' fluid. Sections were cut at 10 μ thick and stained with dilute carbol-fuchsin or weak eosin. The activity of the reticulo-endothelial system in the organs studied was measured by the number of dye-bearing cells and the intensity of the vital staining.

The results are as follows. In two of the four animals which received 5 mgm. of cortisone once daily for seven days, the intensity of the vital staining was reduced in the macrophages of the spleen compared with the results in the controls; but no appreciable effect was observed in the macrophages of the liver and lymph nodes. In the remaining animals which received 5 mgm. of cortisone daily for seven days, then 10 mgm. for a further two to three weeks, the reduced intensity of the vital staining in the macrophages of the spleen was still more marked; in those which received hormone treatment for four weeks, the vital staining was also slightly reduced in the macrophages of the liver and lymph nodes.

These preliminary results show that cortisone depresses the activity of the reticulo-endothelial macrophages especially in the spleen, and in this manner probably lowers the defence of the body against infection and new growths.

For this research we gratefully acknowledge the gift of cortisone by the Medical Research Council.

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Chemotherapeutic Experiments with Natural Constituents of the Body

Borsook and co-workers[1], from redox potential measurements, claimed in 1935 to have found that dehydroascorbic acid and reduced glutathione can form an intermediate compound *in vitro* from which ascorbic acid can be regenerated. The occurrence of this reaction in living organisms was contested by Bersin and others[2], who considered that the formation of ascorbic acid from dehydroascorbic acid was effected by an enzyme. Neither the supposed intermediate compound nor the enzyme has so far been actually shown to exist.

The fact that ascorbic acid itself has a bactericidal action was shown by von Gagyi[3] and myself[4]. Cysteine has been used in the treatment of hepatitis and also in the treatment of mustard gas burns of the skin; for which latter purpose I devised[5] an electrophoretic method. As is well known, mustard-gas burns in their clinical course strongly resemble X-ray injuries, and cysteine has also been used for the treatment of injuries of this kind. Presumably the effect is due to detoxication of toxic substances resulting from the irradiation. In the same way cysteine has been used for diminishing the toxic effects of nitrogen mustard when this is employed in cancer therapy[6].

The results referred to above seem to indicate the probability of a chemotherapeutic activity of cysteine and ascorbic acid, and for this reason as early as 1939 a compound of cysteine and ascorbic acid was prepared by me under the direction of Prof. Hans Schmalfuss.

Synthesis of cysteylascorbic acid. 0·02 mol. dried cysteine hydrochloride (Merck) was warmed at 40° for 30 min. with 12 ml. of carefully purified thionyl chloride and the mixture then shaken at room temperature for 4 hr. The acid chloride was then removed by filtration and the product washed with purified acetyl chloride and light petroleum (boiling point 49°) in an atmosphere of nitrogen. The product was added with stirring and in an atmosphere of nitrogen to a suspension of very pure 0·02 mol. sodium ascorbate dried in 300 ml. of thoroughly dried absolute alcohol; the stirring was continued for 4 hr. The undissolved residue was filtered off, and the solution kept overnight in the ice-chest under nitrogen. Next day a small precipitate was removed by filtration and the solution concentrated in a stream of nitrogen at 20 mm. until turbidity appeared; dry ether was added until precipitation of solid was complete; the precipitate is the chemotherapeutically active substance.

For chemical investigation attempts were made to purify the compound by two recrystallizations from alcohol. This purification has so far only been partly successful. The recrystallized compound forms rhombic crystals of questionable disintegration point 157° (found: C, 35·7; H, 4·71; N, 4·9 per cent. $C_9H_{13}O_7NS,H_2O$ requires C, 36·6; H, 5·1; N, 4·7 per cent). The absorption curve in the ultra-violet gave a maximum at 255 mμ in absolute alcohol. Pure ascorbic acid shows a maximum at 245 mμ.

More précise details must await further experiments on the constitution of the compound. By far the most effective compound in bacteriological experiments was finally prepared with a modification of the above-mentioned synthesis, which is referred to later on.

Chemotherapeutic experiments. As experimental animals young mice weighing about 6 gm. were used. The bacterial strains employed were highly virulent, virulence having been increased by five passages through mice.

Since the chemotherapeutic action might also be exercised by a mixture of ascorbic acid and cysteine, the following mixtures and individual substances were studied for their action on intraperitoneal pneumococcal infections of the mouse: (1) an equimolecular mixture of cysteine hydrochloride and sodium ascorbate; (2) the residue obtained by evaporating to dryness an aqueous solution of an equimolecular mixture of cysteine hydrochloride and sodium ascorbate; (3) the same product stirred with light petroleum for several hours; (4) cysteine hydrochloride; (5) the first insoluble residue obtained during the synthesis of cysteylascorbic acid; (6) the residue obtained by evaporating the final solution after precipitation of the cysteylascorbic acid with ether.

Infection was induced by intraperitoneal injection of 0·3 ml. of undiluted culture of *Pneumococcus mucosus*; the various substances to be tested were dissolved in 0·2 ml. saline and injected immediately or within 30 min. of the time of the inoculation. For each experiment two experimental animals and two controls were used. The results are shown in Table 1.

Table 1

Substance No.	50 mgm.	25 mgm	6·25 mgm	12·5 mgm.	3 mgm.	Control
1	− −	+ +	+ +	+ +	+ +	+ +
2	− −	− −	+ +	− −	− −	+ +
3	− −	− −	+ +	− −	− −	+ +
4	− −	+ +	+ +	+ +	+ +	+ +
5	+ +	+ +	+ +	+ +	+ +	+ +
6	+ +	+ +	+ +	+ +	+ +	+ +

+ indicates death

At the same time, and by the same technique, an experiment was carried out with the cysteylascorbic acid, the results of which are shown in Table 2.

Table 2

Experiment No.	30 mgm.	12 mgm.	8 mgm.	4 mgm.	2 mgm.	1 mgm.	Control
1	*LL*	*LL*	*LL*	*LL*	*LL*	*LL*	+ +
2	*LL*	*LL*	*LL*	*LL*	*LL*	*LL*	+ +

L = survived

In a further experiment, groups of four mice were inoculated with 30,000 lethal doses of another strain of pneumococcus and treated similarly with the cysteylascorbic acid at different dose-levels with the results shown in Table 3.

Table 3

Experiment No.	20 mgm.	15 mgm.	10 mgm.	5 mgm.	Control
3	*LLLL*	*LLLL*	*LLLL*	+ + *L* +	+ + + +

Finally, groups of three mice were treated with 10 mgm. of cysteylascorbic acid 1½, 3 and 4½ hr. after inoculation. All treated animals survived; the four controls died after 12 hr. In all the experiments with pneumococcal infection taken together, 107 control animals died, mostly within 12 hr., and 45 treated animals survived.

In vitro, the cysteinylascorbic acid inhibited the growth of the pneumococcus employed down to a concentration of 450 μgm. per ml. as compared with inhibitory concentrations of aureomycin and streptomycin of 25–250 μgm. per ml.

Experiments with Staph. aureus, Strep. pyogenes haemolyticus and Esch. coli. Similar chemotherapeutic experiments were carried out with mice infected with two lethal doses of a virulent strain of *Staph. aureus*. Survival of all animals was obtained with doses of cysteinylascorbic acid as low as 0·075 mgm., and again, as in the case of the pneumococcus infection, doses of 10 mgm. of the compound given 1¼, 3 and 4½ hr. after inoculation were sufficient to protect mice against heavy doses of the organism. The strain of *Staph. aureus* employed was resistant to penicillin, aureomycin and streptomycin.

Preliminary experiments with *Streptococcus* and *Esch. coli* indicate a similar degree of chemotherapeutic activity. Most of the bacteriological experiments were carried out by the director of the Bacteriological Department, Dr. Hans Lodenkämper, with the assistance of Dr. Stienen, Lohmuhlenkrankenhaus, Hamburg. I myself was responsible for the first bacteriological experiments.

Summary. The experiments described above leave no doubt concerning the chemotherapeutic activity of the cysteylascorbic acid, although this compound has not yet been prepared in a completely pure state. Since the experiments reveal a new principle, namely, the possibility of the chemotherapeutic employment of natural constituents of the body, it is considered desirable to publish the observations although the chemical constitution of the compound is not yet certainly established.

The ultra-violet absorption spectrum and polarographic analysis of the compound make it likely that it is a cysteyl ester of ascorbic acid, the attachment of the cysteine residue being at C_2 or C_3. The yield of the compound obtained by the method described is 15–20 per cent. Possible alternative synthetic methods for its preparation are now being studied. The toxicity of the compound for mice is negligible since a dose of 3 gm./kgm. is tolerated without ill-effect. The effect could probably be explained through the formation of a complex compound of the cysteine with the copper of the serum and certain copper-containing ferments of bacteria. The copper is, according to Heilmeyer and Keiderling[7], much increased after infections, whereas the iron is diminished.

It seems possible that the compound may find a use in diminishing the toxicity of nitrogen mustard and in preventing injury from X-irradiation; experiments to test these points are in view.

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Secretion of Juvenile Hormone by the Corpus Allatum of *Calliphora*

IT is now generally accepted that metamorphosis in insects is prevented throughout the larval stages by the secretion of the 'juvenile hormone' by the corpus allatum; but this has never been quite satisfactorily proved in the Diptera. Vogt[1] obtained some evidence that the corpus allatum restrains the development of the imaginal disks in the early stages of *Drosophila*. She also showed[2] that the corpus allatum of young *Drosophila* larvæ would induce yolk formation in adult *Drosophila* deprived of the corpus allatum; and since the yolk-forming hormone is the same as the juvenile hormone[3], this finding suggests that the hormone is present in the *Drosophila* larva. Vogt[4] and Possompès[5] also obtained evidence that the corpus allatum of the adult *Drosophila* and *Calliphora* will cause partial and local inhibition in the formation of pupal or adult cuticle.

The problem has been re-investigated by implanting the corpus allatum of *Calliphora* into the abdomen of the fifth-stage larva of *Rhodnius* fed one day previously. Implantation of the corpus allatum (together with the corpus cardiacum) from adult *Calliphora* of either sex, fed on sugar alone or on sugar and meat, resulted in several instances (three out of twenty survivals) in the appearance of a small localized patch of larval cuticle in the resulting adult.

The ring gland together with the central nervous system from second-stage larvæ of *Calliphora*, or the isolated dorsal region of the ring gland of small third-stage larvæ of *Calliphora*, were similarly implanted. Out of fifty-one adult *Rhodnius* surviving, six showed patches of cuticle with more or less well-marked larval characters over the site of the implant. Fig. 1 illustrates one of these patches overlying the implant of the dorsal part of the ring gland of a third-stage *Calliphora* larva.

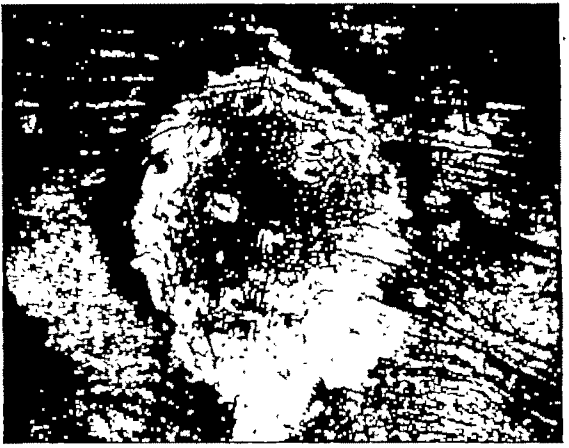

Fig. 1. Part of an abdominal tergite in *Rhodnius* adult with a patch of larval cuticle, showing bristle-bearing plaques and characteristic folding of the epicuticle, overlying an implanted ring gland from a third-stage *Calliphora* larva. The pale patch is just 0·5 mm. wide

These results not only prove the existence of the juvenile hormone in Diptera, but also they provide further evidence of the non-specific character of this hormone.

I am indebted to Mr. P. J. Judge for supplying *Calliphora* larvæ reared under sterile conditions.

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Submerged Culture Production of Diphtheria Toxin

It has been shown[1-3] that high-titre diphtheria toxin can be produced by growing the Park Williams No. 8 strain of *C. diphtheriae* in shaking flasks, and one of us[4] has reported the production of 100 Lf. u./ml. toxins in stirred and aerated cultures. Recently, using the latter technique, we have been able to prepare high-titre toxins (Lf. 150–200 u./ml.) by growing the organism for 48 hr. in 14-litre amounts of tryptic digest medium[1] in 20-litre 'Pyrex' flasks stirred by either a glass or a 'Birmabright' (a magnesium–aluminium alloy) stirrer with air bubbling through the cultures from an 'Aerox' filter (porosity *P* 28) at the rate of one-sixth litre of air per litre of medium per minute. Such culture filtrates contain 1,500–1,700 Lf./mgm. protein nitrogen and are, therefore, very suitable starting material for the further purification of the diphtheria toxin. Moreover, the antigen composition of the culture filtrates, concentrated by ultrafiltration, when examined by a gel diffusion test against antitoxin[5], was found to be as complex as in surface-culture filtrates; but the amounts of the contaminating antigens were less, thus explaining the higher purities obtained from submerged cultures.

Further experiments using glass-lined vessels stirred with aluminium 'vortex' stirrers of a type similar to that suggested by Chain[6], with air being passed over the surface of the medium and not through a bubbler or sparger ring, have also given as good results as those obtained with 'Pyrex' glass flasks. Experiments with culture vessels constructed of commercial aluminium have given quite high titre toxins, but such vessels show signs of attack by the culture on continued use, accompanied by a decrease in toxin production. This problem is now under investigation.

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Blood Platelets as Carriers of Adrenaline and Noradrenaline

It is now widely accepted that, provided the sympathetic innervation is intact, adrenaline is discharged continuously from the suprarenal medulla, even under basal conditions. Several authors[1] found a basal discharge of 0·03–0·06 μgm./kgm./min. from the two suprarenals of cats and dogs. According to our results[2], the adrenaline arteriovenous difference in man is about 0·5 μgm./l. of blood, which corresponds, as a first approximation, to a rate of utilization of about 0·03 μgm./kgm./min.—a value in good agreement with the established rate of adrenaline discharge.

An arteriovenous difference of 0·5 μgm./l. is compatible with the figures which we find for the concentration of adrenaline in venous plasma, namely, 1·0–1·6 μgm./l. of blood[3]. The validity of the method used has been checked by paper-chromatographic studies which showed that the material estimated could be recovered from the expected positions in yields approximating to those of model experiments, and that the fluorescence developed in the eluates had the expected spectral properties[3].

However, Holzbauer and Vogt[4], on the basis of a biological method, recently came to the conclusion that the adrenaline content of plasma is much lower. They also found that insulin injection increased the plasma adrenaline concentration, whereas we had found the opposite effect[3].

It occurred to us that these discrepancies might be explained, at least in part, by the different methods of blood collection. Holzbauer and Vogt, conforming to the exigencies of the biological method, took every precaution to prevent platelet breakdown, whereas in our method[3] the blood is collected in a hypertonic solution and in untreated glassware, conditions known to lead to the disintegration of the blood platelets. 209 ml. blood was collected in a silicone-coated cylinder containing 3,500 units of heparin dissolved in 1·5 ml. isotonic sodium chloride; 15 ml. was withdrawn and mixed with 5 ml. of a sodium fluoride – sodium thiosulphate solution[3] for estimation by method of Weil-Malherbe and Bone[3], the remainder centrifuged in silicone-coated tubes at ~ 600 *g* for 20 min. Plasma (72 ml.) was separated and half of it recentrifuged at ~ 3,000 *g* for 20 min. Both plasma fractions, and the residue from the second spin, were transferred to untreated glassware and mixed with the sodium fluoride – sodium thiosulphate solution and acetate buffer, prior to chromatography on alumina columns[3]. The eluates from the two plasma fractions were each divided into four parts: one part for estimation by the ethylenediamine method[3] and three parts for estimation according to Lund[7] (one part each for oxidation at *p*H 3·0, oxidation at *p*H 6·5 and for the blank).

It appears from the results shown in Tables 1 and 2 that the substances estimated as adrenaline and noradrenaline by our method are indeed associated, to a large extent, with the blood platelets. When platelet disintegration is avoided, about 70–80 per cent may be removed from plasma by centrifuging and a considerable part may be recovered from the platelet residue.

Table 1. ESTIMATION OF ADRENALINE AND NORADRENALINE (μGM./L. BLOOD) IN 'PLATELET-RICH' AND 'PLATELET-POOR' PLASMA

	Assay by ethylenediamine method (ref. 3)		Assay by Lund's method (ref. 7)	
	Adren.	Noradren.	Adren.	Noradren.
Blood collected in NaF–Na$_2$S$_2$O$_3$ solution	1·46	3·70	1·56*	5·40*
Blood collected in heparin and siliconized glass:				
Plasma spun at ~600 *g*	1·47	4·25	2·37	2·96
Plasma spun at ~3,000 *g*	0·34	1·20	0·36	1·17
Residue from second spin	0·72	2·11		

* These values were determined on a different blood sample collected from the same subject some days previously.

Table 2. EFFECT OF FRACTIONAL CENTRIFUGATION ON PLASMA CONTENT OF ADRENALINE AND NORADRENALINE

Blood (64 ml.) collected in heparin and siliconised glass. Plasma (24 ml.) divided into three parts and two parts re-centrifuged at ~ 3,000 *g* and 12,000 *g*, respectively. Estimation by ethylenediamine method (ref. 6)

	Adrenaline (μgm./l. blood)	Noradrenaline (μgm./l. blood)
Plasma spun at ~ 600 *g*	1·24	5·56
Plasma spun at ~ 3,000 *g*	0·64	3·44
Plasma spun at ~ 12,000 *g*	0·31	1·56

It is also shown in Table 1 that Lund's method[7] gives, in our hands, results which are very similar to those obtained by the ethylenediamine method[6]. The fact that the same result is obtained with two independent chemical methods, both having a high degree of specificity, surely is yet another strong argument in favour of the substances estimated being identical with adrenaline and noradrenaline.

The fraction previously regarded as 'plasma' adrenaline undergoes rapid and extensive changes in response to the injection of various hormones and drugs, to convulsions and to changes in the level of consciousness (natural sleep). In contrast to the adrenaline content of the red blood corpuscles, which is not significantly affected by these stimuli, the adrenaline store of the platelets appears to have important physiological functions. The platelets are already known to harbour histamine, at least in the rabbit[8], and 5-hydroxytryptamine[9]. They thus emerge as a store-house of circulating pharmacologically active amines.

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Vitamin B_{12} in Crude Liver Extracts

IN a previous communication[1], we reported that when cyanocobalamin was added to certain crude liver extracts, assays carried out by means of a mutant of *Escherichia coli* gave much lower results than would have been expected from the amount of vitamin B_{12} added, although *Lactobacillus leichmannii* gave fairly satisfactory recoveries. It was suggested that such extracts contained a substance that interfered with the utilization of vitamin B_{12} by *E. coli*. We have since obtained additional results on the nature of this interfering factor, and the publication of two recent papers[2,3] on the presence of bound forms of vitamin B_{12} in human serum and in sow's milk respectively prompts us to put our preliminary results on record.

In the first of these papers, Pitney *et al.*[2] reported that in the assay of human serum for vitamin B_{12} by means of *Euglena gracilis* higher values were obtained after the serum had been heated (confirming an earlier observation by Ross[4]), and that when vitamin B_{12} was added to the serum not more than 50 per cent could be accounted for on subsequent assay. From electrophoretic experiments it was concluded that the α-globulin fraction of human serum was able to bind vitamin B_{12}, forming a complex which did not stimulate the growth of *E. gracilis*.

In the second paper, Gregory and Holdsworth[3] reported the isolation from sow's milk of a protein which formed with cyanocobalamin a complex that did not stimulate the growth of *L. leichmannii*; after digestion with trypsin or papain some stimulation of growth occurred, and this was enhanced after the enzymic digest had been heated. Sow's milk not only contains vitamin B_{12} in bound form but also is capable of binding considerable amounts of added cyanocobalamin.

We have obtained evidence that some of the vitamin B_{12} in crude liver extracts cannot be assayed by means of the *E. coli* mutant, and have also observed binding of cyanocobalamin by crude liver extracts analogous to that recorded by Pitney *et al.* and Gregory and Holdsworth; but there are important differences in the nature of the complex formed. We have shown, for example (using for assay the *E. coli* mutant and not *L. leichmannii* or *E. gracilis*), that the apparent vitamin B_{12} content of these liver extracts increases on boiling and that only a proportion of added cyanocobalamin can be accounted for when using *E. coli* for assay. It was observed, however, that the 15-min. boiling found to be adequate by Pitney *et al.* was insufficient to liberate the bound vitamin in our liver extracts, heating for 4 hr. being optimal. Another striking difference between the behaviour of blood serum and liver extract towards vitamin B_{12} is that whereas Pitney *et al.* imply that liberation of vitamin B_{12} takes place as the result of denaturation of the protein to which it is bound, so that binding is presumably irreversible, we have found that when a crude liver extract is allowed to stand for some days after having been boiled, the apparent vitamin B_{12} content falls to the original value.

Our results suggest to us that crude liver extracts contain a vitamin B_{12}-binding substance, and that the vitamin B_{12} in such extracts is to some extent present in bound form, as has already been postulated by other workers[2,3]; but we believe that the binding is not due to the formation of a complex with a protein as has been suggested, although the possibility that vitamin B_{12} is bound to a peptide of low molecular weight cannot be excluded. We have found, for example, contrary to the observations of other workers[2,3] that the microbiological activity of our extracts is not increased by treatment with cyanide; secondly, that the bound vitamin B_{12} can be dialysed, although slowly, through a 'Cellophane' membrane; and thirdly, that the activity of the extracts is not increased by digestion with papain or trypsin, although pancreatin significantly enhances the activity.

We have also compared the behaviour of vitamin B_{12} in liver extracts with the behaviour of cyanocobalamin in presence of an intrinsic factor concentrate made from hog's stomach by the method of Prusoff *et al.*[5]. The two types of binding appear to be quite different. In the first place, there was no increase in activity as measured by *E. coli* after the solution had been boiled as occurred with liver extracts; and secondly, it has been reported that vitamin B_{12} is not dialysed through a 'Cellophane' membrane in presence of intrinsic factor, in contrast to the behaviour of the bound vitamin B_{12} in liver extracts.

Wijmenga *et al.*[5] have pointed out that no method of isolating cyanocobalamin from liver extracts has been described that does not involve a proteolytic step, and that when Smith[9,10] originally described the isolation of vitamin B_{12} he reported that two pink bands were formed on partition chromatography, one of which appeared to be transformed into the other on treatment with a proteolytic enzyme. Cooley *et al.*[6] have suggested that vitamin B_{12} may be present in liver in the form of a cobalichrome in which the cyano group is replaced by a protein or polypeptide moiety. That this may be partially true is suggested by the fact that we have invariably found less cyanocobalamin in liver extracts by the chemical method of Boxer and Rickards[11] than by microbiological assay, unless the liver extract has first been subjected to cyanide treatment, when the agreement between the two sets of results is fairly good. This confirms Boxer and Rickards's conclusion that "in liver concentrates, cyanocobalamin usually accounts for only a small fraction of total cobalamins".

By contrast, the cyano group is apparently unaffected when intrinsic factor is added to cyanocobalamin, since the results obtained with such a mixture by the method of Boxer and Rickards was in good agreement with the amount of cyanocobalamin present. This supports the observation of Wijmenga *et al.*[12], based on a study of absorption spectra, that the cyano group is still present in the cyanocobalamin-intrinsic factor complex.

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A Riboflavin-producing Bacterium

RIBOFLAVIN synthesis has been demonstrated in a wide variety of micro-organisms by means of growth studies; these have been adequately reviewed from time to time[1]. Among the bacteria, members of various genera have been reported to produce riboflavin in very small amounts[2], and none has been reported which exceeds the capacity of *Cl. acetobutylicum* to produce this vitamin.

During the course of routine work, an air-contaminant was found to produce an intense greenish-yellow pigment in a medium consisting of casein hydrolysate and beef-extract. This pigment appears to be riboflavin; the compound, like the vitamin, has the following properties: (*a*) it exhibits an intense greenish-yellow fluorescence in ultra-violet light; (*b*) the fluorescence is instantaneously discharged on the addition of sodium hydrosulphite; (*c*) it has absorption maxima at 225, 269, 372 and 445 mμ, as measured in the Beckman spectrophotometer.

The air contaminant was found to be a bacterium. It was isolated in the pure state by the usual methods. On microscopic examination it was found to be coccoid, arranged in irregular groups of sizes 0·8–1·0 μ in diameter. It is Gram-negative (observed after 6 hr., 12 hr., 24 hr. and 48 hr.).

The amount of riboflavin produced by this organism was determined by carrying out static and agitated fermentations, using a medium containing casein hydrolysate and beef-extract. Riboflavin production was assayed by the fluorimetric method using a pure riboflavin solution as the standard and found to be of the order of 150–250 μgm./ml., the maximum amount being produced in the reciprocating shaker at 26° C., the yield obtained being 250 μgm./ml. This high yield of riboflavin by a bacterium is very interesting and further studies on the identification of the organism are in progress.

Acknowledgments are made to Dr. S. C. Roy, Dr. S. K. Bose and Mr. P. R. Pal, of the Department of Applied Chemistry, University of Calcutta, for their suggestions during the progress of the work.

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Inhibition of D-Amino-acid Oxidase

PEPTIDES containing D-amino-acids are not attacked by D-amino-acid oxidase[1,2]. We have found that the action of pig kidney D-amino-acid oxidase on DL-leucine was inhibited by DL-leucinamide, DL-leucylglycine, DL-leucylglycylglycine, and by glycyl-DL-leucine. These compounds also inhibited the enzymic oxidation of DL-valine and DL-phenylalanine. Thus, DL-leucinamide when added to DL-leucine, DL-valine or DL-phenylalanine in a molar ratio 5 : 1 inhibited the oxidation by 35–45 per cent. DL-Leucylglycine inhibited the oxidation of DL-leucine by 40–45 per cent, of DL-phenylalanine by 50 per cent, and of DL-valine by 60 per cent. DL-Leucylglycylglycine inhibited the oxidation of DL-phenylalanine by 25 per cent, of DL-leucine by 30 per cent, and of DL-valine by 65 per cent. Glycyl-DL-leucine gave similar results. With glycylglycine no inhibition was obtained.

It was also found that derivatives of DL-valine, DL-leucine and DL-phenylalanine in which one of the amino-hydrogens was substituted by ethyl, hydroxyethyl or cyclohexyl radicals also acted as inhibitors of D-amino-acid oxidase. Thus, DL-N-ethylphenylalanine inhibited the oxidation of DL-phenylalanine by 70 per cent; DL-N-ethylleucine that of DL-leucine by 80 per cent; DL-N-hydroxyethylvaline that of DL-valine by 80 per cent; and DL-N-cyclohexylvaline that of DL-valine by 65 per cent. It was found in some cases that derivatives of one amino-acid inhibited the oxidation of other amino-acids more than that of the parent compound. For example, DL-N-ethylvaline inhibited the oxidation of DL-leucine by 45 per cent, whereas the oxidation of DL-valine was inhibited by 15 per cent only.

The oxidative deaminations of DL-valine, DL-leucine and DL-phenylalanine were also 23–30 per cent inhibited by DL-N-ethylleucylglycine.

The experiments were carried out in a Warburg apparatus at 38° by the usual technique. The *p*H varied between 8·1 and 8·5 (pyrophosphate buffer, 0·06 *M*). Aqueous extracts (usually 1 ml. per reaction mixture) of acetone-dried pig kidney preparations were used[1]. The final concentration of the DL-amino-acids was 0·008 *M* and that of the derivatives 0·04 *M*. The total volume of the reaction mixture was 2·5 ml. Oxygen uptake was measured after 60 min.

None of the amino-acid derivatives mentioned above was attacked by the enzyme to any significant extent.

It is known that the effects of crude enzyme preparations as used by us are the results of the combined activities of D-amino-acid oxidase proper and catalase[2]. The apparent inhibitions described above might therefore represent an increase in the rate of catalase action rather than an inhibition of the oxidase. We therefore tested the action of our enzyme extracts on hydrogen peroxide in separate experiments. The addition of either DL-N-ethylleucine, DL-leucinamide, DL-leucylglycylglycine or glycyl-DL-leucine had no influence on the catalase activity measured. Hence it may be concluded that the effects of the various compounds here described represent a true inhibition of D-amino-acid oxidase.

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Hydrolysis of Methylglucosides

In the course of a study of the mechanisms involved in the solvolytic reactions of glycosides, we have investigated the position of bond fission occurring in the hydrolysis of α- and β-D-methylglucosides. The reactions were carried out in water enriched in oxygen-18, and the methanol produced was isolated by fractional distillation in an efficient column, and then pyrolysed to give carbon monoxide which was examined by a mass spectrometer. We have found that the hydrolysis of α- and β-D-methylglucosides both in 1 *N* acid solution and in the presence of appropriate methylglucosidases proceeds by fission of the hexose–oxygen bond:

$$R|\text{—O—CH}_3 + H_2{}^{18}O \rightarrow R\text{—}^{18}\text{O—H} + \text{HOCH}_3$$

The results of typical experiments are shown in Table 1.

Table 1

Substrate	Catalyst	*p*H	Temp. (° C.)	Time of heating (hr.)	% excess abundance oxygen-18 in solution	% excess abundance oxygen-18 in methanol
α-D-Methylglucoside	1 10 *N* HCl	—	80	65	0·540	0·006
"	Yeast* α-methylglucosidase	6·5	35·7	6	0·800	0·000
β-D-Methylglucoside	1 10 *N* HCl	—	80	65	0·540	0·008
"	Almond emulsin	4·6	35·7	24	0·360	0·029
Blanks Glucose + methyl alcohol	1 10 *N* HCl	—	80	65	0·540	0·001
"	Yeast α-methylglucosidase	6·5	35·7	6	0·800	0·003
"	Almond emulsin	4·5	35·7	30	1·63	0·005

* A solution containing yeast α-methylglucosidase was obtained by killing, after washing and pressing, brewer's bottom yeast with liquid nitrogen and extracting the resultant autolysate with 0·1 *N* ammonia. Extracts prepared by autolysing the cells with toluene or ethyl acetate gave similar results.

Armstrong's[1] classical demonstration that α-D-glucose could be detected in the products of enzymolysis of α-D-methylglucoside, and that similarly β-D-glucose could arise from β-D-methylglucoside, has been used for relating the configurations of the glucosides to those of the parent sugars. The implicit assumption is, as Koshland[2] has pointed out, that no Walden inversion occurs. The present results show that since it is the hexose–oxygen bond which breaks, Armstrong's results cannot safely be used in this way. It can be said, however, that given the configurations on other grounds, Armstrong's work shows that under his conditions substitution at the $C_{(1)}$ atom occurs without a Walden inversion.

It is interesting to note that, both in the acid- and the enzyme-catalysed reactions, the position of bond fission is the same. The acid-catalysed reactions presumably proceed via the reversible formation of the conjugate acids of the glucoside followed either by rate-determining formation of a carbonium ion, with or without ring opening, or alternatively by bimolecular attack on the $C_{(1)}$ atom of the pyranose ring by a water molecule. The latter possibility, which seems unlikely on steric grounds, would, of course, involve a Walden inversion at the $C_{(1)}$ atom; but owing to the rapid mutarotation of the product under acid conditions, this test has no diagnostic value.

We are grateful to Profs. E. D. Hughes and C. K. Ingold for their help and encouragement. We are also indebted to Messrs. Barclay Perkins, Ltd., for a generous gift of brewer's bottom yeast.

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Effect of Oxygen on the Frequency of Chromosome Aberrations produced by 8-Ethoxycaffeine

SOME years ago, Thoday and Read[1,2] discovered that the frequency of chromosome aberrations produced by X-rays in root tips of *Vicia faba* is dependent on oxygen tension during irradiation, while that produced by α-rays is not. Since then this discovery has been confirmed by several investigations, and a similar effect of oxygen was found also, when other tissues and organisms were used as experimental material (for references, see Giles[3] or Gray[4]). In the case of X-rays, therefore, it seems to be a general rule that much less chromosome damage of the physiological, as well as of the structural, type is obtained when the irradiations are performed in the absence than in the presence of oxygen.

At present, the generally accepted explanation of the oxygen effect is "that oxygen makes available certain radicals produced from the decomposition of water which would otherwise be lost"[4]. Thus the effect of oxygen indicates that chemical steps intervene between ionization and chromosome damage. Since hydrogen peroxide is produced in water by irradiation only if oxygen is present in the case of X-rays, but independently of oxygen tension in the case of α-rays, Thoday and Read[2] assumed "that hydrogen peroxide had some influence on the process involved in chromosome structural damage". Facts in favour of the peroxide hypothesis have been presented also by Fabergé[5] and Giles[3]. Current opinion, however, favours the view that, in the case of X-rays at least, the major part in chromosome damage is played by the hydroperoxyl radical (HO_2).

With this radiochemical explanation of the oxygen effect in mind, it would not be expected that oxygen could have any influence on the frequency of chromosome aberrations produced by radiomimetic chemicals.

In connexion with a comparative study of the effect of X-rays and the purine derivative 8-ethoxycaffeine on root tip chromosomes of *Allium cepa*, the influence of oxygen tension was also tested. The radiomimetic effect of this and other purine derivatives as well as the methods used have been described previously[6,7].

The onions were placed on tubes with their roots immersed in saturated aqueous solutions of 8-ethoxycaffeine (10^{-2} *M*) through which nitrogen or oxygen was bubbled. In order to minimize the back diffusion of air, the bulbs as well as the upper parts of the tubes were enclosed in plastic bags with small openings for the egress of the gases. Before treatment, the 8-ethoxycaffeine solutions were saturated with oxygen or nitrogen. In the first experiment performed, four onions were treated with 8-ethoxycaffeine for 1 hr., two in nitrogen and two in oxygen, while two were used as controls. Before the 8-ethoxycaffeine treatments, the roots were pretreated in water for 30 min. with the gases in question, and after the treatment the onions were kept in oxygen or nitrogen for 15 min. before they were transferred for recovery to tubes containing tap-water. The two controls were treated in tap-water with oxygen and nitrogen respectively for 105 min. The temperature during treatment and recovery was 18° C. Fixations in alcohol–acetic acid (3 : 1) were made 3/4, 4, 8 and 24 hr. after the 8-ethoxycaffeine treatments. Slides were prepared as Feulgen squashes.

The examinations of the slides revealed that 8-ethoxycaffeine is much more effective in producing chromosome aberrations in oxygen than in nitrogen. As in the case of X-rays[2,3], both the stickiness effect and the frequency of structural chromosome changes were influenced by the oxygen concentration during treatment. The stickiness effect in oxygen was very strong and could be observed as long as four hours after treatment. After an ordinary treatment (in air), the stickiness effect usually disappears within two hours. In nitrogen only a very slight stickiness effect was produced. Fig. 1 shows how the structural chromosome changes produced by 8-ethoxycaffeine are influenced by the oxygen concentration. The effect is scored as abnormal anaphases, that is, anaphases with fragments and bridges. In each case the effect is estimated on the bases of at least 50, usually 100, analysed anaphases. Although the variation between the two bulbs treated in oxygen is very great, particularly in the 4- and 8-hr. fixations, there can be no doubt about the significance of the difference between the effects obtained in oxygen on one hand and those obtained in nitrogen on the other. Eight hours after the treatment, the frequency of chromosome aberrations produced by 8-ethoxycaffeine is at a maximum. At the same time the mean effect in oxygen is more than six times greater than that in nitrogen. The only effect found in the controls (oxygen or nitrogen alone) was a somewhat higher frequency of mitosis in the oxygen control.

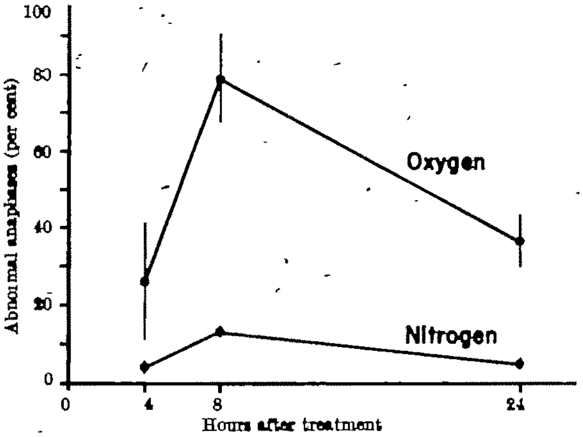

Fig. 1. Effect of 8-ethoxycaffeine in oxygen (upper curve) and in nitrogen (lower curve)

Because of the unexpected results obtained, the experiment was repeated. The experimental conditions were, however, altered in some respects. Thus the pretreatment with oxygen or nitrogen was reduced to 15 min., the 8-ethoxycaffeine treatment was reduced to 45 min., and the temperature during treatment and recovery was changed to 20° C. The results of this experiment were essentially the same as before: the effect produced by 8-ethoxycaffeine in oxygen was much greater than that in nitrogen. Thus the results indicate that the oxygen concentration influences the effect of 8-ethoxycaffeine on chromosomes similarly to the way in which it influences that of X-rays; the similarity seems, however, to be restricted to the production of chromosome aberrations. While the inhibition of mitosis by X-rays, according to Thoday and Read[2], is increased by oxygen, no such increase was observed in the case of 8-ethoxycaffeine.

Finally, it may be mentioned that, besides oxygen tension, the temperature during treatment also seems to influence the effect of X-rays and 8-ethoxycaffeine in a very similar way. Further, the cell is most sensitive to chromosome breakage by 8-ethoxycaffeine in the second half of interphase, as was found for X-rays by Revell[9], while the stage of greatest sensitivity to di (2 : 3-epoxypropyl) ether, and to other radiomimetic chemicals so far studied, lies in the first half of interphase[9,10].

A detailed account of these investigations will be published elsewhere.

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A Second Virus Disease of the Leatherjacket, *Tipula paludosa*

IN an earlier communication[1], a 'polyhedrosis' of apparently cancerous blood cells of *Tipula paludosa* larvæ was described. The cytoplasmic disease described here is primarily of the larval fat body. No multiplication of the fat cells is involved, and no inclusion bodies are formed as the result of the disease. A few animals with both diseases have been observed in addition to the many in which they occurred singly.

The intact infected animal may be recognized in strong sunlight, when the fat body appears purple through the wetted skin. In the course of the disease the lobules of the fat body distend enormously and the tissue becomes nodular. The nodules are orange in transmitted light and iridescent, purple, blue, green, etc., in reflected light. The animals, when moribund, become purplish-white in colour with the disruption of diseased fat cells and the liberation of their contents into the blood. Death occurs two to four weeks or more after the disease becomes detectable. As many as 15 per cent of a low-density natural population of *Tipula* larvæ were found to have the disease, which appears to be less virulent than the polyhedroses of lepidopterous larvæ.

The cytology of infected cells has been examined in whole mounts of fat tissue, both unfixed and fixed in osmic acid, alcohol and Carnoy's fluid, and in sections fixed in the last. Early in the course of the disease the cells lose their fat globules. While the infected cells are still only slightly enlarged, highly refractile cytoplasmic networks form which usually completely surround their nuclei. At this stage one or several small spots, orange in transmitted light, become visible in the cytoplasm. The fat body then becomes nodular owing to the enormous enlargement of the infected cells, the cytoplasms of which outside the networks, which are now also enlarged, become completely filled with this material, orange in transmitted light and iridescent in reflected light (Fig. 1). The iridescence is readily visible even in 4-μ sections of fixed tissue.

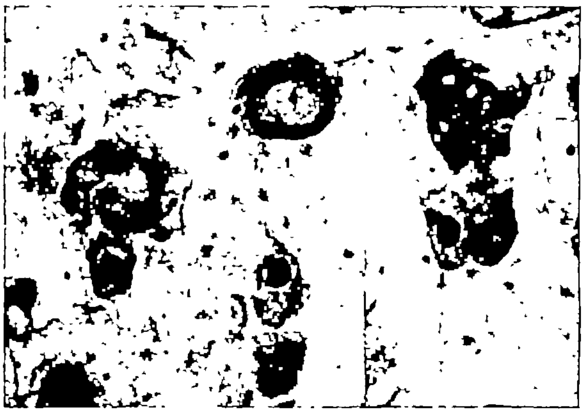

Fig. 1. Section of fat body cells of diseased larvæ of *Tipula paludosa* showing 'normal' nuclei, enlarged cytoplasm, and the peculiar cytoplasmic nets × 900

The cytoplasmic nets of the infected cells are heavily loaded with ribose nucleic acid, and after acid hydrolysis lose their capacity to stain intensely with Giemsa fluid. They are Feulgen-negative. The cytoplasm of these cells stains only a pale blue wash with Giemsa; but after acid hydrolysis it stains an intense purple-red colour. It is intensely Feulgen-positive throughout. Sections, 4 μ or more in thickness, of Carnoy-fixed nodules swell markedly in glacial formic acid and in 1 *N* sodium hydroxide, and shrink again in water, properties which are shared by the untreated Feulgen-positive 'polyhedra' described previously[1]. The homogeneous unfixed cytoplasm swells in water and dilute alkalis and proceeds to break down to minute granules at the limits of visibility. By high-speed differential centrifugation of infected fat bodies disrupted and washed in water or 0·14 *M* sodium chloride, pellets of particles 100 mμ diameter may be obtained. These pellets are orange in transmitted light and iridescent in reflected light. After hydrolysis for 1 hr. in 1 *N* hydrochloric acid at 100° C., this material has a typical nucleic acid absorption spectrum with its peak at about 265 A.

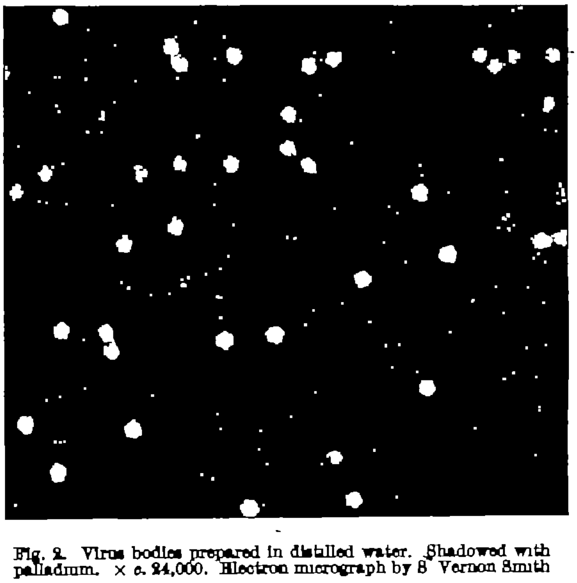

Fig. 2. Virus bodies prepared in distilled water. Shadowed with palladium. × *c.* 24,000. Electron micrograph by S. Vernon Smith

The evidence indicates that the particles contain deoxyribose nucleic acid. It is concluded that the 100-mμ particles (Fig. 2), with which the iridescence of the cytoplasm is associated, are the virus. The virus bodies are not simple spheres, but are somewhat irregular in shape and composite, many smaller particles being embedded in each. They thus resemble the viruses of the cytoplasmic polyhedroses of the midgut of lepidopterous larvæ[1,2], rather than the rod-shaped viruses of the nuclear polyhedroses.

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Factors affecting the Larval Spot Colours of the Emperor Moth, *Saturnia pavonia* L.

FROM time to time the variation in the colour of the spots of the larvæ of *Saturnia pavonia* has attracted attention. These spot colours do not develop until the fourth and fifth instars. The spots of any given larva are similarly coloured; but the colour itself may vary within the range of pale lemon-yellow through orange to pink. From the selective breeding experiments of Poulton[1], it was apparent that the colour differences between larvæ could not be attributed to a simple genetical basis.

I have observed that the spot colour of the individual larva changes progressively throughout the duration of the instar, being pale lemon-yellow immediately after the moult and generally orange or pink by the time of the next moult or ensuing pupation. This progressive colour change has been found not to be simply dependent on the larval age within the instar but to be primarily a response to the intensity of the light to which the larva is exposed throughout the instar, the spots of larvæ which are kept in the dark remaining yellow. With larvæ exposed to light the rate of the colour change is most rapid in the few hours immediately following the moult. Larvæ which have been kept in the dark for the first three days after the moult show little colour change when exposed to normal daylight for the remainder of the instar. The final spot colour of the fourth instar does not appear to influence the spot colour of the fifth instar.

Experiments have been carried out and are continuing on the relationship between the rate of response and the light intensity in order to determine the nature of the response and to ascertain if it depends on a trigger-type reaction. The response appears to be locally determined and is not dependent on light entering the ocelli. The actual colour change itself involves two major components, the change from yellow to orange occurring in the underlying epidermal cells while changes from yellow through orange to pink occur in the overlying cuticle.

Fuller details will be published later.

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Identity of *Gammarus tigrinus* Sexton 1939

Gammarus tigrinus Sexton[1] was described from saline waters in the Avon area, and has since been recorded from fresh and saline waters in several places in England and Ireland[2,3]. A map showing the known localities will appear in volume 12 of the *Proceedings* of the International Association of Theoretical and Applied Limnology.

Because it is unknown from other parts of Europe, and is closely related to the North American species *G. annulatus* Smith, Spooner[3] has suggested that it is probably a recent introduction from the New World. At the suggestion of Dr. S. G. Segerstråle, of Helsinki, I asked Dr. E. L. Bousfield, of the National Museum of Canada, if he could assist me in identifying the species. He informed me that he had long been of the opinion that it was the common North American freshwater and oligohalme brackish species *G. fasciatus* Say, which it resembles in being distinctly striped when alive—a character not shown by the brackish-water species *G. annulatus*. Comparison between specimens of *G. fasciatus* kindly sent to me by Dr. Bousfield and British specimens of *G. tigrinus* has fully confirmed this belief. The name *G. tigrinus* must therefore be superseded by *G. fasciatus*.

This species occurs widely in eastern North America, and is common in weedy places (Clemens[4]). In Great Britain it is also found in weedy places on muddy substrata, a type of habitat not favoured by any of the native species, although often colonized here by *Crangonyx gracilis* Smith, which is also of North American origin. In view of this, and of the importance of amphipods as food for fishes, *G. fasciatus* may well prove to be a useful animal for introduction into fish-ponds. At Wyken Slough, near Coventry, a muddy weedy lake, it would appear to be the main food organism for a large and varied population of coarse fishes.

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The Maximum of the Planck Energy Spectrum

THE spectral distribution of energy radiated from a black body is well known to exhibit a maximum. For example, the thermal radiation from a 6,000-deg. black body (to which the sun approximates) is chiefly concentrated towards the visible wave-lengths and falls off in the infra-red and ultra-violet.

It is natural to inquire where this maximum falls, and Wien's law is usually called on to supply the answer. This law is often quoted in the form:

$$\lambda_m T = 0 \cdot 2897 \text{ cm. deg.},$$

where λ_m is the wave-length where the maximum falls and T is the temperature of the black body. (Numerical values are based on the following values of fundamental constants: $h = 6 \cdot 623 \times 10^{-27}$, $c = 2 \cdot 99772 \times 10^{10}$, $k = 1 \cdot 3803 \times 10^{-16}$.) Thus, at 6,000 deg. the formula gives $\lambda_m = 4{,}829$ angstroms, which is towards the middle of the visible spectrum.

The derivation of the formula reminds us that the spectral concentration of energy is measured by the amount lying between wave-lengths λ and λ + dλ. But one might adopt the equally valid interval between frequencies f and $f + df$, which is in fact more appropriate for certain kinds of apparatus. Although it is not well known that this would make a difference, the formula changes to

$$\lambda_m T = 0\cdot5098 \text{ cm. deg.},$$

the constant being increased by a factor 1·76. This substantial change moves the maximum for a 6,000-deg. body to 8,497 angstroms.

This is an infra-red wave-length not visible to the human eye. As the calculation is quite as valid as the one familiar in text-books, it runs counter to the widespread impression that the energy spectrum of sunlight has its maximum in the spectral band visible to the human eye.

This is one point of interest. If we return to the inquiry about the location of the maximum of the black-body energy spectrum, it must be concluded that Wien's law does not give a unique answer. The line of reasoning on which it is based leads to two different answers, according as one measures the radiation per unit of frequency or per unit of wave-length. This suggests that Planck's formula be re-examined for any further maximal properties, especially any which are invariant with change from a wave-length to a frequency basis.

Let $\Lambda = \log \lambda$ and consider the energy $E_\Lambda d\Lambda$ lying between Λ and $\Lambda + d\Lambda$. Let its maximum fall at $\Lambda_m = \log \lambda_0$. Consider also the energy between F and $F + dF$ where $F = \log f$. In this case the maximum clearly falls at the same wave-length λ_0 as in the first case. The reason is that dF and $d\Lambda$ represent fractional increments of f and λ, and thus maintain their ratio constant throughout the spectrum. Previously, when spectral intervals were measured in units of frequency or wave-length, the relative sizes of the two measures varied with frequency so that maximum energy per unit frequency interval was not a maximum per unit wave-length interval, and vice versa.

Now if one considers any function L, more general than *log*, and regards it in turn as a function of λ and then of f, the energy lying between L and $L + dL$ will in general not exhibit a maximum at the same wave-length in the two cases. But if it does, the wave-length is found to be λ_0 as before. In order that L should lead to a single maximum, it is necessary that $dL/d\Lambda = 0$ when $\Lambda = \Lambda_m$.

The maximum at λ_0 is thus unique in being free from the objection of altering when a change is made from a wave-length to a frequency basis. It falls where the energy per octave (or similar logarithmic interval) is a maximum. It may be located by differentiating Planck's formula with respect to the logarithm of either the frequency or the wave-length. A Wien-type law continues to hold for the maximum so defined, but in the form

$$\lambda_m T = 0\cdot3669 \text{ cm. deg.}$$

(This constant comes from the root of the equation $\exp. (-x) + \frac{1}{4}x - 1 = 0$, where $x = hc/k\lambda T$.)

The location of this natural maximum of the 6,000-deg. spectrum proves to be 6,115 angstroms, at the red end of the visible spectrum.

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Sydney. June 8.

Measurements of Lifetimes of Excited States of Atoms by the Method of Delayed Coincidences

WE have adapted the method of delayed coincidences[1] to the investigation of lifetimes of excited states of atomic helium. Helium gas at a pressure of about 0·01 mm. mercury was excited by a beam of 40 eV. electrons, and the photons emitted in the subsequent de-excitation detected by means of an *E.M.I. VX* 5031 photo-multiplier, the wave-lengths corresponding to the various transitions being selected by means of Barr and Stroud interference filters. The intensity of the electron beam was modulated by means of a grid which was maintained at a potential sufficiently negative to cut off the beam completely except during the application of a positive voltage pulse of duration 2×10^{-8} sec. and repetition rate 10 kc./s. The helium atoms were therefore excited by short bursts of electrons. The voltage pulses from the photomultiplier, corresponding to the ejection of single electrons from its cathode, were amplified and applied to one side of a coincidence unit of resolving time 2×10^{-8} sec. The pulse used for modulating the electron beam was also applied to the other side of the coincidence unit through a variable length of 'Uniradio 57' cable. A coincidence was therefore registered only if the delay in this cable was equal to the interval between the electron burst and the subsequent emission of a photon, and for delays longer than the overall resolving time of the apparatus the variation of coincidence-rate with delay should show an exponential decrease, the decay constant being the reciprocal of the mean life of the excited state involved. We are satisfied that for the transitions referred to below, the conditions of our experiment are such that the effects on the apparent lifetime of recombination of ions and of cascade transitions from higher states are negligible.

It is desirable to test the performance of an apparatus of this sort by examining a transition the lifetime of which is believed to be much shorter than the resolving time of the apparatus, so giving what is usually called a 'prompt' curve. We have endeavoured to use for this purpose the 5016 A. line emitted in the transition $3\,^1P \rightarrow 2\,^1S$. The $3\,^1P$ level is expected to have a very short lifetime because it can also decay to the ground state with the emission of a quantum of wave-length 537 A., and this latter transition should be very fast because of the λ^{-3} factor in the theoretical expression for the transition probability. Theoretical calculations indicate that the mean life of the $3\,^1P$ level is about 2×10^{-9} sec. Results obtained with the 5016 A. line are represented by the two lower curves in Fig. 1, which shows the coincidence-rate plotted logarithmically as a function of the delay for pressures of 0·005 and 0·03 mm. mercury. For delays greater than $1\cdot5 \times 10^{-7}$ sec. the curves are linear, showing that the decay is exponential. The fact that the curves do not rise until the delay is 9×10^{-8} sec. is due to the transit time of the electrons in the photomultiplier.

The curve obtained at 0·005 mm. is appreciably narrower than that at 0·03 mm.; but even the former is significantly wider than is to be expected for a truly prompt transition, indicating that the apparent lifetime of the transition is greater than 10^{-8} sec. We believe that the reason for this increase in the apparent lifetime of the $3\,^1P$ level and its dependence on pressure lies in the phenomenon of imprisonment

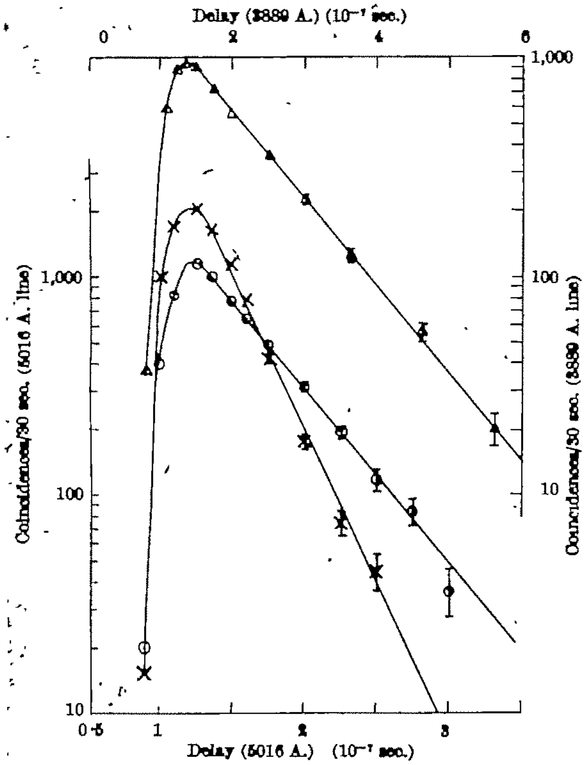

Fig. 1. ○—○—, 5016 A., p = 0·03 mm. mercury; ×—×—, 5016 A., p = 0·005 mm. mercury; △—△—, 3889 A., p = 0·03 mm. mercury

of resonance radiation[2]. Because the 537 A. line is a resonance line, the time which atoms spend in the $3\,^1P$ level is considerably lengthened, and this is accompanied by an increase in the apparent lifetime of the $3\,^1P \rightarrow 2\,^1S$ transition. The linear portions of the curves correspond to exponential decays with mean lives of $2{\cdot}9 \times 10^{-8}$ and $5{\cdot}3 \times 10^{-8}$ sec., which agree well with the values calculated from Holstein's theory[3] of the imprisonment process for pressures of 0·005 and 0·03 mm. mercury respectively when allowance is made for the effect of the $3\,^1P \rightarrow 2\,^1S$ transition. We were unable to work at pressures lower than 0·005 mm. because, as was pointed out by Skinner and Lees[4], one consequence of the imprisonment process is that the intensity of the 5016 A. line is not proportional to pressure. At pressures low enough to make the apparent lifetime approach the natural lifetime, the intensity is so low as to be unusable with our present apparatus. For this reason we have been unable to obtain a truly prompt curve, but we are considering alternative ways of doing so.

As a transition the lifetime of which is expected to be long we have chosen the 3889 A. line emitted in the transition $3\,^3P \rightarrow 2\,^3S$. This would be expected to have a longer lifetime than the corresponding singlet transition because the $3\,^3P$ levels cannot decay to the ground-state. Results obtained with the 3889 A. line are represented by the top curve in Fig. 1. The shape of this curve was found to be independent of pressure, which is to be expected since triplet lines cannot be imprisoned. From the slope of the linear portion of this curve we estimate the mean life of the $3\,^3P$ triplet to be $(1{\cdot}08 \pm 0{\cdot}07) \times 10^{-7}$ sec.

Measurements of this sort are of interest because for light atoms lifetimes of states can be computed quantum-mechanically with moderate accuracy, so that a check on radiation theory is possible. Calculations of transition probabilities for helium have been made by Hylleraas[5], Goldberg[6] and Bates and Damgaard[7]. Taking the total decay constant of the $3\,^3P$ triplet to be the sum of the transition probabilities for the $3\,^3P \rightarrow 2\,^3S$ and $3\,^3P \rightarrow 3\,^3S$ transitions, we obtain the following values for the mean life τ:

	Hylleraas	Goldberg	Bates and Damgaard
$\tau \times 10^7$ sec.	1·18	0·83	0·97

Too much weight should not be attached to the results of Goldberg because he uses rather inexact wave-functions. Our experimental value is almost exactly the mean of the other two values; but this result is perhaps somewhat fortuitous in view of the uncertain accuracy of the theoretical calculations.

A full account of this work will be published elsewhere.

(the late) S. Heron
R. W. P. McWhirter
E. H. Rhoderick
Department of Natural Philosophy,
The University, Glasgow.

June 5.

[1] See, for example, Bell, R. E., Graham, R. L., and Petch, H. E., *Can. J. Phys.*, 30, 35 (1952).
[2] Mitchell, A. C. G., and Zemansky, M. W., "Resonance Radiation and Excited Atoms", 106 (Cambridge, 1934).
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Random Fragmentation

The problem of random fragmentation of a line into a finite number of N parts has received considerable attention, partly because of its application in assessing the randomness of radioactive disintegrations and cosmic ray events. For a line of length l the average number of fragments equal to or greater than x is[1]:

$$N(x) = N(1 - x/l)^{N-1}. \qquad (1)$$

This equation is readily applied to discuss[2] an idealized case of random fragmentation of area. Consider a rectangle of sides l_1 and l_2 (area $\Sigma = l_1 l_2$) and imagine it to be divided into subrectangles by drawing at random N_1 and N_2 lines respectively parallel to the two sides of the rectangle. If $N(S)$ be the average number of elements of area equal to or exceeding S, we have, using equation (1):

$$N(S) = \frac{N_1 N_2 (N_1 - 1)\,(N_2 - 1)}{l_1 l_2} \iint\limits_{xy > S} \left(1 - \frac{x}{l_1}\right)^{N_1 - 2} \left(1 - \frac{y}{l_2}\right)^{N_2 - 2} dx\,dy$$

$$\sim -\,2N_0 \left(\frac{S}{S_0}\right)^{1/2} K_1 \left[2\left(\frac{S}{S_0}\right)^{1/2}\right], \qquad (2)$$

where $K_1(z)$ is the usual Bessel function of imaginary argument, $N_0 = N_1 N_2$ is the total number of elements and S_0 the average area of an element,

$$S_0 = \Sigma / N_0.$$

For $S \gg S_0$ we obtain the approximate relation:

$$N(S) \sim \pi^{1/2} N_0 \left(\frac{S}{S_0}\right)^{1/4} \exp\left\{-\,2\,(S/S_0)^{1/2}\right\}. \qquad (3)$$

As already remarked, equation (2) has been obtained for an idealized case. It may not be unreasonable to expect that it would describe the essential features of the observed fragmentation of plates, for example. We have found it to be the case for the fragmentation of glass plates; details will be published elsewhere.

It is an obvious step to extend the foregoing treatment to the case of random fragmentation of volume. Taking as before an idealized case of the random subdivision of a rectangular parallelepiped of volume Ω, we obtain, using equation (1), for the number of elements with volume equal to or greater than V,

$$N(V) \sim \frac{2\pi}{3^{1/2}} N_0 \left(\frac{V}{V_0}\right)^{1/3} \exp\left\{-3\,(V/V_0)^{1/3}\right\}, \qquad (4)$$

where N_0 is the total number of fragments and V_0 the average volume of a fragment ($V_0 = \Omega/N_0$): this means that log $N(V)$ and $V^{1/3}$ follow a nearly linear relation. If V_1 denotes the volume of the largest element, we have from equation (4), by putting $N(V) = 1$:

$$\left(\frac{V_1}{V_0}\right)^{1/3} = \frac{1}{3}\log\left(\frac{2\pi N_0}{3^{1/2}}\right) + \frac{1}{9}\log\,(V_1/V_0). \qquad (5)$$

It is of interest to consider the application of (4) to the cosmological problem of the mass-distribution of stars in the galaxy. A similar consideration should apply, and possibly even more plausibly, to the problem of the mass-distribution of galaxies. Fig. 1, in which the values given are based on the data (pp. 334, 367) taken from Baker, R. H., "Astronomy" (D. Van Nostrand Co., New York, 1950), is a plot of log $N(M)$ against $M^{1/3}$ (M is in units of the solar mass) where $N(M)$ is the (relative) number of stars of mass equal to or exceeding M. What is directly known from observation is the distribution of stars according to their intrinsic luminosity—the luminosity function. The use of the observed mass–luminosity relation gives the distribution of stars according to mass, that is, $N(M)$ as a function of M. It will be observed that the points (log $N(M)$, $M^{1/3}$) lie almost on a straight line. This makes it likely, as is envisaged in some current cosmological theories, that stars have been formed as a result of some sort of a random fragmentation of dense pre-stellar matter (at an epoch about 3 × 10^9 years ago). The process can be conceived as equivalent to fragmentation of volume, because at the epoch of fragmentation the material could be regarded as of almost uniform density (of the order of nuclear density of matter). It is indeed remarkable that the distribution law (4) accords as well as it does with the observed distribution of stars in the Milky Way. A more detailed account of this investigation will appear in the *Proceedings of the National Institute of Sciences, India*.

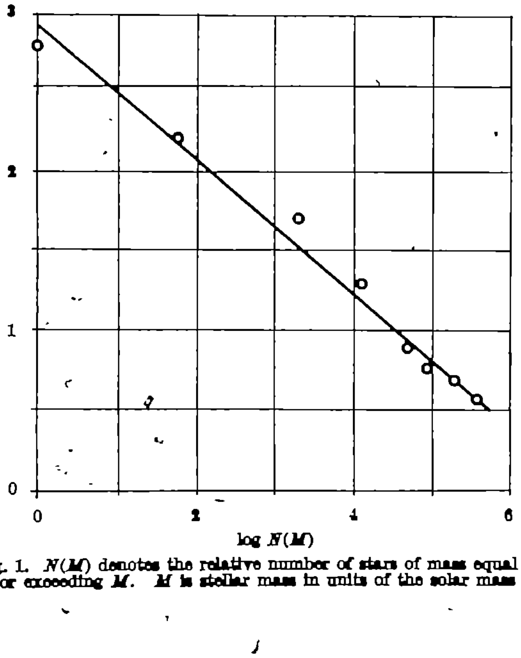

Fig. 1. $N(M)$ denotes the relative number of stars of mass equal to or exceeding M. M is stellar mass in units of the solar mass

F. C. AULUCK
D. S. KOTHARI

University of Delhi.
May 27.

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[1] Feller, W., *Phys. Rev.*, 57, 906 (1940).

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Thermoelectric Power and the Bauschinger Effect

It has been proposed[1,2] that the Bauschinger effect which occurs in face-centred cubic metals after a plastic strain exceeding 1 per cent might be attributed to the rearrangement of dislocations at the beginning of the reversal of strain. If we rather crudely reckon that changes of thermoelectric power and electric resistance are measures of the total disorder in a lattice, then these should remain constant during the Bauschinger strain, though increasing during previous and subsequent plastic strain, because during the Bauschinger strain the total disorder in the lattice is not increasing, but merely being re-arranged.

Preliminary measurements of the thermoelectric power of copper now support this view. We have measured the thermoelectric power of 99·9 per cent copper as a function of plastic shear strain, using torsion and reverse torsion of a thin-walled tube. The change of thermoelectric power during a unidirectional plastic shear strain of 1 per cent is very small, and the change during the Bauschinger strain is even smaller, so that even when all precautions are taken the overall accuracy is not as high as might be desired. In our experiments the ends of the specimen are maintained at 10° and 30° C. respectively, and the thermal e.m.f. is measured to an accuracy of 5 × 10^{-11} V./deg. C. by a null method using a Paschen galvanometer as detector.

Six tests were carried out. Each specimen was first deformed by the application of a stress $+\sigma_0$, then unloaded, and a negative stress applied in suitable increments until it exceeded $-\sigma_0$. In these tests the stress σ_0 had values between 550 kgm./cm.^{2} and 1,100 kgm./cm.^{2}, corresponding to strains between 10 and 30 per cent. In each test the mean rate of increase of thermoelectric power with plastic shear strain during the Bauschinger strain (that is, between $+\sigma_0$ and $-\sigma_0$) was compared with the mean rate of increase after $-\sigma_0$ was passed, and their ratio determined. This ratio is found to lie within the range 29 ± 21 per cent. We therefore conclude that during the Bauschinger strain the increase of disorder in the lattice is decidedly smaller than during ordinary unidirectional plastic strain.

It may be argued that though the Bauschinger strain is attributed to the rearrangement of dislocations, changes in thermoelectric power are more probably due to changes in the number of vacancies and interstitial atoms present, as suggested by Seitz[3] for the case of electric resistance. This difference is of no significance if we assume that vacancies and interstitial atoms are formed as a result of the intersection of screw dislocations; during the Bauschinger strain the dislocations are regarded as each moving a distance equal to their mean distance apart[1], so that to a first approximation no dislocations cross each other, and relatively few vacancies or interstitial atoms are generated.

R. L. WOOLLEY

Natural Philosophy Department,
St. Andrews University.
June 2.

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[1] Woolley, R. L., *Phil. Mag.*, 44 597 (1953).

[2] Polakowski, N. H., *Nature*, 168, 838 (1951).

[3] Seitz, F., "Advances in Physics", 1, 43 (1952).

Simplified Particle-size Calculations

PARTICLE-SIZE analysis by microscopical methods provides large samples of measurements which then need numerical analysis to give estimates of average diameters, specific surface, etc. When, as is often the case, particle sizes are log-normally distributed[1–4], tedious summation of powers of the sizes can be avoided if the cumulative distribution is plotted on log-probability paper[1,4]. From this, estimates of the mean, $\bar{y}$, and standard deviation, σ, of the distribution of log sizes can be read off; from these two values can be calculated any of the many kinds of average which are used in this work. If D be such an average, the general equation for this purpose is:

$$\log D = \bar{y} + c\,\sigma^2, \tag{1}$$

where the value of c depends only on the kind of average, D, that is being calculated[1,4].

Even this calculation can be avoided, and a simple completely graphical method substituted with little loss of precision.

If we regard the (linear) abscissa scale (see Fig. 1) as the normal deviate z with origin at the 50 per cent point, the line drawn on probability paper has the equation:

$$Y = \bar{y} + \sigma z. \tag{2}$$

If one unit of y (between particle sizes of 1 and 10, or 10 and 100) occupies a distance A on the paper and one unit of z a distance B (the distance between the 0·1 per cent and 99·9 per cent abscissæ is $6{\cdot}2B$), equation (2) becomes:

$$Y = \bar{Y} + \frac{A}{B}\,\sigma Z, \tag{3}$$

where Y, Z are co-ordinates in units of distance and $\bar{Y}$ is then the ordinate corresponding to $\bar{y}$.

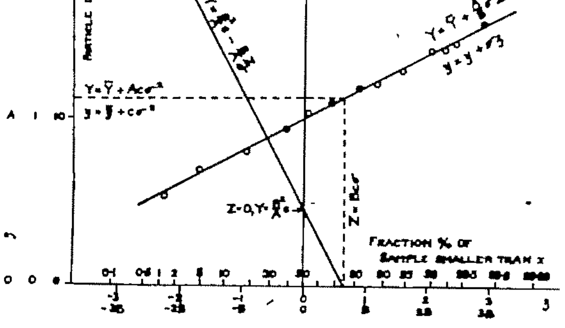

Fig. 1. Graphical method using logarithmic probability paper

The line through the point $Z = 0$, $Y = \frac{B^2}{A}c$ ($z = 0$, $y = \frac{B^2}{A^2}c$) normal to (3) will be:

$$Y = \frac{B^2}{A}c - \frac{B}{A}\frac{Z}{\sigma}, \tag{4}$$

and will meet the Z-axis at $Z = Bc\,\sigma$.

The ordinate of (3) corresponding to this value of Z, namely,

$$Y = \bar{Y} + Ac\,\sigma^2,$$

is equivalent to: $y = \bar{y} + c\,\sigma^2 = \log D$, and gives the average that is sought.

The scale-factors A, B are constant for any one kind of probability paper, and c depends only on the average diameter being estimated. Hence the point $Z = 0$, $Y = \frac{B^2}{A}c$ is independent of the sample of sizes and can be determined beforehand for each average diameter.

There are occasions also when very approximate results will suffice and are needed rapidly; the number of particles measured and the calculation can then both be greatly reduced. It is necessary only to pick out and measure the largest particle and the smallest particle of the sample and to make a rough estimate of the total number, n, of particles that could have been measured.

If y_1, y_n are the logarithms of the largest and smallest particle sizes, their mid-range $\frac{1}{2}(y_1 + y_n)$ provides an estimate of the mean $\bar{y}$, and from the range the standard deviation σ can be estimated as $\frac{1}{w}(y_1 - y_n)$, where w is roughly the expected range in samples of n. The value of w depends on n and can be chosen from the following table, which is based on Tippett's table[5] and is sufficient for this approximate method.

n	w
20–35	4
35–70	4½
70–140	5
140–300	5½
300–700	6
700–1,700	6½
1,700–3,000	7

It must be borne in mind not only that this method is approximate and not efficient but that, as in all cases where range and mid-range are used as estimators, the results can be affected, without it being known, either by truncation of the sample or by the presence in the sample of exceptionally large or small particles which do not belong to the population of particles under consideration. Thus it is recommended that this method is best used as a rough check on calculations by some longer method, or for obtaining quickly approximate information from a sample of a material about which something is already known, so that an unexpectedly large or small estimate of σ can be recognized and regarded with suspicion.

C. H. LEIGH-DUGMORE

Research Centre,
Dunlop Rubber Co., Ltd.,
Birmingham 24. April 22.

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[1] Hatch, T., and Choate, S. P., *J. Franklin Inst.*, 207, 369 (1929).

[2] Dalla Valle, J. M., "Micromeritics" (Pitman Pub. Corp., New York, 1943).

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FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, September 21—Friday, September 24

Institution of Naval Architects (at the Electric Hall, Torquay)—Annual Meeting.

Wednesday, September 22—Friday, September 24

National Smoke Abatement Society (at Scarborough).—Twenty-first Annual Conference.

Thursday, September 23

Oil and Colour Chemists' Association (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 10.30 a.m.—Symposium on "Rheology and Settlement of Pigmented Systems".

Friday, September 24

Biochemical Society (in the Department of Biochemistry, The University, Sheffield 10), at 11 a.m.—Scientific Papers

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Geoffrey Taylor, F.R.S.: "Diffusion and Mass Transport in Tubes" (38th Guthrie Lecture).*

Friday, September 24—Saturday, September 25

Society of Leather Trades' Chemists (in the large Chemistry Lecture Theatre, The University, Leeds)—Annual Conference.

Friday, September 24

At 2 p.m.—Prof. J. T. Randall, F.R.S.: "Observations on the Collagen System" (Sixth Procter Memorial Lecture).

Friday, September 24—Monday, September 27

Aslib (at Church House, Westminster, London, S.W.1)—Annual Conference

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemists (with honours degree in chemistry or chemical engineering or A.R.I.C. or A.M.I.Chem.E.), to carry out work on the supply of potable water, disposal of radioactive solid and liquid waste, control of pickling and plating shops and other industrial chemical processes—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berkshire, quoting 2/103/140 (September 24).

Demonstrator in Chemistry and Biology—The Registrar, The Technical College, Sunderland, Co. Durham (September 25).

Physicist (with good honours degree in physics and at least two years research experience, and preferably with some practical acquaintance with electronics) for work in the field of psycho- and physioacoustics—The Secretary, Institute of Laryngology and Otology, 330–332 Gray's Inn Road, London, W.C.1 (September 25).

Experimental Officer (with university degree in an approved scientific subject, or equivalent qualifications, and preferably with qualifications or experience in library and information work and a knowledge of foreign languages) in the Scientific Development and Forensic Science Department, Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (September 27).

Scientific Officer (with an honours degree in chemistry and postgraduate experience in agricultural chemistry, or an honours degree in agricultural chemistry) in the Chemical Research Division, Ministry of Agriculture, for research work and possibly for teaching duties in the Faculty of Agriculture, Queen's University, Belfast—The Secretary, Civil Service Commission, Stormont, Belfast (September 27).

Principal Assistant Engineer (with honours degree or Corporate Membership of the I.Mech.E., or I.E.E., and with sound knowledge of power station design) in the Station Development Sub-Branch, for work in connexion with the siting, planning and negotiation of facilities and consents for new and extended power stations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting T/518 (September 28)

Senior Lecturer (with high academic and research qualifications, and ability to teach to special (honours) degree standard) in Organic Chemistry—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (September 28).

Advisory Officer (with high scientific qualifications and considerable postgraduate experience in animal husbandry) in Animal Husbandry, to assist the advisory services with animal husbandry problems and to carry out investigational work arising therefrom—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 30).

Lecturer or Assistant Lecturer (with honours degree in physical oceanography, mathematics or physics, and prepared to spend several weeks each year at sea) in the Department of Oceanography—The Registrar, The University, Liverpool (September 30).

Research Assistant (graduate in science (biochemistry)) for work on the metabolism of vitamin C in relation to rheumatic disease—The Secretary, Rheumatic Unit, Northern General Hospital, Ferry Road, Edinburgh (September 30).

Lecturer (with good honours degree in electrical engineering and should preferably have completed a graduate apprenticeship) in Electrical Engineering—Head of the Electrical Engineering Department, City and Guilds College, London, S.W.7 (October 1).

Assistant Metallurgist with knowledge of copper and its alloys, and preferably with the ability to write on technical matters—The Secretary, Copper Development Association, Kendals Hall, Radlett, Herts.

Assistant Surveyors (with experience in carrying out topographical surveys by plane table and tacheometer) in the Government of Kenya Agricultural Department—Crown Agents, 4 Millbank, London, S.W.1, quoting M2B/40428/TA.

Chemists (science graduates, with first- or second-class honours degrees) in the London Transport Central Laboratory, Chiswick, for work on the development of tests for lubricants and investigations on the performance of lubricants under service conditions—Staff Officer, London Transport, 55 Broadway, London, S.W.1, quoting F/HV538.

Engineering Surveyor (with experience in the use of the level, theodolite, tacheometer and plane table sufficient to carry out surveys for engineering projects) with the Government of Tanganyika—Crown Agents, 4 Millbank, London, S.W.1, quoting M2B/30471/TA.

Head (with teaching, industrial or research experience) of the Chemistry and Applied Chemistry Department—The Principal, Royal Technical College, Salford 5.

Heads (with honours degree in chemistry, metallurgy, physics or engineering, or equivalent qualifications, with experience in the control and administration of applied research, and preferably with experience of the techniques and precautions involved in the handling of highly toxic and radioactive materials) of Laboratories of the United Kingdom Atomic Energy Authority, for duties including the administration and management of the laboratories, the direction of the scientific work and liaison with the operations and design groups—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 666.

Lecturers and Assistant Lecturers in Physics, Mineralogy, Chemical, Electrical, Mechanical and Mining Engineering, at the University of Indonesia—The Cultural Attaché, Indonesian Embassy, 38 Grosvenor Square, London, W.1

Organic Chemist for the National Coal Board, North-Eastern Section, for work on the investigation of problems connected with by-products from coke oven plants—Divisional Chief Scientist, Roundwood Colliery, Parkgate, Rotherham, Yorkshire.

Physicist (with a degree in physics and the ability of applying experimental techniques to the solution of fluid problems in the iron and steel industry) in the Fluid Dynamics Section of the Physics Department—Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Principal Scientific Officers or Senior Scientific Officers (with first- or second-class honours degree in physics and with some years postgraduate research experience in mass spectrometry or nuclear physics), to undertake research and development work—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 280/WGE/2.

Research Assistant (with qualifications in mathematics or physics and preferably with experience of either X-ray crystallography or large-scale computing) in the Department of Inorganic and Structural Chemistry, for work on the preparation and carrying out of programmes on crystallographic calculations—Prof. E. G. Cox, Department of Inorganic and Structural Chemistry, The University, Leeds 2.

Research Assistant in the Department of Physics, for work on an X-ray investigation of ternary alloy systems with adamantine structure—The Registrar, The University, Nottingham.

Research Entomologist (with an honours degree in biology and with at least two years postgraduate training in scientific research specialising in entomology, and preferably with statistical training or interest in statistics) in the West African Institute for Trypanosomiasis, to undertake research upon the behaviour, breeding and longevity of the tsetse fly under controlled climatic conditions—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.197/198/04.

Scientific Assistant (with an honours degree in biological sciences and able to write correct English, and preferably with some knowledge of foreign languages), for work including the collation, abstracting and reviewing of biological literature—The Director, Commonwealth Bureau of Plant Breeding and Genetics, School of Agriculture, Cambridge.

Scientific Officer (with first- or second-class honours degree in physics, with experience in the detection and measurement of nuclear radiations and a good practical and theoretical knowledge of electronic counting techniques), to work in conjunction with a group of chemists engaged in research on radioactive materials—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 161/WGH/34.

Scientific Officers (with first- or second-class honours degree in physics or electrical engineering), at Royal Air Force Stations in Buckinghamshire and Norfolk, for operational research duties and theoretical studies in communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A109/54A.

Senior Lecturer or Lecturer in Pathology—The Registrar, The University, Sheffield.

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THE OPPENHEIMER CASE

THE decision of the Atomic Energy Commission by a vote of four to one, as announced on June 29, that Dr. J. R. Oppenheimer should be denied access to restricted data because, on the record before the Commission, he was not entitled to the continued confidence of the Government and of the Commission "because of the proof of fundamental defects in his 'character' " is, of course, a matter of domestic policy within the United States. Even had, however, Great Britain and the United States not been somewhat "mixed up" (Sir Winston Churchill's phrase) in the early development of the atom bomb, the termination in this manner of the Government career of one who had rendered such outstanding services in this field could not but be a matter of profound interest, if not concern, to scientific circles in Britain. His services could scarcely be utilized, for example, by the European Organization for Nuclear Research or the new international agency to promote the use of atomic energy for peaceful purposes without some embarrassment or at least raising some awkward questions for the United States. Moreover, as the B.B.C. Reith Lecturer of 1953, Dr. Oppenheimer's name and achievements in science have been brought before millions with whom they might otherwise have been unfamiliar. The last of the lectures was delivered several weeks before Dr. Oppenheimer was notified, on December 23, that his security clearance had been suspended. Nevertheless, the shock to public opinion generally is sufficiently great for a clear understanding of what has really taken place and what is implied in the decision to be matters of public importance as well as of scientific interest.

On the scientific side there are other important aspects. It has been generally known in Britain that before the Atomic Energy Commission announced its decision, and while the Personnel Security Board, appointed by the Commission, under the chairmanship of Mr. Gordon Gray, was conducting its hearing, numerous leading American scientists had affirmed their faith in Dr. Oppenheimer, and Dr. Du Bridge and Mr. Gordon Dean, a former chairman of the Atomic Energy Commission, had made statements in his support. The Executive Committee of the Federation of American Scientists and a number of physicists at the University of Illinois, many of whom had been closely associated with Dr. Oppenheimer, had testified to his loyalty and expressed concern at his suspension. Moreover, the recommendation of the Personnel Security Board that it would not be clearly consistent with the security interests of the United States to reinstate Dr. Oppenheimer's clearance rested on the opinion of the chairman, Mr. Gordon Gray, and one member of the Board, Mr. T. A. Morgan, and was opposed by Dr. W. V. Evans, the sole scientist on the Board, who recommended that Dr. Oppenheimer's clearance be reinstated. Further, the dissentient from the Atomic Energy Commission's decision was also a scientist, Dr. H. D. Smyth, well known as the author of the Smyth Report of 1945.

In such circumstances some attempt to appraise the situation impartially is essential, if only to avoid misunderstanding or recriminations between partners in what was once a joint enterprise and which may in the future become increasingly one again. This is the more essential in that the circumstances in which the inquiry into Dr. Oppenheimer's loyalty was reopened are such as to confuse the real issues—issues which are of importance to scientists everywhere, and not simply for those concerned with nuclear physics or the development of atomic energy in the United States. Fortunately, they have been well stated, independently of the Oppenheimer case, by American writers themselves such as Prof. W. Gellhorn, Prof. H. S. Commager, and recently by N. D. K. Price in his "Government and Science".

The Personnel Security Board itself was obviously aware of the importance of having some such yardstick by which to reach its decision after hearing about forty witnesses, including Dr. Oppenheimer, and examining some three thousand pages of testimony. In the twenty-three pages of its own findings and recommendations it attempts to set forth frankly some of these major issues and questions which it recognizes as possibly even more important than the outcome of the inquiry itself. Moreover, both the concurring and the dissenting opinions of the Atomic Energy Commissioners indicate a certain confusion of thought and clash of opinion over the ideas of loyalty and activity and the extent to which they can be fostered in a free community and the means by which it is possible to do so.

First, however, it should be said that the texts of the principal documents and letters of the Personnel Security Board, the Atomic Energy Commission and its general manager now published leave no doubt as to the fairness and thoroughness of the inquiry. To this, Mr. L. K. Garrison, Dr. Oppenheimer's attorney, pays generous testimony. Some of the assumptions made by Mr. Gray and his colleagues in reaching their findings may be naive and their soundness is questionable; but there can be no question that they have carried out, with outstanding patience, consideration and integrity, a difficult task which had been handed to them in consequence of a change in the security regulations of the United States and in the climate of opinion.

That fact must be kept in mind if we are to understand the apparent inconsistency between the Board's vindication of Dr. Oppenheimer's loyalty and discretion and the recommendation that he should not be reinstated. Dr. Oppenheimer, as is known to all scientists, took a leading part in developing the atom bomb in the United States, and his work for the Atomic Energy Commission since the War has been highly praised by the chairman of that Commission. Of his services here the Security Board says:

> "The impact of his influence was felt immediately and increased progressively as his services were used. The Nation owes these scientists, we believe, a great debt of gratitude for loyal and magnificent service. This is particularly true with respect to Dr. Oppenheimer".

On the loyalty issue, in recording their conclusion that Dr. Oppenheimer is a loyal citizen, it adds:

> "The Board believes, however, that there is no indication of disloyalty on the part of Dr. Oppenheimer by reason of any present Communist affiliation, despite Dr. Oppenheimer's poor judgment in continuing some of his past associations into the present. Furthermore, the Board had before it eloquent and convincing testimony of Dr. Oppenheimer's deep devotion to his country in recent years and a multitude of evidence with respect to active service in all sorts of government undertakings to which he was repeatedly called as a participant and as a consultant. . . . The Board was impressed by the fact that even those who were critical of Dr. Oppenheimer's judgment and activities or lack of activities, without exception, testified to their belief in his loyalty".

In spite of this clear conclusion that Dr. Oppenheimer is a loyal citizen, the majority of the Board were unable to recommend that "the reinstatement of his clearance would not be a danger to the common defence and security". The case, as has already been indicated, was reopened because of a change in the security regulations and in the climate of national opinion. The accusations against Dr. Oppenheimer considered by the Board fall into two main categories: those which concern his contacts prior to 1943 with Communists or Communist-sponsored groups; and those which relate to his opposition later to the development of the thermonuclear or hydrogen bomb.

Of the first, the majority of the Board found that Dr. Oppenheimer's "continuing conduct and associations have reflected a serious disregard for the requirements of the security system", and they also found "a susceptibility to influence which could have serious implications for the security interests of the country". Of the second they found that his conduct in the hydrogen bomb programme was "sufficiently disturbing as to raise a doubt whether his further participation, if characterized by the same attitudes in a Government programme relating to the national defence, would be clearly consistent with the best interests of security".

In reaching its decision on the first set of facts, which were substantially known to military intelligence when Dr. Oppenheimer was placed in charge of the atom bomb development at Los Alamos and to the Atomic Energy Commission when he became chairman of the General Advisory Committee of that Commission, the Security Board has obviously been influenced by the climate of opinion and the doctrine of guilt by association against which Prof. Commager protested with such clarity and force. Admittedly, Dr. Oppenheimer has shown poor judgment in continuing some of his past associations; but, as the Board itself points out, his sympathetic interests diminished from 1942 to apparent complete rejection in 1946, and they are in part family associations. It asks, indeed, the question whether an individual, who has been a member of the Communist Party or closely associated with it, can later on so comport himself personally, so clearly demonstrate a renunciation of interest and sympathy, so unequivocally display his zeal for his country and its security as to overcome the presumption of security risk. The Board believes this to be possible and that it should be a part of the security policy of the United States; but in making this assumption, it appears also to be making the naïve if not arrogant concept that, in its own words, "the Government can search its own soul and the soul of an individual whose relationship to his Government is in question with full protection of the rights and interests of both".

Such prescience has scarcely been claimed even under a totalitarian regime, and it is difficult also to accept the Board's contention that the proceedings have shown that such investigations can be conducted with complete disregard of public clamour and private pressures. That such investigations can be conducted calmly, fairly and with dignity signifies little in comparison with the harm which they are liable to do to creative and sensitive minds. The charges brought against Dr. Oppenheimer required examination when they were first made; but the Editorial Board of the *Bulletin of the Atomic Scientists* will not be the only body to whom it will seem contrary to both decency and common-sense to revive them now from the irrelevance to which a brilliant record of national service had relegated them. To do so seems to make a particular security system the master rather than the servant of national interest.

The Security Board does indeed seem to be uneasy on this score. It points out that the protection and support of the entire security system itself has had insufficient public attention, and at least by implication it admits the right of criticism of, or dissent from, that system. Having gone so far it fails, however, to recognize that any particular security system may in its structure or administration have defects which impair the dynamic and creative elements which are the real source of national strength. "It seems to us", writes the Editorial Board of the *Bulletin of the Atomic Scientists*, "a breach of faith on the part of the Government to call upon a man to assume such heavy responsibilities in full knowledge of his life history and then, after he has demonstrably done his best and given the most valuable service to the nation, to use the facts which were substantially known all the time to cast aspersions on his integrity". Others may well feel that in accepting a task which should not have been given to it, the Security Board was led into making claims of competence in areas where it had no title.

The real issue here was, in face of the new security regulations, whether, as a matter of national policy, Dr. Oppenheimer should be employed regardless of the narrow standards laid down for screening a typist or a clerk. Perhaps only the United States could have spared the time and energy of distinguished men to discover whether Dr. Oppenheimer was a security risk according to its standards. Unquestionably he was, but having regard to the framework of American philosophy it was not right to expect the Security Board to make any such distinction even on the ground of critical national need. Only the President can fairly accept responsibility for any such decision, nor can he evade the final responsibility if the climate of opinion forces on the Executive changes in the security system which endanger the real strength of the nation.

One further passage in the Security Board's findings touches on a particular aspect of this question. It was repeatedly confronted with the question whether, in determining the security status of a scientist, the Government must take into account the reactions of, and the possible impact upon, all other scientists. Even here, however, the Board scarcely seems to appreciate the effect of security inquiries and procedure upon scientific and other creative work. The Board recognizes that it is encouraging evidence of the vitality of society when so many scientists spring to the defence of one who is regarded as unfairly attacked; but the deeper issue that an ill-judged security system may endanger the roots of security is not recognized. It is not that scientists, for example, claim any special privilege to be exempt from security regulations or inquiries. The Board itself testifies to their loyalty and responsibility. The Oppenheimer case does, however, seem to raise the fundamental issue of the appropriateness of the whole security system and whether its structure or administration are not, in fact, eroding the basis of a free society.

The second group of accusations regarding Dr. Oppenheimer's opposition to the development of the hydrogen bomb raises an equally fundamental issue. The Security Board found that Dr. Oppenheimer's conduct was sufficiently disturbing as to raise a doubt as to whether his future participation, if characterized by the same attitudes in a Government programme relating to the national defence, would be clearly consistent with the best interests of security. This finding is in contrast, as Mr. Garrison pointed out in the letter already quoted, with the fact that the basic allegations in this matter were regarded as disproved. The Board agreed that Dr. Oppenheimer's opposition to the hydrogen bomb programme "involved no lack of loyalty to the United States, or attachment to the Soviet Union", that his opinions regarding the development of the hydrogen bomb were shared by other competent and devoted individuals, both in and out of Government, and that it could be assumed that these opinions were motivated by deep moral conviction". After the decisions in January 1950 to proceed with the development of the hydrogen bomb, Dr. Oppenheimer did not oppose the project in a positive or open manner, nor did he decline to co-operate in the project, and the allegations that he urged other scientists not to work on the hydrogen bomb programme were unfounded.

Nevertheless, the Security Board concluded that the "security interests of the United States were affected by Dr. Oppenheimer's attitude because they believed that, had Dr. Oppenheimer given his enthusiastic support to the programme, a concerted effort would have been initiated at an earlier date and because, following the President's decision, he did not show the enthusiastic support for the programme which might have been expected of the chief atomic adviser to the Government under the circumstances". Dr. Garrison argues that the injection into a security case of a scientist's alleged lack of enthusiasm for a particular programme is fraught with grave consequences to the United States, and his contention is supported by comments of other scientists which indicate that this is the aspect that the majority of scientists in the States find most disturbing.

"How can a scientist", asks Mr. Garrison, "risk advising the Government if he is told at some later day a security board may weigh in the balance the degree of his enthusiasm for some official programme, or that he may be held accountable for a failure to communicate to the scientific community his full acceptance of such a programme ?". The Security Board did not find that Dr. Oppenheimer urged other scientists not to work on the hydrogen bomb programme, although it believes that enthusiastic support on his part would have encouraged other leading scientists to work on it. Nevertheless, it found that "if Dr. Oppenheimer had enthusiastically supported the thermonuclear programme before or after the determination of national policy, the hydrogen bomb project would have been pursued with considerably more vigour, thus increasing the possibility of certain success in this field".

To argue thus introduces an entirely new standard of acceptability for employment as a technical adviser. It has not previously been suggested that a government employee or consultant must give his enthusiastic support to official policy. Dr. Oppenheimer was not alone in opposing the development of the hydrogen bomb, at least in so far as his opposition was based on the nuclear technology then existing. Nor does even the Security Board challenge Dr. Oppenheimer's right to hold moral or political opinions opposed to that development. It is admitted that when his opinion was rejected he co-operated loyally in the furtherance of the official programme. To dispense with his services on the ground of lack of enthusiasm, instead of doing so by exercising the right possessed by any government to change its advisers without challenging either their competence or their patriotism, involves grave risk that men of creative, original and independent minds will no longer care to enter the government service, or indeed be accepted for it, and, as Prof. A. Macbeath remarked at Belfast, the only safeguard against major mistakes has then gone.

Mr. N. D. K. Price, writing on this issue of the hydrogen bomb before the Oppenheimer case developed, remarked: "If there were any problem on which the highest public officials should accept their proper responsibility and in which scientific advisers should not be held accountable except for the accuracy of their scientific advice this was the problem. . . . Published articles that attack the motives of scientific advisers will obviously weaken the government's ability to get scientific advice".

The danger of alienating scientific advisers has been emphasized by Dr. Vannevar Bush in an article which advocated an overhaul of the entire system of security clearance within the executive branch of the Government. The comments of other scientists in the scientific press of the United States indicate that it is the security system itself, rather than Dr. Oppenheimer, that is on trial. The issue is one between the positive and the negative concepts of security. The lone scientists on the Security Board and on the Atomic Energy Commission, attaching first importance to the former, were of opinion that Dr. Oppenheimer's services should be retained; their colleagues, guided by the negative concept, voted to dispense with them. In this connexion it should be noted that the Security Board said: "It seemed to us that an alternative recommendation would be possible if we were allowed to exercise mature practical judgment, without the rigid circumscription of regulations and criteria established for us".

There is one further comment to be made here on the introduction of this new concept of enthusiasm as fitness for service. That involves a threat to the freedom of the scientific conscience which seems, indeed, to have troubled the Commissioners. More important, however, even than the possible discouragement to first-class men from entering the service of their country, the introduction of this criteria of enthusiasm destroys the real basis of advice. What a nation requires primarily of its advisers is not enthusiasm but responsibility. That is the condition on which advice is given, and it implies loyalty as well as the judgment and the wisdom to select and apply the relevant knowledge. Responsibility does not and cannot condone the subordination of judgment to any political doctrine or policy.

Once again, therefore, we are brought face to face with the voice of power and responsibility. Unless our advisers are trusted and are allowed discretion, they cannot give us that independent judgment, that unimpeded inquiry and scrutiny which are the source of major and vital advances and the safeguard against major mistakes. Perhaps the most hopeful feature of the whole business is the extent to which these issues have been recognized by American scientists themselves. It is not so much the way in which they rallied in support of Dr. Oppenheimer, with whose opinions and judgments many of them have often disagreed. It is rather that they have recognized with remarkable unanimity that security regulations that enforce a decision which puts a blot not clearly justifiable on the reputation of an outstanding American scientist, generate distrust between American scientists and their government and endanger the readiness of government advisers to give the government the benefit of their best thought, are themselves a danger to the security of the country.

Meanwhile, in the United States other atomic scientists have had their zeal for their work damped by what they regard as the unrealistic standards applied in Dr. Oppenheimer's case and may hesitate to renew their contracts with the Atomic Energy Commission, just as promising young scientists may now prefer to seek employment elsewhere. Already secrecy regulations and the impediment they offer to the free exchange of knowledge tend to discourage a certain type of the ablest young minds from entering this field. Once the opinion gains ground that scientists in government service have to work under such restrictive conditions or in such an atmosphere of suspicion that creative and original work and the spirit of free inquiry are inhibited, the quality of the State service will be irreparably impaired.

In Britain, as in the United States, national security depends primarily on the country's ability to enlist in its service a sufficient proportion of the ablest minds among its scientists and technologists and allowing them to work under conditions which give full scope to their originality and vitality. Security regulations which do not subserve this condition themselves endanger national security. The protests that have been forthcoming over the Oppenheimer decision may indeed offer some safeguard that it will not form a precedent for "insidious encroachments by men of zeal, well-meaning but without understanding", which are the major threat to national security as well as freedom. More positively, it may perhaps be hoped that the co-operation which will be demanded if the United States is to participate effectively in the new world agency to promote the growth and spread of atomic energy for peaceful purposes, announced by President Eisenhower on September 6, will itself encourage the realistic appraisal of the security system which American scientists have urged and the formation of a climate of opinion in which the balance of freedom and security and the issues of responsibility and power are more clearly understood, and guarded with imagination and understanding as well as zeal.

As has been said, the manner in which Dr. Oppenheimer has been dismissed makes it difficult for the free world to avail itself of the services of the man whom Dr. Smyth describes as "one of the most knowledgeable and lucid physicists we have" without raising awkward issues.

But the really important questions which the Security Board and the Atomic Energy Commission have left unanswered are not concerned with Dr. Oppenheimer at all, or at least only indirectly. Was it really necessary for three such distinguished men to spend their time and energy on determining the answer to a question which was obvious to common sense? Apart from the question whether even the most richly endowed nation can afford to divert an unlimited amount of its man-power to security investigations, the contrast between the ambiguous answers produced after so much voluminous inquiry and the swiftness and perspicacity with which Sir John Woods's committee investigating the Crichel Down episode in Britain reported on issues touching the public interest no less vitally is startling. Almost inevitably it suggests that there may be substance in what some American scientists are saying, and that Dr. Oppenheimer has been dismissed because his opinions were unpalatable to the authorities, and particularly the military authorities, who have chosen this retrograde method of removing an adviser so as to minimize the possibility that others may avail themselves of his advice or services. Meanwhile, grave damage has been done to the co-operation and understanding between scientists and government, without which no effective system of defence can to-day be developed. To establish conditions in which the scientific adviser can make his full and most effective contribution to the tasks of defence and of peace is an imperative over-riding necessity for the free world, and until clear answers are given to the questions which are raised by the case of Dr. Oppenheimer the belief may well grow that its significance is to be seen, not in comparison with the recent Crichel Down episode, but in the analogy with the case of Dr. Dreyfus two generations ago.

SIR WILLIAM PETTY: A GENIUS OF THE SEVENTEENTH CENTURY

Sir William Petty

Portrait of a Genius. By E. Strauss. Pp. 260. (London: The Bodley Head, 1954.) 25s. net.

THE mid-seventeenth century was for England an exciting and expansive era. Increasing population and wealth, with accompanying changes in the structure of society, created new problems of political organization; the development of industrial technique and sea-borne trade gave a new importance to commercial policy; and the scientific movement offered not only the greatest intellectual stimulus of the time, but provided also a hope that through its mastery of Nature the material progress of mankind would steadily advance. Many reactions to the opportunity of the age were possible. Some men prospered in wealth while understanding little of the changes that had made their success possible. Others who achieved distinction in science or philosophy were passive to the social currents by which they were borne. A peculiar interest in the career of Sir William Petty (1623–87) is that he was of both camps—a *parvenu* opportunist who had won wealth and title by exploiting the devastation of Ireland, and at the same time a philosopher, the father of political economy and an Original Fellow of the Royal Society.

In a tough society Petty was no weakling, as Mr. E. Strauss shows. He was ambitious to rise in the world, and not too scrupulous. An accident took him from the sea to a Jesuit College; a little learning brought him to Oxford, the medical profession and to many useful friends. But Petty was destined to be neither a Sydenham nor a Radcliffe. Ireland called him, as it had called all adventurers since Elizabeth's reign. Although he began with little capital, the Down Survey and the distribution of land to Cromwell's veterans yielded him a wonderful opening, so that by outwitting the administration and shrewd bargaining with the soldiers he emerged possessed of at least thirty thousand acres and a heritage of litigation.

With wealth assured, Petty's ambition turned to politics. Mr. Strauss analyses the means by which this servant of the Cromwellian régime secured something more than tolerance from the restored Stuarts. He won rather less by his change of heart than some of his colleagues in the Royal Society. His massive proposals for increasing population, production and revenue were ignored. Even the scientists were surprisingly indifferent to his venture with the double-bottomed boat. This was partly because (as Mr. Strauss says) Petty preserved ideals and policies which were no longer in favour, such as opposition to the aggrandisement of France; but it was also no doubt due to a more fundamental disability. Attractive as he was to his friends, and greatly as he impressed them by his intellectual capacity, Petty was a more difficult character than Mr. Strauss seems willing to admit. His one great exercise in authority and administration—the Down Survey—proves that he had a superlative ability for arousing hostility and envy; and there is no sign that their main cause, Petty's love of money, diminished with age. Rather, his every scheme for enriching England was designed to enrich Petty, too. Perhaps, as with other philosopher-kings, it was best for the philosopher in Petty that his kingship should remain frustrated.

It is when he comes to examine Petty's writings on political economy that Mr. Strauss's claim of genius is best sustained. The Down Survey (1655–56) was indeed an astonishing feat of organization, but it should be remembered that it was effected with the aid of a disciplined military force; and important as the Survey was for the cartography of Ireland, Petty contributed nothing to the development of surveying methods. It was in his riper years as a cabinet statesman, in the many papers that remained unpublished until after his death, that the originality and power of Petty's mind were revealed. For if his schemes for the demographic and economic reform of England were often fanciful in detail, they were based on theoretical conceptions which (in Mr. Strauss's words) "provided the starting-point for the growth of classical economic science up to the time of Adam Smith, David Ricardo and Karl Marx". The foundation of these conceptions was Petty's notion of wealth, far removed from the crude bullionist equation of wealth with plenty of money, as residing in a dense and productive population. Only less original was his grasp of the importance of statistical information, though Mr. Strauss concludes that John Graunt's share in the authorship of the famous "Observations upon the London Bills of Mortality . . ." was far from trivial. Petty's conclusions were necessarily often based on numerical conjectures, and he added nothing to the mathematical aspects of this subject; what he did do was to indicate the kind of information that could usefully be collected, and the type of answer that statesmen and administrators could extract from it.

As a natural scientist, on the other hand, Petty had no great merit. His Baconian ideas were rendered outmoded by the growth of disinterested research in the several sciences. Something of his intellectual virtues and defects are portrayed in his remark in 1687 that "As for Mr. Newton's book, I would give £500 to have been the author of it". His one great adventure in applied science, the double-bottomed boat, proved a dismal failure. In navigation, as in politics, the brilliant amateur was outdistanced by plodding professionals.

Mr. Strauss has given a full and interesting account of this extraordinary career, which is a fitting supplement to Lord Lansdowne's volumes of twenty-five years ago. He has placed Petty firmly in his historical context, and evaluated skilfully the merit of his varied writings. If in seeking to justify the unbounded admiration felt by many better-known contemporaries (including John Evelyn and Samuel Pepys) for this rather neglected figure in the "century of genius", Mr. Strauss has made some claims for Petty of which the strength is not immediately obvious, he has nevertheless given a fair picture of the weaknesses in Petty's intellect and character. He has written an excellent book. A. R. HALL

MINERALS USED IN INDUSTRY

Minerals for the Chemical and Allied Industries

By Sydney J. Johnstone. Pp. 692. (London: Chapman and Hall, Ltd., 1954.) 75*s*. net.

THIS is a concise, encyclopædic account of the sources, properties, uses and standard specifications of a great variety of mineral substances that now find application in modern chemical and related industries and, incidentally, in the metallurgical industry. The term 'mineral', as used here, is to be interpreted in its very broadest sense, implying substances obtained out of the earth, either directly, or indirectly from complex ores, and also certain synthetic derivatives of such minerals. Thus, the main section headings include such diverse materials as slate waste, rhenium, wollastonite, perlite, mercury, nitrates and ochre. In fact, many of the minerals dealt with are described under sections bearing the name of the principal element or substance, metallic or otherwise, entering into their composition, so that other headings are aluminium, titanium, iodine, sulphur, silica, and so on. The main sections are in alphabetical order, an arrangement doubtless convenient to the commercial users for whom the book is primarily intended. An adequate index assists in rapid reference to more specific minerals. There is no main heading for iron (a rather surprising omission), which seems to be accounted for by the fact that the materials described are essentially those in use or potentially useful for chemical rather than metallurgical industry, although in the case of many other metals their metallurgical applications receive mention. However, certain naturally occurring ferruginous minerals are included under other headings, and the applications of other metals—for example, manganese and zirconium—in iron metallurgy are mentioned in the appropriate sections.

The fact that this book has been prepared by the former principal of the Mineral Resources Department of the Imperial Institute, London, who also served as head of the Commodities Section of the Ministry of Economic Warfare during the Second World War, is sufficient guarantee of its authoritative character. It is based on a series of articles that he published in *The Industrial Chemist and Chemical Manufacturer* between 1946 and 1949. Much new material has been incorporated, however, bringing the text thoroughly up to date; and accounts of a number of minerals not included in these articles have been added. Each section concludes with a selected bibliography of sources from which more detailed information is obtainable. Statistical details of sources and production in recent years are given, so far as they are available, and also references to countries that were able to produce increased quantities of certain materials during the War. All this material has been collected from many widely scattered sources, and presented concisely in an easily accessible form.

The book makes instructive reading for all interested in economic minerals and their uses, and is particularly informative, for example, on the uses to which some of the rarer metals are now being put. It will prove invaluable to the industrial chemist, for whom it is especially intended; but should also be useful, as a reference book, in those technical and other educational establishments where the curriculum includes the economic applications of chemistry and mineralogy. V. A. EYLES

THE FIRST COLONIZATION OF BRITAIN BY FARMERS

The Neolithic Cultures of the British Isles

A Study of the Stone-using Agricultural Communities of Britain in the Second Millennium B.C. By Prof. Stuart Piggott. Pp. xix+420+12 plates. (Cambridge: At the University Press, 1954.) 70s. net.

WITH the aid of soberly scientific imagination and historical insight, the fragmentary results of fossilized behaviour that constitute the archæological record have been here interpreted by Prof. Stuart Piggott as documenting the first colonization of the British Isles by farmers, the adaptations of their exotic cultures to the insular environment and the reactions of surviving Mesolithic 'natives' to the impact. The result is no tedious catalogue of invasions (though to explain the facts the author has to postulate at least six distinct bands of "Neolithic" immigrants apart from several groups of "Beaker folk"), but genuine history—at least economic history—as concrete as the limitations of archæological data allow; for example, the lively account of the autumn round-up of stock in "causewayed camps" is no product of fancy, but a legitimate inference from observed phenomena that have been factually described. For the archæological data are here assembled, classified and presented so fully that a sceptical reader can discern possible inconsistencies even in statements that the author accepts (for example, a "cremation" of which no burnt bone survives; the account of the Baltinglass cairn is vitiated only by a defect in the published plan that Prof. Piggott justifiably followed) and illustrated by figures and maps that are artistic as well as instructive. As a result, Prof. Piggott's work is a standard and indispensable source-book from which all further work on the problems of the period must start. For problems still are left.

Most of the material so exhaustively surveyed has been accumulated during the past twenty-five years, much in the past decade, while some of the most reliable data are due to the author's own excavations at well-selected sites. At the same time, Prof. Piggott has extracted every scrap of serviceable information from older accounts of digs into flint mines and long barrows. The interpretative concepts are likewise novel and original. As to chronology, the book's sub-title will advise the reader that the Neolithic period surveyed does not begin, as it would have a quarter of a century ago, with the end of the Pleistocene. Its end will still surprise many readers; "Neolithic" for Piggott does not end, as has been assumed for the past fifty years, with the advent of "the Beaker folk". Though typologically early bronze weapons are doubtless found, albeit very rarely, in their graves, and exports on the Continent of Europe imply even the contemporary existence of a school of local metallurgy at least in Ireland, societies here described undoubtedly continued to maintain purely Neolithic traditions after the Beaker invasion and down to the rise of the Wessex culture. After all, on Montelius's system for Scandinavia, Neolithic IV coincides with Bronze Age I, and a similar usage would be legitimate here.

The Beaker invaders are not here treated among "the stone-using agricultural communities of Britain"; they are excluded not as consumers of metal ware, but as exponents of "the novel rite of individual burial", while "some form of collective burial appears to be characteristic of all the neolithic cultures here described". Therewith, "collective burial" too is given a novel sense, being applied to cremations interred in individual graves, if these are grouped in closed cemeteries, as much as to the burial of several persons' remains in a common tomb, to which latter rite the term had hitherto been restricted. Admitted cases of individual burial in "Neolithic" cultures are explained as due to the influence of the Beaker invaders, even though at Linch Hill such a burial was stratigraphically prior to an interment with a Beaker.

Original, too, and fruitful is Prof. Piggott's concept of "Secondary Neolithic cultures", in which such elements as "can be regarded as intrusive" are "inextricably mixed with other features which have a long local ancestry in Mesolithic cultures", whereas the Primary cultures, associated with the first farmer-colonists, should represent "a virtual transfer of French early Neolithic traditions to this country". But in the sequel it is suggested that the distinctive secular monuments of the colonists—the "causewayed camps" (which are really cattle corrals)—together with the techniques of skin-dressing illustrated in them, may be due to "intermixture with indigenous hunter-fishers", while their long barrows might have been as appositely compared to Megalithic tombs in north-east Germany as to the *tertres allongés* of Morbihan. On the other hand, Secondary Neolithic pottery of the Peterborough class is so like the pitted ware of Sweden that the author inclines to regard its "appearance as an indication of settlement in south-east England of people arriving by sea from Scandinavia". Now, since the book went to the press (in 1951), Becker has shown that the makers of pitted ware played just the same part in the distribution of flint axes in Scandinavia as Secondary Neolithic folk played in Britain in the remarkable trade in axes from the Langdale, Penmaen Mawr and Antrim factories which systematic petrological examination has revealed recently, but in time for description by Prof. Piggott. This three-year interval between composition and publication must also be remembered in connexion with other comparisons with North European material. The author has just failed to translate the older Danish–Swedish chronological terminology into that adopted during the past five years, and consequently seems to have inverted the chronological relations between the Beacharra C and Peterborough phases here, in so far as these are deduced from North European parallels. In the precocious science of prehistoric archæology progress is so rapid and publication has become so slow that any book must be to some extent out of date when it is issued. Prof. Piggott has written an exhaustive and authoritative account of Neolithic Britain as it appeared in 1951. V. G. CHILDE

A Bibliography of the Research in Tissue Culture, 1884 to 1950

(An Index to the Literature of the Living Cell Cultivated in Vitro.) Prepared by Margaret R. Murray and Gertrude Kopech. Vol. 1: A–K. Pp. xxviii+840. Vol. 2: L–Z. Pp. 841–1742. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 24 dollars the set.

THIS monumental bibliography of the literature on tissue culture, which occupies two large volumes, is indeed a remarkable achievement. The plan to produce this work was conceived in 1946 at the Hershey Conference and has been sponsored throughout by the Tissue Culture Commission, which was founded at this meeting, and by its successor, the Tissue Culture Association. When the scheme was first launched, the vast size of the literature was not fully realized, and the authors and sponsors had to surmount many unforeseen difficulties, both financial and editorial, before the project was at length completed.

In the preface, tissue culture is defined as "the maintenance of isolated portions of multicellular organisms in artificial containers outside the individual for considerable periods of time". To prepare the book, "29,000 articles were read in their entirety"—a truly horrifying thought—and, from these, 15,000 were selected as being covered by the definition; this number was expanded by excellent cross-indexing to 86,000 entries.

It is astonishing to discover how much work has been done by means of the tissue culture technique in a wide variety of fields. To have this exhaustive collection of references assembled in one book, however large, is a blessing not only to all those who use the method, but also to many others who are concerned with the information provided by experiments on tissue cultures. The authors are to be warmly congratulated on the scholarly way in which they have accomplished their formidable task, and they can rest assured that grateful colleagues throughout the world will "arise up and call [them] blessed".

Journal of the Institute of Metals

Vol. 80, 1951–52. Editor: N. B. Vaughan. Pp. xvi+728+113 plates. (London: Institute of Metals, 1952.)

THE present volume is the first to appear in the enlarged size (11 in. × 9 in.). This new format has enabled diagrams and photographs to be reproduced more satisfactorily; but the volume of 728 pages weighs more than 5¼ lb. and is too heavy for convenient handling, while its cloth binding is insufficiently strong to stand up to normal laboratory or library use. The volume contains seventy-seven papers, and a further disadvantage of this large size is that a single reader in a library immobilizes seventy-six papers besides the one he is consulting. It is to be hoped, therefore, that future volumes will be smaller and published at more frequent intervals.

Except for its inconvenient weight, the volume is excellent. It is well and clearly printed, and the standard of reproduction of tables, diagrams and photographs is admirable. The papers cover a wide range of subjects, and the majority can be read from the point of view of general scientific interest, quite apart from industrial applications. Work on the structure of metals and alloys is prominent, and the volume includes the presidential address by Dr. C.-J. Smithells, the twenty-second Autumn Lecture on "Electrochemistry and the Science of Metals" by Prof. R. Piontelli, and the forty-second May Lecture by Dr. J. J. P. Staudinger on "The Place of Plastics in the Order of Matter". There are also a summary of a discussion on metal economics and a symposium on equipment for the thermal treatment of non-ferrous metals and alloys. W. HUME-ROTHERY

Synthetic Organic Chemistry

By Romeo B. Wagner and Prof. Harry D. Zook. Pp. xii+887. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 92s. net.

THIS comprehensive work aims at giving a concise summary of the chief synthetic methods used in organic chemistry for preparing compounds of single and dual function. For this purpose the authors have undertaken an exhaustive examination of twenty of the leading journals and books dealing with organic chemistry from 1919 to 1950.

The thirty-nine chapters bear such headings as acetylenic compounds, halides, ethers, lactones, *iso*cyanates, amines, imines, hydrazines, diazo and diazonium compounds, and sulphonic acids. As an illustrative example, Chapter 24, dealing with amines, adduces forty methods for preparing this type, including the reduction, or the hydrolysis, of various other types; degradation of amides, acyl azides and hydroxamic acids; ring dehydrogenation; and various ways of applying Grignard reagents. A short discussion, with copious references for each method, is followed by twelve tables which summarize the preparative methods, yields and physical properties of some seven hundred individual compounds listed under the heads of amines, diamines, olefinic and acetylenic amines, halo- and hydroxy-amines, amino-ethers, -aldehydes, -ketones, -acids, -esters and -cyanides. The chapter closes with a list of 561 references to original sources finding mention in it.

The enormous amount of information in this time-saving compendium is set out clearly and systematically, the book is well printed, and it can be commended to organic chemists and biochemists as a reliable and up-to-date guide through the maze of modern synthetical methods. JOHN READ

The Heron

By Frank A. Lowe. (New Naturalist Special Volume.) Pp. xiii+177+9 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 18s. net.

BOOKS about birds continue to come from the publishers in steady numbers and are evidence of the ever-growing appreciation of ornithology. In "The Heron" Mr. F. A. Lowe has written an interesting monograph and an excellent addition to the "New Naturalist" series of volumes. Based on long observation of the heron breeding colony in Dam Wood, Lancashire, his book ranges over world distribution and populations, breeding biology, the mechanics of flight and dispersal, the heron in history and folk-lore, etc. It is a painstaking and thorough survey, written in an unpretentious style, that will be read with pleasure alike by the experienced ornithologist and the recent recruit to the ranks of bird-lovers.

The illustrations range from maps and diagrams to photographs taken in the wild, and include as frontispiece a photograph in colour of a heron at its nest. Where all are so excellent, it seems invidious to carp; but it would certainly have been pleasing had it been possible to include one or two heron portraits by outstanding artists, including an example of the heron in Japanese art. FRANCES PITT

PHYSIOLOGICAL ASPECTS OF THE HEATING AND VENTILATION OF HOUSES IN BRITAIN

AT the recent meeting in Oxford of the British Association, the first session of Section I (Physiology), held on September 2, dealt with various physiological aspects of heating and ventilation, the emphasis of the papers being on the requirements of houses in Great Britain.

In his introduction the chairman, Dr. Thomas Bedford, gave a brief survey of the results of recent studies of thermal comfort and the assessment of environmental warmth. It can be concluded from recent research in the United States that for satisfactory ventilation the supply of fresh air should be at the rate of not less than 600 cu. ft./hr. for each person, and this standard had been accepted by the Egerton Committee as one of the requirements for post-war housing. People doing light work during the winter months in Great Britain liked a temperature of about 65° F. and were reasonably comfortable at temperatures of between 60 and 68° F. With a suitable temperature there should be adequate but not excessive air movement. At room temperatures of about 65° F. the air speed should be between 20 and 40 ft./min. At lower speeds complaints of stuffiness are likely, and at higher speeds sensitive persons will complain of draughts.

Investigations have confirmed that with a given level of warmth most people find conditions pleasanter when the boundary surfaces of a room are warmer than the air than when they are cooler. It is undesirable that the warmth around the head should be appreciably greater than that near the floor. The gradient of air temperature over the height of a man should not be more than 5° F. When a room is heated by panels embedded in the ceiling, the elevation of the mean radiant temperature at head-level due to the warm ceiling should not exceed 4° F. Many buildings are now warmed by heating the floors. Research nearly completed shows that for sedentary people the temperature of the floor surface should not be higher than 75° F.; but people who are moving about can tolerate a rather higher temperature. These figures relate to rooms with an air temperature of about 65° F.

Various scales of warmth have been used for making allowance for different combinations of the individual factors which make up the thermal environment. The best known of these is the American scale of effective temperature. This makes no specific allowance for radiant heat, and during the Second World War it became necessary to attempt some adjustment of the scale to allow for radiation effects. Such an adjustment has been made by using the temperature of a black-globe thermometer instead of the air temperature in calculating the effective temperature. Recent physiological research carried out at the R. N. Tropical Research Unit, Singapore, has shown that this method of adjustment gives good results.

War-time studies have led to certain criticisms of effective temperature as an index of the stress imposed by work in hot environments, but a recent study of the bases of these criticisms has led to the conclusion that effective temperature, properly used, remains a valuable index of warmth. Finally, it was suggested by Dr. Bedford that attention should be given to local methods of warming a person rather than the whole room or the whole house, especially with reference to the requirements of the aged. Dr. E. F. DuBois had asked: "Why overheat 100 tons of house and furniture, when all that is necessary is to warm 100 lb. of grandmother?"

Prof. G. P. Crowden spoke on the heating and ventilation requirements of dwellings. He outlined the climatic factors which affect the control of body temperature and the comfort of the individual, and then detailed the standards set out in the codes of practice drawn up by the British Standards Institution. In living-rooms the temperature should lie between 60 and 68° F. and in bedrooms between 55 and 57° F. In both, the relative humidity should be between 30 and 65 per cent, with a fresh air supply of 600 cu. ft./hr. per person. For kitchens a temperature of 60° F. is specified, with a relative humidity of less than 70 per cent, and the supply of fresh air should be at least 2,000 cu. ft./hr.

Prof. Crowden then went on to describe tests that had been carried out in experimental rooms of the type described as 'kitchen/living-room', with housewives and men of varying ages as the experimental subjects. These tests showed that the provisions for heating and ventilation make it possible to maintain the specified conditions.

When housing schemes were again undertaken after the Second World War, it was evident that building resources would be stretched to the utmost, and methods of economy in building were examined. One obvious way of saving in both cost and materials was to reduce the heights of rooms. Generally it was not permissible to build houses with rooms less than 8 ft. in height; but it was thought by many that rooms 7 ft. 6 in. in height would be quite satisfactory. Others feared that houses with the lower ceilings would be unsatisfactory on grounds of health or of comfort. Prof. Crowden described a survey of some trial houses that were built with rooms only 7 ft. 6 in. high. The families who lived in them did so in comfort. Very few expressed the opinion that they would prefer higher rooms, and the majority had not noticed that the ceilings were lower than usual. The conditions specified in the codes of practice were readily maintained in these houses.

When ordinary gas wash-boilers and cookers were used in small kitchens these became undesirably hot and steamy, and the air was contaminated with products of combustion, unless the ventilation greatly exceeded the 2,000 cu. ft. of fresh air per hour laid down, or unless flues were provided to remove the products of combustion.

Two examples were given of the failure of occupants to make proper use of provisions for ventilating their houses. In one house the excessive use of draught-excluding devices made it impossible to use a solid-fuel fire, while a gas fire made the air unpleasant, even though the heating was inadequate. In the second example, the deliberate restriction of ventilation resulted in four deaths from carbon monoxide poisoning due to the incomplete combustion of coal gas.

In a paper on problems of working conditions in the home, Dr. J. R. Brown described experiments in which women engaged in washing clothes were studied, the work being done without the aid of washing machines. Careful measurements were made of the thermal environment as the work proceeded, the subjective impressions of heat and of moisture of the experimental subjects were noted, their blood pressures and pulse-rates were measured and used for computing the Crampton index of vasomotor tone, and the electrical conductivity of the skin was measured. From experiments carried out under control conditions it was concluded that changes in the Crampton index were related to changes in thermal stress. The numerical value of the index declined as the women subjects felt hotter and more fatigued. It has been found that, until the skin becomes visibly wet with sweat, there is a linear relation between its electrical conductivity and the number of active sweat glands.

Dr. A. Parker spoke on house heating and atmospheric pollution. Domestic chimneys are responsible for a million tons of smoke a year and for a million tons of sulphur dioxide, and the solution to the problem lies in the use of smokeless fuels—gas, electricity and coke—in proper balance. Problems of economics as well as fuel technology arise here. Only one day's supply of gas can be stored, and it is impracticable to store electricity on a large scale, so that the main stand-by must necessarily be solid fuel. Coke should not be regarded as a surplus product arising from the manufacture of gas, but rather the needs for coke and for gas should be taken into account together. People should regard coke as a valuable smokeless fuel in its own right, and not merely as partly-used coal. Dr. Parker thinks the problem is not insoluble. In Britain, he said, people insist on having open fires, and such fires are perhaps desirable in this climate, but there is no prospect of burning bituminous coal in such fires without creating smoke. When convective methods of heating are used, people tend to demand an air temperature about 8° F. higher than with radiant heating, with consequently greater fuel consumption. It might be suggested that district heating should be extended; but with this form of heating it is usual to make a weekly charge for heat without reference to the quantity used, so that the consumer has no incentive to practise economy, with the result that the amount of fuel used per house with district heating is greater than with open fires.

Mr. J. B. Dick spoke about factors of design and construction affecting heating and ventilation in dwellings. It is the experience of the Building Research Station that, with an internal flue, about 40 per cent of the heat from an open fire is delivered into the house, and with such a fire an acceptable standard of comfort can be obtained at lower cost than with a hot-water radiator. It is important not to provide a heating system that will be too costly for the householder to maintain.

Recent improvements in construction were described. An 11-in. cavity wall with a foamed-slag inner leaf has an overall thermal transmittance of only two-thirds that of an 11-in. cavity wall entirely of brick, and a transmittance of less than half that of a solid 9-in. brick wall. The use of glass wool for roof insulation was described. Besides reducing fuel consumption to maintain a given air temperature, good thermal insulation also raises the temperature of the inner surface of external walls and thus enhances comfort. Temperature gradients can be caused by the convection from cold walls or windows. Better insulation of the walls and tubular heaters beneath windows can cure this. Floor heating also helps to prevent these gradients, and when heating is by the admission of warmed air this should enter at low level and air exits should be placed at high level.

The temperatures maintained in houses depend not only on the preferences of the occupants, but also on the cost. Thus, in some experimental houses the temperatures in the living-rooms at 9 p.m. commonly averaged 65° F., but during cold weather the figure fell to 60° F. It was evident that the householders would not pay for the heat then required to maintain a temperature of 65° F. With improved insulation some of the potential saving of fuel may not be realized because higher temperatures are likely to be maintained by the occupants. Hence emphasis must be placed on better insulation without increased capital cost. One way in which this can be achieved is by use of the foamed-slag inner leaf in cavity walls.

Dr. C. G. Douglas, who opened the discussion, believes that the problems of heating and ventilating factories and offices are easier than those relating to houses. Instrumental methods have been devised for the study of the indoor environment, and the difficulties that now arise are mainly economic. It is important to consider what could be done to provide comfortable warmth for aged people with limited resources. The high cost of coal has driven many people to use kerosene for supplementary heating.

AHMEDABAD TEXTILE INDUSTRY'S RESEARCH ASSOCIATION

By DR. VIKRAM A. SARABHAI

Director

ON April 10, Mr. Jawaharlal Nehru, Prime Minister of India, opened the new laboratory building at Navrangpura, Ahmedabad 9, of the Ahmedabad Textile Industry's Research Association, the foundation stone of which was laid in November 1950 by the late Sardar Vallabhbhai Patel, Deputy Prime Minister of India. The Association is modelled on the same lines as the research associations in Great Britain, and this constitutes the first enterprise of its kind in which industry and the Government of India have co-operated in the field of research. The past five years have witnessed the growth in India of a chain of national laboratories inspired by Sir Shanti Bhatnagar, director of the Council of Scientific and Industrial Research, and Sir Shanti has also been actively associated with the growth and development of the new Association at Ahmedabad, which is the second largest centre of the textile industry in India.

The idea of establishing a textile research laboratory maintained by the joint effort of industry and the Government of India was first conceived by the Ahmedabad Millowners' Association in 1944, and the Ahmedabad Textile Industry's Research Association was registered in December 1947. Its seventy-one founder-members made an initial contribution of approximately £370,000 towards the initial expenses, and the Government of India gave approximately £145,000. The recurring expenses are shared equally by industry and the Government. Recently, membership of the Association was thrown open to mills all over India, and co-operative research is now increasingly made use of by the premier industry of the country.

The laboratories are on the Gujarat University campus and consist of a multi-story central block, covering an area of 100,000 sq. ft., which accommodates the library, offices and laboratories of the various research divisions, the administrative offices, the stores and precision workshop, and the services in a basement. The block is connected at one end to a single-story building which houses the pilot mill. At the other end are situated a cafeteria and an auditorium. The pilot mill is equipped with complete machinery for spinning, weaving and chemical processing, with facilities for experimenting under a variety of conditions. The physical testing laboratory has a comprehensive range of modern testing instruments for fibres, yarns and fabrics. The unit plant laboratory has a number of laboratory models of standard dyeing and printing machines and will also be equipped in the near future for some of the unit processes of chemical engineering. The entire building is air-conditioned for comfort, except for the physical testing room and the pilot mill, which have separate air-conditioning to maintain required constant temperatures and humidities.

Even though the laboratory building has only now been completed, the work of the Association commenced about five years ago in the Science College at Ahmedabad with the recruitment of staff for statistics, chemistry, physics and psychology. Recognizing the increasing importance of industrial psychology and the science of management, the Association decided from the outset to include these in its organization. It was also felt that during its early years the Association should commence its work with the utilization of existing scientific knowledge and apply this for the immediate benefit of the industry. Emphasis was deliberately placed on operational research aimed at standardization and rationalization of existing processes and work methods, and on applied research designed to introduce developments of practical use to the industry. This was done with the view of fostering scientific consciousness among those who work in the industry and creating confidence in the practical utility of applying the scientific method to the problems of industry.

Operational and applied research is generally carried out in the mills in collaboration with the technical staff of the mills. At all stages of the experiment, critical evaluation is continuously done in frequent conferences among the staff of the Association and in discussions with mill management and technicians. After the successful completion of experimental studies in two or three mills, the results are published in the form of research notes. This, however, constitutes only half the work. Successful implementation and translation of the benefits to industry are equally important tasks on which the Association has placed great emphasis. It believes it to be its duty to demonstrate without cost to its members, in their own mills, the full utility of implementation of its research work. However, every effort is made to ensure that its resources are not diverted to routine operations which legitimately fall within the domain of individual mill management. When circumstances require that the Association should be engaged in routine services, separate units are created for this purpose. In this way the Association operates routine physical and chemical testing laboratories and provides servicing and supervision of quality control, training-within-industry programmes and other management techniques to industry. The cost of these units is defrayed by the mills which participate in these benefits.

To-day the Association has eight Divisions dealing with Physics, Chemistry, Statistics, Psychology, Liaison, Technology, Library and Documentation and Administration.

Pending the establishment of the Textile Technology Division, the Physics Division mainly concentrated during the initial years on problems of spinning. It modified the micro-sample spinning technique developed in other laboratories so that a sample of one pound of cotton may be spun in a short time on the usual mill spinning plant under mill conditions of speeds, settings, etc. The yarns produced by this small-sample spinning method check well in lea strength with the yarns produced by the normal large-scale mill processes. This technique has also been used for investigating the application of various spinning aids and in the investigation of blending of cottons. A study has been undertaken of the fibre length distribution and the evenness of the material under process at various stages in spinning. This Division has a well-equipped optics laboratory in which work is being done at present on a study of the adsorption of dyes and other chemicals on the surface of textile materials. Attempts are also being made to correlate the degree of orientation of mercerized fibres with lustre and to use the X-ray technique for determining the degree of mercerization. A modest beginning in instrumentation and electronic developments has been made by creating a separate section for these in the Physics Division.

The Chemistry Division started initially with a survey of the various textile chemical processes in the member mills of the Association and the determination of optimum conditions for these processes. A detailed study of sizing practice was made, and simple experimental methods for the evaluation of sizing materials and methods were demonstrated to mills. Extensive studies were also made to assess the value of tamarind kernel-powder, an indigenous material, as a sizing material for cotton warps for both bleached and grey sorts. Suitable modifications were worked out to overcome the objectionable reddish colour of this material. A long-term fundamental study of sizing has been planned, and work on this programme has been started very recently. Attempts are also being made to produce improved finishes, using so far as possible indigenous materials. Three such processes have been worked out on a laboratory scale and will shortly be tried in mills on a pilot-plant scale. In order to explore the possibilities of mercerizing textiles made from Indian cottons, an extensive study has been undertaken on a comparison of the mercerization of different cottons (Indian, African, American and Egyptian) in fibre, yarn and cloth stages. The Chemistry Division also maintains a technical service which undertakes investigation of a number of production problems from the chemical processing departments of member mills.

The Textile Technology Division has been created this year with the arrival of machinery for the pilot mill. Among the problems that are being taken up for investigation are (1) the relationship between individual fibre characteristics of a blend and the properties of the yarn and its weavability, and (2) the effect of yarn conditioning, atmospheric conditions and loom tensions on weavability.

The main effort of the Statistics Division has been directed to the development and application of quality control methods to the textile industry. With the Association's collaboration, quality control sections have been established in about twenty-four mills, and statistical methods have been applied by these sections to improve operational characteristics such as breakages, uniformity, waste, damages and efficiency. The Statistics Division has also carried out a number of short-term experiments in spinning, including studies on the effect of mixing soft waste with cotton, the effect of vibrating bobbins, the effect of different speeds and settings in processing, a comparison of two and three passages of drawing, and an improved method of ribbon lap preparation. Theoretical studies of machine interference have also been made and are being checked with the results of actual mill working. At present the quality control technique is being extended to chemical processing. The possibility of introducing acceptance sampling is also being explored. The Division maintains a computing section to analyse the data coming from various Divisions as well as from the quality-control sections of mills; it publishes a quality-control bulletin incorporating the data collected by the various quality-control sections in mills and the results of experiments carried out by them, and conducts classes for training technicians in statistical methods.

The Psychology Division has been concerned mainly with problems of attitudes, labour management relations, supervisory training, incentives, time-and-motion studies, the effect of physical working conditions on the health of workers and their efficiency, etc. A number of interesting results have been obtained in these various fields, some of which have found practical application on a large scale in mills. A project was conducted during 1950–51 in collaboration with Prof. Gardner Murphy, Unesco consultant to the Government of India, in order to study labour-management tension within the textile industry. As a result of this study, the need for supervisory training was emphasized and training-within-industry programmes were started in 1953 to fulfil this need with the technical assistance of the International Labour Organization. Thirty-one mills are participating at present, and in the short period of one year 2,884 supervisors have been trained. The three training-within-industry programmes have been translated into the Gujerati language so that a greater number of supervisors can participate in them. At the joint request of organized industry and labour, the Psychology Division has worked extensively on assessment of work loads in the various occupations of the industry and on applying the job evaluation methods for recommending a scientific wage structure.

Recently the newly established Liaison Division has taken over, from the research divisions, primary responsibility of maintaining close contacts with member mills and the quick translation of the Association's research into routine industrial practice.

With the completion of the first five years of the Association, the need for a properly balanced research programme covering both fundamental and applied problems has been increasingly felt. Such a programme, where fundamental and applied research would complement one another and constantly provide new ideas, has now been initiated. With technical assistance from Unesco, a project for the study of the nature of macromolecules has been started. An equilibrium centrifuge and gas adsorption apparatus have been set up. Some of the other fundamental problems in this programme are the preparation and properties of colloid solutions with special reference to spinning aids; the spectrophotometric, colorimetric and chemical study of adsorption of substances on textiles; changes in the surface and mechanical properties and in the fine structure of textiles, caused by processes such as sizing, dyeing, mercerizing and finishing; the theory of tensile strength of yarns; the relation between structural geometry and mechanical properties of fabrics; and morale and attitude surveys. Along with the national laboratories of India, the Ahmedabad Textile Industry's Research Association is playing a significant part in tackling the great and important problems which face India to-day.

ABNORMAL PROPERTIES OF HISTONES FROM MALIGNANT CELLS

By Dr. H. J. CRUFT, Dr. C. M. MAURITZEN* and Dr. E. STEDMAN, F.R.S.

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THE main object of this article is to give a brief description of a difference which has been observed to exist between the histones of malignant and normal cells. For an appreciation of the nature and significance of this difference, however, a knowledge of the properties and behaviour of histones from normal cells is required. It is therefore proposed, before describing and discussing the results obtained with the histones from cancer tissue, to summarize the pertinent aspects of our knowledge of these proteins, much of which has not hitherto been published.

Basic Proteins of Cell Nuclei

It has long been known that proteins with pronounced basic properties are present in the sperm heads of many fishes as well as in the nuclei of calves' thymocytes and of nucleated erythrocytes, and more recent work has shown that such proteins are, in fact, widely distributed in the nuclei of animal, and probably also of plant, cells where they constitute a considerable proportion, in some cases amounting to 30 per cent, of the dry weight of the nucleus. Two types of such proteins have been distinguished, namely, protamines and histones, the former of which seem to occur only in the sperm heads of certain fishes. The best known and most investigated of the protamines are salmine and clupeine, the basic proteins present in the sperm heads of the salmon and herring, respectively. Their properties fully justify their separate classification on chemical grounds, for they are distinguished from the histones in three respects: their salts form true solutions in water; no aromatic amino-acids enter into their composition; and they possess considerably stronger basic properties due to a higher content of basic amino-acids. It is not certain if all the basic proteins which have been termed protamines exhibit these properties, for there is little information available about them, while some doubt remains about the purity of the specimens originally examined.

While justified on chemical grounds, the classification of the basic proteins of cell nuclei into protamines and histones is not warranted physiologically, for a study of their distribution indicates that they are homologous proteins. Thus, so far as they have been examined, all fish sperm heads contain a basic protein. In the salmon and herring this is a protamine. On the other hand, in the cod it is a histone. Taken in conjunction with the fact that basic proteins are present in all animal cell nuclei so far examined, this constitutes ample evidence of the identity of the functions of the two types of protein.

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* I.C.I. Research Fellow.

Composite Nature of Histones

The older work on histones served to demonstrate the occurrence of these proteins and to establish their general nature. With the development of methods for the isolation of cell nuclei from animal tissues additional to fish sperm and nucleated erythrocytes, the examination of an extended range of histones became possible. Such work[1,2], carried out in this laboratory, revealed the fact that the basic proteins extracted directly from isolated cell nuclei contained at least two components; one present in greater amount being provisionally termed the main histone and the other the subsidiary histone. As judged by their constancy in composition after fractionation, a number of the main histones were obtained in an apparently pure state. Purification of the subsidiary histones offered more difficulty, largely because of their occurrence in smaller amount. Nevertheless, two were fractionated to a degree approaching, although somewhat short of, purity. It has since been possible to supplement this work with electrophoretic studies both on many of the earlier preparations and on new ones obtained by identical methods. The results have confirmed and extended the former conclusions. Electrophoretic analysis indicates that, with few exceptions, the unfractionated histones extracted from isolated cell nuclei consist of three components. This is illustrated in Fig. 1, where the electrophoretic diagram obtained from the total histones extracted from the nuclei of fowls' erythrocytes is reproduced. It is proposed, following the convention in use for other proteins, to term these components, in descending order of mobility, α-, β- and γ-histones. By comparing the electrophoretic mobilities of histones from various sources with those of the fractionated preparations described in earlier investigations, it has been possible to identify the α-component with the subsidiary histones previously described. The so-called main histone consists essentially of the β-component contaminated with a small proportion of γ-component.

Cell Specificity of Histones

The species specificity of homologous proteins is such a general phenomenon that it would be expected to apply without question to the basic proteins of the cell nucleus. Nevertheless, it is difficult to demonstrate chemically such specificity if proteins of the same type are compared. Thus, salmine and clupeine, the protamines of the sperm heads of the salmon and herring respectively, are extraordinarily similar in chemical composition, although it is now known[3] that there are small differences between them, the most convincing being the presence of threonine in the latter and its absence in the former. With the recognition, however, that the histone present in the sperm head of the cod is homologous with the protamines in the sperm heads of the salmon and herring, no doubt remains that the basic proteins of nuclei from the same type of cell follow the general rule.

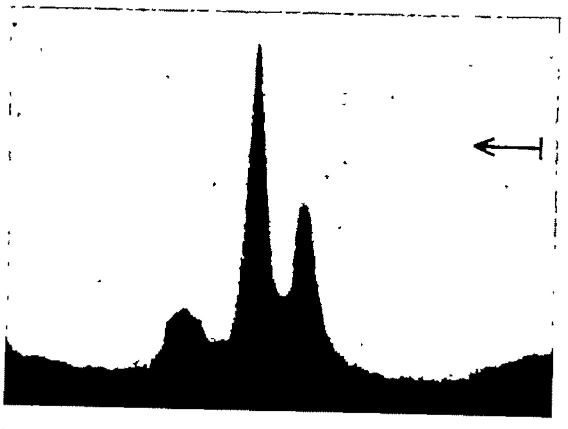

Fig. 1. Electrophoresis of total histone from fowl erythrocyte nuclei. Descending boundary; conc. 0·6 per cent; μ = 0·18; veronal buffer pH 7·6; showing α-, β- and γ-histones

In contrast to species specificity the cell specificity of proteins within a given organism has scarcely been discussed, no doubt because many of the proteins of the various types of cells exercise entirely different functions. But if the reasonable assumption be made that the nuclei in the different cells of the same species possess similar functions—an assumption which receives much cytogenetical and chemical justification—the question of the identity or cell specificity of the basic proteins of cell nuclei assumes considerable importance. For cell specificity in these proteins would imply that each protamine and histone was essential to, and possibly assisted in the control of, the particular character of the cell in which it occurred. That some protamines and histones are, in fact, cell specific has already been demonstrated. Thus, the nuclei of the erythrocytes and liver cells of the salmon contain histones in place of the protamine in the sperm head[3]. There is, moreover, some evidence that the histones in the two former types of cell differ considerably from one another in their arginine contents. The main histones in the erythrocytes and thymocytes of the fowl also differ demonstrably in their arginine contents, while the particular α-histone present in the erythrocytes of this species is entirely absent from the thymocytes[1]. It is true that the main histones from fowls' tissue upon which the analyses demonstrating their cell specificity were made were not homogeneous but, as indicated in the preceding section, consisted of mixtures of β- and γ-histones. This does not, however, invalidate the results, for it has since been found that the electrophoretically pure β-histones isolated from the main histones by preparative electrophoresis do not differ from the latter in their basic amino-acid contents. It is not yet certain if this absence of change in composition after purification is due to the relatively small quantity, which did not amount to more than a few per cent, of γ-component present in the main histones or to the very similar composition of the β- and γ-components, although some evidence, at present incomplete, supports the latter explanation. To illustrate the degree of purity attained by preparative electrophoresis, the electrophoretic diagram of a preparation of the β-histone from calves' thymus glands is reproduced in Fig. 2.

One impediment to the complete generalization of the above results on the cell specificity of histones has been the failure to detect any difference between the compositions of the main histones from the liver cells and thymocytes of the ox. It has now been found that these two β-histones possess different isoelectric points, which are at pH 11·0 and 10·8 respectively for the thymus and liver histones, and that their electrophoretic mobilities differ from one

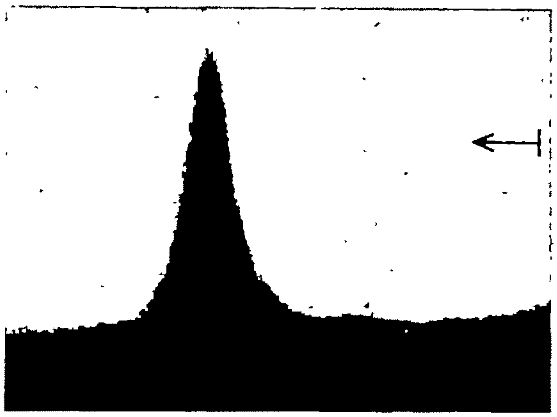

Fig. 2. Electrophoresis of pure β-histone from ox thymus nuclei. Descending boundary; conc. 0·5 per cent; $\mu = 0\cdot18$; veronal buffer pH 6·2

another over a wide range of pH[8]. These differences are outside the limits of experimental error. They are nevertheless so small as not, perhaps, to appear completely convincing, particularly as attempts to effect the electrophoretic separation of a mixture of the two histones gave inconclusive results. As will be described below, the cause of this failure has now been ascertained, with the result that no doubt remains that the β-histones from the liver cells and thymocytes are different substances. This achievement goes a long way to establishing as a generalization the former finding that the basic proteins of many cell nuclei are cell specific.

Aggregation of Histones

The key to the solution of the problem of unequivocally distinguishing between the liver and thymus β-histones of the ox was provided by determinations of the rates of diffusion of the two proteins. These measurements, which were made in the Hilger Tiselius electrophoresis apparatus, were primarily required for other purposes; nevertheless, it was hoped that they might also provide evidence of differences between the physical properties of the two histones. No such evidence was, however, obtained. On the contrary, the rates of diffusion of the two substances were indistinguishable at all pH's examined. This is evident from Fig. 3, where the diffusion constants are plotted against pH. While giving another example of the very great similarity which exists between the two histones and thus tending to suggest that they are identical, the curve in Fig. 3 is nevertheless remarkable in that it indicates not only that aggregation of the protein micelles takes place, but that this aggregation increases much more rapidly with increase in pH than is usual with other proteins. This can be better appreciated from the particle weights. When these are calculated by standard methods from the diffusion constants and the viscosities of the solutions, it is found that they increase from $7\cdot6 \times 10^4$ at pH 1·4 to 7×10^6 at pH 7·0. In other words, the particle weight at pH 7·0 is approximately 100 times that at pH 1·4.

Mixed Aggregates of Histones

The histones of the liver cells and thymocytes are clearly very closely related to one another. Their basic amino-acid and tyrosine contents are indistinguishable; their electrophoretic mobilities and isoelectric points differ only slightly; their particle weights in solution are, within the limits of experimental error, identical; and they possess the same pronounced capacity to form aggregates, which they do to the same degree and with the same dependence upon pH. This great similarity between them suggested that under appropriate conditions they might be capable of forming mixed aggregates in solution which would simulate the behaviour of a homogeneous protein. If this were the case an explanation would be offered of the failure, referred to above, to effect an unequivocal separation of a mixture of the two histones by electrophoresis in the Tiselius apparatus. The conditions used for preparing a solution of the mixture, which were identical with those employed for making the solutions for electrophoresis or diffusion experiments, were, moreover, such as to favour the formation of mixed aggregates if the molecules possessed the capacity to do this. Thus, in each type of experiment, the sulphate of the histone or histones, which itself would yield an acid solution of about pH 2·0 if dissolved in water, was dissolved in dilute hydrochloric acid and the solution brought to a less acid pH by dialysis against the appropriate buffer for a period of about three days. By this procedure the histone was changed slowly from an unaggregated or little aggregated form to that characteristic of the final pH of the solution. Every opportunity was thus provided for the formation of mixed aggregates when two histones were used.

With the object of submitting the above suggestion to experimental verification, it was postulated that if separate solutions of the two histones at the same pH and in a highly aggregated form were mixed, the formation of mixed aggregates would either not take place at all or would only do so extremely slowly. In either case, it should be possible to effect their separation from the mixture by electrophoresis. Tests of this postulate with artificial mixtures of the β-histones from ox liver and thymus glands have not only resulted in its verification but also have simultaneously conclusively demonstrated that the two histones are different compounds. This is illustrated

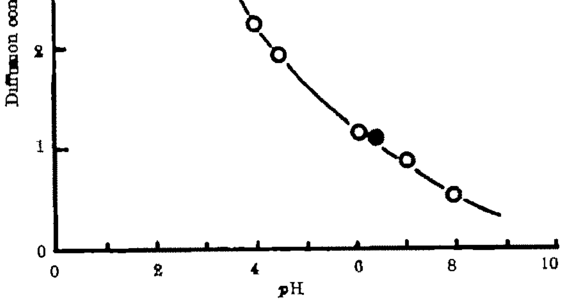

Fig. 3. Graph of diffusion constant against pH, for ox thymus and ox liver β-histones; conc. 0·5 per cent; $\mu = 0\cdot2$; veronal-HCl buffers

Ox thymus β-histone, ○; ox liver β-histone, ●

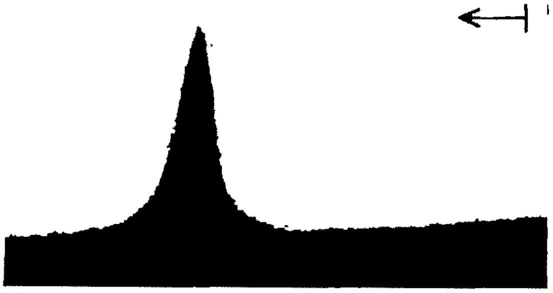

Fig. 4. Electrophoresis of an artificial mixture of ox thymus and ox liver β-histones, solution of the mixture dialysed for 60 hr., conc. 0·6 per cent total; $\mu = 0·18$; veronal buffer pH 8·6

in Figs. 4 and 5, which give electrophoresis diagrams for mixtures of liver and thymus histones dialysed together and separately at *p*H 8·7. A similar separation was obtained at *p*H 6·7. Other experiments have shown that mixed aggregates are formed with both dialysis procedures when the *p*H of the buffer is between 4·0 and 5·0. As can be seen from Fig. 3, this corresponds with the *p*H at which a rapid increase in aggregation commences. It is thus evident that below *p*H 5·0 aggregation is too small and perhaps too labile to prevent the formation of mixed aggregates on mixing solutions of the two histones.

Another example of the formation of mixed aggregates between different histones will be recorded below. Whether it is a general phenomenon among histones or whether it is confined to very closely related histones is not yet known. It is possible that it may even occur between histones and other proteins, and thus account for the power of histones to precipitate other proteins from solution.

The Histones of Malignant Cells

The investigation of the nature and properties of the components of normal cell nuclei which has been in progress in this laboratory for more than twelve years has been carried out not only for its own intrinsic interest, but also because it seemed to be a necessary preliminary to an examination of the characteristics of the nuclei of malignant cells. Some malignant cells have, nevertheless, occasionally been examined concurrently with this work on normal cells, particularly when suitable cancer tissue has become available. But in the absence of detailed information about the nature and functions of the components of the nuclei of normal cells, such investigations have necessarily been somewhat restricted in scope.

The earliest work[4] of this kind indicated that the nuclei of malignant cells differed from normal cell nuclei in containing a much smaller amount of histone. Similar results have since been obtained by Debov[5], and further examples have also been encountered in this laboratory. Thus, the nuclei from a human breast sarcoma yielded only 4 per cent of their dry weight of histone sulphate as compared with a yield of 25–30 per cent from many normal cell nuclei. Similarly, in work to be discussed below in another connexion, the nuclei from an induced rat hepatoma gave only 14·8 per cent histone sulphate. Nevertheless, such great deficiencies in histone do not appear to be characteristic of all cancer tissue, for, while high contents have never been observed in nuclei prepared from such material, figures which approach the normal value have occasionally been obtained. This was the case, for example, with a human bronchogenic carcinoma, the nuclei of which yielded 20·5 per cent of their dry weight of histone sulphate. In view of this result it appears probable that the low content of histone in the nuclei of many malignant cells is a result rather than a cause of their abnormal nature.

A new approach to the cancer problem became possible with the discovery that histones are cell specific. As an expression of the possible physiological meaning of this remarkable phenomenon, the hypothesis was advanced[1,2] that these basic proteins function in the nucleus as gene inhibitors, thus maintaining, if not wholly determining, the character of the cells in which they are present. It was implicit in this hypothesis that a change in the properties of the histone present in a cell would result in a change in its character, so that the transformation of a normal into a malignant cell would necessarily be associated with a change in the histone which it contained. Histones from both human cancers and experimental tumours have therefore been examined from this point of view.

In the first phase of the work, material accumulated by Stedman and Stedman during the course of their earlier studies was mainly used. This consisted of the β-histones obtained from the nuclei from: (1) the lymph glands in a case of human lymphatic leukæmia, (2) a human bronchogenic carcinoma, (3) a human breast sarcoma, (4) the Walker rat carcinoma, (5) the mouse carcinoma 2146, and (6) the *Rb*3 transplantable rat sarcoma induced by dibenzanthracene. All these histones were found to differ markedly from those from normal tissues in two respects. They proved to be much less soluble, and to possess considerably smaller electrophoretic mobilities than normal histones. These divergences are well illustrated by the behaviour of the histone from the case of lymphatic leukæmia. When a 0·5 per cent solution of the sulphate of this histone in dilute hydrochloric acid is dialysed against a veronal buffer above a *p*H of 4·6 for several days, a precipitate of the histone forms in the solution. The precipitation is complete at *p*H 7·0 and nearly so at *p*H 5·0. In contrast to this behaviour, histones from normal tissue such as

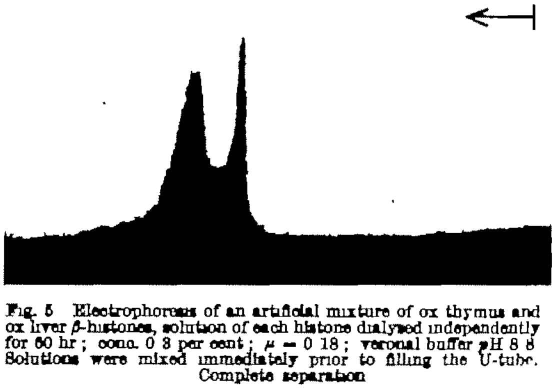

Fig. 5 Electrophoresis of an artificial mixture of ox thymus and ox liver β-histones, solution of each histone dialysed independently for 60 hr; conc. 0·3 per cent; $\mu = 0·18$; veronal buffer pH 8·6. Solutions were mixed immediately prior to filling the U-tube. Complete separation

ox liver and thymus glands, fowl erythrocytes and mouse spleen and liver, exhibit no tendency to precipitate under the same conditions until a *p*H of about 10·0 is reached, that is, one approaching their isoelectric points. It is true that normal histones show an increased Tyndall effect, indicative of an increase in aggregation, with increasing alkalinity; but this effect is present in the tumour histones in much more acid solutions. The insolubility of the leukæmic histone necessarily restricts the *p*H-range over which its electrophoretic mobility can be measured. Nevertheless, in the range below *p*H 4·6, where such determinations are possible, its mobility falls with increasing *p*H very much more rapidly than is the case with normal histones. The *p*H-mobility curve appeared, in fact, to suggest that its isoelectric point is in the region of *p*H 7·0. Similar solubility and mobility effects, although sometimes somewhat less marked, were observed with the other abnormal histones[8].

The above results show that the physical properties of histones from malignant cells exhibit pronounced differences from those of normal cells. There is presumably an underlying chemical cause of these differences; but its nature has not yet been ascertained. Analytical results do not suggest that deficiencies in basic amino-acids are involved. Many features of the abnormalities could, however, be explained by an increased content of acidic amino-acids; but a further discussion of this point must await its experimental verification.

There is one respect in which the above experiments fall short of the ideal: no direct comparison was made between the histone from a malignant cell and the cell type from which it originated. It is true that, in the course of this investigation, the histone from human thymocytes has been found to exhibit a normal behaviour with respect both to solubility and electrophoretic mobility; but it might be argued that the thymocyte was of a different cell type from the lymphocyte. It was therefore deemed advisable to repair what might be regarded as a defect in this work.

For this purpose malignant hepatomas were induced in rats by the well-known method of including 3′-methyl-4-dimethylaminoazobenzene in their diets. After the tumours became palpable they were allowed to grow for 10–14 days or until the animal became moribund, whichever was the shorter period.

As the growth of the tumours had proceeded to different degrees in the individual rats, they were divided into two groups according to their weight. Those weighing between 15 and 20 gm. were termed early stage tumours, while the larger ones, weighing between 40 and 90 gm., were described as fully developed tumours. The cell nuclei were prepared separately from the two groups as well as from normal rat livers by our general methods[4], and the histones extracted from them by our normal procedure[3]. Without any purification by fractionation, all three preparations surprisingly proved to be electrophoretically homogeneous. It is certain, from their behaviour and properties, that they are not α-histones, but it is impossible at present to decide whether they are β- or γ-histones, although they are presumed to be the former.

In conformity with the behaviour of the other tumour histones, that from the fully developed rat hepatoma possessed a solubility of less than 0·5 per cent in a veronal buffer at *p*H 5·8. In other words, on dialysing a 0·5 per cent solution of the histone in dilute hydrochloric acid against the buffer, a considerable proportion of it was precipitated from the solution. On the other hand, the histone from the normal rat livers, when treated in precisely the same way, formed no precipitate, nor did it do so when the *p*H of the buffer was increased to about 8·5, the greatest alkalinity tested. The electrophoretic mobilities of the two histones, reproduced in Fig. 6, also differed, the hepatoma histone showing the rapid fall in mobility with increase in *p*H which characterized the other tumour histones. Not only do these histones differ, however, in physical properties. Quantitative determinations of their basic amino-acid contents show that they also differ significantly in their lysine and arginine contents.

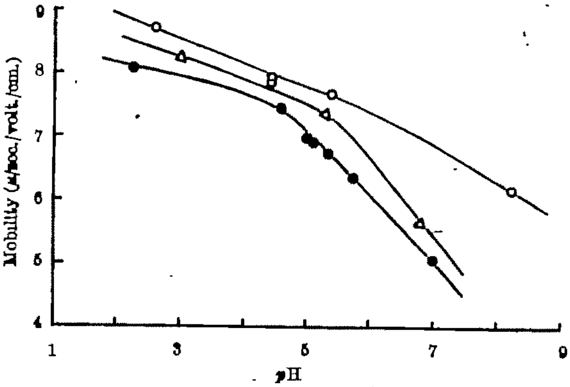

Fig. 6. Mobility – *p*H curves for rat liver histones conc. 0·1–0·5 per cent; $\mu = 0{\cdot}18$; veronal buffers.
Normal rat liver histone, ○; early stage rat hepatoma histone, △; fully developed rat hepatoma histone, ●

While thus giving confirmation of the earlier results, the experiments with the rat hepatomas presented one feature which was at first puzzling. The histone from the early stage hepatoma, although electrophoretically homogeneous, exhibited properties which, as is evident from Fig. 6, were intermediate between those of the other two. In default of any better explanation, this would imply a continuous change in the properties of the histone during the growth of the tumour, despite the contradiction inherent in this implication. A better explanation can, however, be given. Although care was taken to remove normal liver tissue from the early stage tumours, this tumour tissue would undoubtedly still contain a moderate proportion of normal liver cells. As a result, the histone isolated from it would originate partly from hepatoma and partly from liver cells. If the two histones from these different cells then formed mixed aggregates in the manner demonstrated above for ox liver and thymus histones, the product would be electrophoretically homogeneous with a mobility intermediate between those of the two components. In support of this explanation it has been found that a mixture of normal rat liver histone and the histone from the fully developed hepatoma dialysed together at *p*H 5·0 or 6·8 does, in fact, simulate the electrophoretic behaviour of the histone from the early stage hepatoma. But when they are dialysed separately at *p*H 7·25, a procedure which necessarily has to be carried out at the low concentration of about 0·14 per cent for each histone, and then mixed, separation of the components occurs on electrophoresis as with the thymus and liver histones of the ox.

Two main conclusions may be drawn from the above work on malignant cells: (1) the histones present in the nuclei of such cells are, like those of normal cells, cell specific; (2) the histones of cancer cells are characterized by solubilities and electrophoretic mobilities which are smaller than those of normal cells. These effects are associated with their greater ability, as shown by their small diffusion constants, to aggregate in solutions more acid than neutrality.

The results also support the hypothesis that histones function as gene inhibitors. It is not proposed, however, to discuss either this point or its obvious implications, for it is clear that, while the results accord with the hypothesis, they do not give final confirmation to it. But it is perhaps not out of place to point out that this work constitutes the first occasion on which a characteristic and qualitative difference has been shown to exist between a known cell component isolated from malignant cells and that obtained from normal cells.

One observation made during the course of this investigation, although it does not form part of the main theme of this article, seems of sufficient importance to be mentioned by way of a postscript. As pointed out by Miller and Miller[7], when rats are fed 3′-methyl-4-dimethylaminoazobenzene, the dye becomes bound to the liver proteins. This binding reaches a maximum in a month and thereafter slowly and continuously diminishes. In the present work, nuclei were isolated from the livers at this particular period and examined. They were found to contain dye. Nevertheless, the histone extracted from the nuclei was completely free from dye, which remained bound to the nuclear residue. If Miller and Miller's statement that deoxyribonucleic acid does not bind the dye is correct, it follows that it must be bound by chromosomin. It is thus possible that the first stage of its carcinogenic action is its attachment to the protein of the chromosomes.

We acknowledge with thanks the receipt of a grant from the Department of Health for Scotland which has defrayed part of the expense of this investigation.

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OBITUARIES

Dr. H. A. Lafferty

HENRY ALOYSIUS LAFFERTY was born at Ardstraw, Co. Tyrone, on May 10, 1891. His early education took place at the local National School; at St. Columb's College, Londonderry; and at the Christian Brothers School, Omagh. He entered the Albert Agricultural College, Glasnevin, in 1908, and in the following year was awarded an agricultural scholarship into the Royal College of Science, Dublin. On receiving his diploma of the latter institution in 1912 he became a research scholar under Dr. Pethybridge, and later was appointed assistant in the Seeds and Plant Disease Division. He held this post until 1921 and was then appointed junior agricultural inspector. On Dr. Pethybridge's resignation in 1923, Lafferty became head of the Seed Testing and Economic Botany Division of the Department of Agriculture, Republic of Ireland, a post which he held until his death.

Lafferty collaborated with Pethybridge for a number of years on investigating potato diseases in the west of Ireland; but he is best known in the plant pathological world by his contributions to our knowledge of flax diseases, in investigations of which he played an important part.

During the First World War flax became an important crop, as linen was then in high demand for aeroplane construction, and foreign sources of raw material were cut off. Scarcely anything was then known about diseases of flax, and the incidence of failures, or partial failures, of this crop due to disease was common. Pethybridge appointed Lafferty to investigate this problem, and no more suitable choice could have been made. Coming from a farming community situated in the centre of a big flax-growing district, and from a family which from the early years of the nineteenth century had been engaged, first, in processing flax and later as flax buyers, Lafferty was familiar with this crop in all its cultural stages and in its preparation for spinning. This knowledge, together with his training in plant pathology, made him the ideal research worker for the job. As a result, during the period 1917–22, all the major maladies of flax in these islands were fully described and the life-history of each of the causal organisms investigated. The published reports of these researches were not only of scientific but also of economic value.

Besides the reports on investigations on flax diseases, Lafferty was joint author with Pethybridge on maladies of potato, tomato and apples, and his scientific investigations gained him the fellowship of the Royal College of Science in 1923, and afterwards the degree of D.Sc. of the National University in 1938.

As head of the Seed Testing Station from 1923 onwards, his duties left Lafferty little time for investigation of plant diseases. The knowledge of these, however, proved invaluable to him in his new post, and especially so as no plant pathologist was attached to the Seed Testing Station. Although severed from practical investigations, Lafferty never ceased to take an interest in plant pathology, and at the International Seed Testing Congress in Rome in 1928, he spoke on the importance of seed-borne diseases—an international problem which is attracting considerable attention at the present time.

He was very successful in his administration of the Dublin Seed Testing Station, and he took a personal interest in every one of his staff. Among the seed merchants he was held in the highest esteem, while the farming community will always be indebted to him for his endeavours to improve the quality of agricultural seeds sold in Ireland. Lafferty published a number of articles relative to seed testing in the *Journal* of the Department of Agriculture, Dublin, and he was a regular contributor to reports of the International Seed Testing Association.

Recognition of his work was shown by his unanimous selection as president of the International Seed Testing Association in Washington in 1950. His retention of this position each year since was a tribute to the efficiency and courtesy with which he carried out his duties. These culminated in his very successful organization of the Society's International Congress held in Dublin in May 1953.

As a debater at meetings, Lafferty had few equals and his personality was outstanding. Following a chat with him in the ordinary course of work, one always came away stimulated.

A few years ago Dr. Lafferty suffered a serious illness. Although afterwards he resumed duties, he never fully recovered his health. Then in 1953 he had a relapse, yet was again back at the Seed Testing Station in June 1954; but his return was of short duration as he soon suffered a further relapse, and he died on July 19. He was predeceased by his wife some years ago, and he is survived by two sons for whom the greatest sympathy is felt. R. McKay

Dr. W. E. Foster

Dr. W. E. Foster, who died on August 3 as a result of a motor-cycle accident, was lecturer in botany in the Durham Colleges, University of Durham. Apart from the period 1945–49, when he was an I.C.I. Fellow, he had held this appointment since 1940, when he went to Durham from King's College, Newcastle upon Tyne. He had done much work on the physiology and biochemistry of respiration, including studies of carbon dioxide zymasis; recently he had been engaged in work on physiological ecology with special reference to the oxygen supply and respiration of marsh plants. He was a gifted lecturer and an inspiring teacher; and his untimely death at the age of forty-three is deeply regretted by his many pupils, as well as by his friends and colleagues.

NEWS and VIEWS

Chemistry at Dundee: Prof. A. D. Walsh

Dr. A. D. Walsh, who is to succeed Prof. D. H. Everett (see *Nature* of March 20, 1954, p. 523) in the chair of chemistry at Queen's College, Dundee, is thirty-eight years of age and since 1949 has been successively lecturer and reader in physical chemistry in the University of Leeds. He received his undergraduate training in Cambridge, entering Corpus Christi College as an Open Scholar in 1935. His first research (with Dr. W. C. Price) was concerned with the measurement of the far ultra-violet absorption spectra of simple molecules, from which it is possible to compute their ionization potentials. More recently Dr. Walsh has greatly extended the range of his investigations in this field in a manner which has added very considerably to our knowledge of molecular structure. During the War his attention was directed to chemical processes occurring in internal combustion engines. From this work his interest naturally extended into the field of spontaneous combustion. Both in the fields of spectroscopy and of combustion Dr. Walsh has made distinctive and original contributions and, because of his capacity for lucid exposition, has been greatly in demand as a lecturer both in Britain and overseas. Although his departure is a serious loss for chemistry at Leeds, he will take with him to Dundee the good wishes of his colleagues and friends for success in his new post.

J. L. Proust (1754–1826)

One of the architects of modern chemistry, Joseph Louis Proust, was born in Angers two hundred years ago, on September 26, 1754. He began his chemical studies in his father's apothecary's shop and later became chief pharmacist to the Salpêtrière in Paris. In 1784 he made one of the first man-carrying balloon ascents with J. F. Pilâtre de Rozier, in whose *musée* he gave lectures on chemistry. From Paris he went to Spain, teaching chemistry at the artillery school in Segovia, and later at Salamanca. He served as director of the royal laboratory in Madrid during 1789–1808, when the Peninsular War ruined his career and the invading French army destroyed his laboratory and collections. It was in Madrid that his greatest and most enduring work was done. The period 1799–1807 witnessed his prolonged and bitter controversy with Jean Claude Berthollet. With brilliant analytic skill and logical reasoning, Proust pointed out some of Berthollet's errors, showed that chemical combination occurs only in fixed proportions by weight, and thereby established the law of definite chemical proportions. In 1805 he demonstrated the presence of dextrose in various natural products, and he discovered leucine in 1819. Receiving a pension from Louis XVIII, he retired to Craon in Mayenne, was elected to the Paris Academy of Sciences in 1816, and finally returned to the town of his birth, where he died on July 5, 1826, aged seventy-two.

Fire and the Atom Bomb

Fire Research Bulletin No. 1, entitled "Fire and the Atomic Bomb", by D. L. Lawson (pp. 30. London: H.M.S.O., 1954; 2*s*. 6*d*. net), deals specifically with the starting of fires by an atomic explosion and is based on a series of lectures arranged by the Home Office in May 1952 for senior fire officers and senior members of civil defence organizations. The report is written in a semi-popular style, and detailed analyses are omitted with the expressed hope that the report will be technically within the reach of a wide circle of readers. Nevertheless, it is not for the layman, and furthermore, since it is based on the official information contained in "The Effect of Atomic Weapons" (U.S. Department of Defense and U.S. Atomic Energy Commission: McGraw-Hill Book Co., 1950) and thus only on the very earliest of atom bombs, it will lose much of its interest even for those qualified to understand its details. The governing principle, as expected, is not to try to prevent all fires as a result of an atomic explosion, but to aim at reducing the fire danger to a minimum. It is important, therefore, to realize that about one-third of the energy of the bomb is released as heat radiation and that the fire danger occurs in the second flash period lasting for about three seconds, during which the bomb gives off an amount of heat equivalent to approximately 7×10^{12} calories. Accordingly, the first half of the report discusses in some detail radiation as a mode of heat transfer, the ignition of materials by an atomic flash and the physiological effect of heat radiation. In the latter half, concerned with fire prevention, attention is directed to fires started by radiation coming through windows. First, inflammable materials inside a room must be kept outside the danger zone and, secondly, the heat radiation must be prevented as far as possible from entering the room by, for example, fixing some incombustible board across the window space. Any board opaque to light radiation will also form a barrier to the heat, and various means of cutting off the radiation without obscuring the daylight are mentioned.

Formation of Plates of Grey Tin

In a brief communication to the *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen* (57, 79, Jan./Feb.; 1954), L. J. Groen and W. G. Burgers report an important development in that they have been successful in obtaining the first compact pieces of grey tin, about 1 mm. thick and with a surface area of about 25 sq. mm. Previously, grey tin has been obtained only in powder form. From their experiments, the authors judge that the essential conditions for the preparation of the compact form are the use of thin sheets of white tin from which the grey tin is formed, a slow rate of transition and the growth of only one grey tin nucleus. The thin sheets enable the grey tin to extend in volume without splitting too soon under the stresses due to its extension; slow growth, attained by cooling to − 8° C. instead of the usual − 50° C., and starting at one point in the white tin favour a uniform formation of the grey phase. The purity of the white tin used, which in the authors' case was not less than 99·99 per cent, also has an influence. Compact pieces of grey tin were obtained starting with both polycrystalline material and with single crystals. In one instance, starting from a single crystal, a grey single crystal was formed, and a Laue transmission photograph of this single crystal is given in the report.

"Philips Serving Science and Industry"

The technical reports of Philips Industries, Ltd., are well known to the scientific world for the publication of original scientific papers of high merit and often of considerable importance. The series, now terminated, on "Electronic Measuring Instruments", which described new Philips instruments and their applications, was not, however, so well known. A new series has recently been started, known as "Philips Serving Science and Industry" (1, No. 1; 1954. Pp. 32; Eindhoven: N. V. Philips' Gloeilampenfabrieken. 25*s*. per volume of six numbers), and this, as its title implies, has broader terms of reference. In addition to the instrumentation covered by its predecessor, it is designed to deal generally with the engineering and other technological developments of the company and is to be issued monthly by the Industrial Products Division. The first number contains articles on dielectric heating in woodwork fabrication and on a rectifier installation in the water purification plant for Rotterdam; in addition there are contributions on instruments, which comprise vibration recorders, oscilloscopes and the 75-kV. electron microscope. The articles are technical, but the treatment is elementary so that the non-specialist will find the material easy to read and understand.

Impregnation of Small Friable Objects

In the *Museums Journal* for August, Mr. E. Martin Burgess, of the Department of Egyptology, University College, London, describes an inexpensive vacuum tank for impregnating small friable objects. Up to the present, the method has only been used with polyvinyl acetate dissolved in toluene; but it could probably be used with as good results with 'Bedacryl' or other similar strengtheners. Polyvinyl acetate solution may be painted or sprayed on objects; but the solutions must be weak to achieve sufficient penetration. This tends to produce an undesirable glossy surface, and although this may be removed by toluene, a weakening of the surface of the object results. Total immersion produced better results; but it was still doubtful whether full impregnation had been achieved. The only really satisfactory method is to place the object in a sealed chamber containing the strengthening solution and to pump out the air. For this purpose a vacuum desiccator can be used and evacuated with a water pump if some form of trap is placed between the pump and desiccator to prevent water from getting into the solution on release of the vacuum.

Books on Agriculture and Horticulture

The third edition of "Books on Agriculture and Horticulture" has recently been published (H.M.S.O. Bull. 78. 3*s*. net). Though, according to the subtitle, this list is "Selected" (and compilers of select lists will always meet their critics), it is misleading, for no matter how concise or how comprehensive a book-list aims at being, there is no excuse for including books which can be shown to be out of print, or excluding definitely acknowledged texts. This list errs in both ways. Far too many out-of-print books are included, though since some of them may be available in libraries their appearance in such a list as this may be justified; but not when other more up-to-date books are omitted. The books are also classified according to subject; even here it is difficult in certain cases to see on what basis the compiler fits a book into a certain section. Since this list is "prepared by the Ministry of Agriculture and Fisheries" it carries the weight of authority; the compiler should therefore have taken care to ensure that his selection is at least up to date. Inquiries from publishers would have given all the information required for sifting and selecting.

A Game Reserve

The reasons why the Mijeti area in the north-west corner of the Chikwawa district of Nyasaland has been chosen as a possible game reserve by the Fauna Preservation Society of Nyasaland are explained in the latest issue of *Oryx* (2, No. 5; August 1954). The country is rough and wild and has both advantages and disadvantages. One disadvantage is that it would be difficult to attract visitors since they would be unable to see the animals, even when it becomes possible to construct roads through the area. A great advantage is that the area now affords considerable protection from poaching. The main difficulty, however, is to keep the many active animals within the area because of the lack of water during years of poor rainfall. In 1950 the Fauna Preservation Society of Nyasaland approached the Government to see if Mijeti could be declared a game reserve. The shortage of water was admitted to be a serious difficulty, and the Government would only agree to give the Mijeti the status of a non-shooting area, until it could be proved that the game could be kept all the year round within its boundaries. Faced with this challenge, the Nyasaland Fauna Preservation Society decided to do everything within its powers to meet the demand for water, and funds were voted from meagre resources for the building of dams and otherwise improving supplies. Some of these dams have already been constructed and are serving their purpose; more are to be built during the coming dry season.

Welwitschia mirabilis

In a brief but factually rich paper entitled "*Welwitschia mirabilis* Hook. F. from Seed to Seed in the Botanic Garden of the University of Stellenbosch, C.P.", H. Herre has given new and interesting information concerning this remarkable plant (*J. South Afric. Bot.*, 22, I, 23; 1954). In and near Angola, where the species occurs, it is stated that plants are not at all rare; also, farther to the north, plants are to be found growing freely among grasses and small bushes and are not necessarily confined to desert-like areas. H. Herre states that the local inhabitants use the dry parts of the leaves for fire-making and the bigger stems as chairs. The plants typically grow in old river beds and may develop very extensive root systems, up to 60 ft. long. Young plants apparently depend on mists for their main supply of moisture. The plants are exceedingly slow in their growth and it is estimated that very large specimens, with a stem diameter of 10–15 ft., may well be as much as a thousand years old. Some twenty-five years ago seeds were first germinated in the Stellenbosch Botanic Garden. It was observed that seedlings, immediately on germination, form a long tap-root and two cotyledons. The cotyledons are followed by two leaves; these persist throughout the life of the plant and are, in fact, the only leaves the plant ever has. They wear away at the tips and are constantly renewed by growth at the leaf-base. The flowers, which are dioecious, are produced annually. Under Stellenbosch conditions, twenty-three years elapsed before the first (female) flower appeared. Some details of the floral development and pollination are given, a brown bug being the agent of pollination in the plant's natural habitat. The paper is illustrated by some good photographs.

Vegetative Proliferation in Grass Spikelets

THE proliferation of spikelets in grasses other than those races which are habitually viviparous, and the factors which induce proliferation under experimental conditions in *Cynosurus cristatus* and other species, have been discussed by P. R. Wycherley (*Ann. Bot.*, N.S., 18, Jan. 1954). It is concluded that the evidence favours the hypothesis that in the viviparous races a considerably greater minimal concentration of the putative flowering hormone is required for flower induction than for culm initiation, whereas in the seminiferous races this difference is not so great. In the viviparous races, the threshold for flower initiation is rarely exceeded so that perfect flowers appear only occasionally, while in the normally seminiferous races the conditions arise only rarely where an amount of hormone is produced sufficient to initiate culms but insufficient to promote flowering.

Fuel Research Board: Report for 1953

IN these days when public attention is being focused from many directions on questions relating to fuel, its use and misuse, the report for 1953 of the Fuel Research Board with the report of the Director of Fuel Research (pp. 68 + 4 plates. London: H.M.S.O., 1954; 2*s*. 6*d*. net) is particularly opportune. One of the fields of misuse became the subject of public attention as the result of the persistent and highly polluted fog experienced in London in December 1952, and as a result the Government instituted a special inquiry into the broad aspects of the problem of atmospheric pollution and the preventive measures necessary to abate its effects on health and property. (No. 95 of "Reports on Public Health and Medical Subjects", which deals with the great fog of December 1952, has now been published; pp. 61 (London: H.M.S.O., 1954); 2*s*. 6*d*. net.) In the report of the Fuel Research Board will be found many references to the nation-wide surveys of pollution and to the research work which has been prosecuted by the Board for some time into the problems involved. It is opportune, too, that there should be recognition that these matters have not been neglected, and that, in addition, the problem is associated with the work of many other organizations—indeed, with the daily work of almost everyone who is concerned technically with the use of fuel of any type. Most interesting is the statement that the work on the programme of domestic heating has become intensified, for nearly one-half of the pollution by smoke arises from the use of coal in household grates, and this aspect of smoke pollution involves the most difficult problems in the application of preventive measures. Many other fields of fuel research are dealt with in the report, including work on the chemical and physical examination of coal, carbonization, gasification, the synthesis of oil and chemicals from coal, fuel oils, boilers and steam-raising, and the combustion in the coal-fired gas turbine; indeed, the multitude of activities must involve considerable co-ordination with other more specialized organizations also dealing with these aspects of fuel research.

Bibliography of Colour Television

THE Television Society has recently published a most useful "Bibliography of Colour Television" (pp. 16; from the Television Society, 164 Shaftesbury Avenue, London, W.C.2; 1954; 2*s*. 6*d*. post free), which was prepared in November 1953 by Mrs. K. Bourton, librarian of Ultra Electric, Ltd., and circulated among members of the radio industry. The bibliography is divided into two sections: optical and electrical. The former starts with a reference to a paper by J. Clerk Maxwell, "On the Theory of Compound Colours and their Relation to the Colours of the Spectrum" (*Phil. Trans. Roy. Soc.*, 1860), and continues with sixty-eight references to papers and books published up to 1952. The electrical section contains 313 references to papers and books, arranged in chronological order from 1934 to 1954. A list of abbreviations used and an alphabetical list of authors are included. This brochure should prove most useful to all those engaged in the science and future development of colour television.

Fourteenth Congress of Pure and Applied Chemistry, Zurich

THE Fourteenth International Congress of Pure and Applied Chemistry will be held in Zurich during July 20–28, 1955, under the presidency of Prof. P. Karrer (Zurich). At the same time, during July 21–27, the opportunity will be taken to hold the Eighteenth Conference of the International Union of Pure and Applied Chemistry, under the presidency of Prof. A. Tiselius (Uppsala). Further information regarding the Conference can be obtained from Prof. R. Delaby, 4 Avenue de l'Observatoire, Paris 6e. The Congress will be concerned exclusively with pure and applied organic chemistry and has been provisionally subdivided into three main sections: theoretical and physical organic chemistry (molecular structure, stereochemistry and reaction mechanisms); natural products (aliphatic and alicyclic compounds, including terpenes and steroids, carbohydrates, amino-acids, aromatic and heterocyclic compounds, alkaloids and glycosides); and synthetic, industrial and analytical organic chemistry (dyestuffs, plastics, tanning agents, synthetic resins, and synthetic and analytical methods). Those wishing to read papers (10–20 min. duration) must send a short summary before February 1955. All inquiries relative to the Congress should be directed to the Secretary-General, XIVth International Congress of Pure and Applied Chemistry, Zurich 1.

Autoradiography Course at Harwell

A SPECIAL course on autoradiographic techniques will be held in the Isotope School, Harwell, during December 13–16 under the direction of Dr. S. R. Pelc, of Hammersmith Hospital, London. Lectures will be given on the theory of the photographic process; photographic action of electrons; estimation of radiation damage; calculation of concentration of tracer necessary to produce autoradiographs; biological results of investigations using autoradiographic techniques; and design of autoradiographic experiments. Demonstrations will include the squashing technique applied to bean roots grown in phosphorus-32; stripping film technique; autoradiography using stripping film technique; and use of phase-contrast microscope. Practical work will include squash preparations for autoradiography, for example, bean root; autographs of sectioned material using stripping film technique; and processing and staining of autoradiographs using normal and phase-contrast microscopes. The fee for the course is £8. Accommodation in local inns can be arranged if required. Applications should be made to the Isotope School, A.E.R.E., Harwell, near Didcot, Berkshire.

Water Pollution Research Laboratory: New Premises

ON October 1 the Water Pollution Research Laboratory will move from its temporary premises in Watford, Birmingham and elsewhere to a new permanent building in Elder Way, Stevenage, Herts; it is not likely that an official opening will take place before the spring. The new premises include a three-story block, containing administrative offices, an information section and microbiological, chemical and physical laboratories. There are also four pilot-scale laboratories and facilities for building larger experimental plant in the open. Special facilities have been provided for experimental work on the treatment of sewage and industrial wastes, including a radiochemical section which will be concerned at first particularly with problems of disposing of radioactive liquids. Two of the pilot laboratories are designed for experiments on the effect of pollution on fish; this work is carried out in collaboration with a team of biologists of the Ministry of Agriculture and Fisheries.

The Night Sky in October

FULL moon occurs on Oct. 12d. 05h. 10m., U.T., and new moon on Oct. 26d. 17h. 47m. The following conjunctions with the moon take place: Oct. 5d. 24h., Mars 4° S.; Oct. 19d. 04h., Jupiter 2° N.; Oct. 26d. 23h., Venus 3° S. In addition to these conjunctions with the moon, Jupiter is in conjunction with Uranus on Oct. 8d. 04h., Jupiter being 0·4° S.; Mercury is in conjunction with Saturn on Oct. 9d. 11h., Mercury 5·6° S., and again on Oct. 24d. 11h. when Mercury is 4·7° S. Mercury, an evening star throughout most of the month, sets too soon after the sun to be observed. Venus sets about forty minutes after sunset at the beginning and middle of the month and about the time of sunset at the end of the month, and will not be favourably placed for observation. Mars, an evening star, sets about 22h. 10m. during the month, but it lies rather low for good observation in the British Isles. Jupiter rises at 23h. 20m., 22h. 35m. and 21h. 40m. at the beginning, middle and end of the month, respectively, and will be conspicuous in the constellation Cancer, its stellar magnitude varying from −1·7 to −1·8. Saturn sets at 18h. 45m. and 17h. 55m. on October 1 and 15, respectively, and is in conjunction with the sun early in November; throughout most of the month it is unfavourably placed for observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Oct. 15d. 01h. 40·8m., 33 Taur. (*R*); Oct. 15d. 23h. 35·7m., 99 Taur. (*R*); Oct. 16d. 04h. 45·5m., 103 Taur. (*R*); *R* refers to reappearance. The Orionid meteor shower attains its maximum about October 20–23; the radiant of this shower is close to γ Geminorum.

Announcements

WE regret to announce the death of Dr. André Donatien, *correspondant* for the Rural Economy Section of the Paris Academy of Sciences and *chef de service* of the Pasteur Institute of Algeria, on August 10, aged sixty-four.

MR. H. S. TASKER has been elected a Fellow of the Institute of Metals, in recognition of his distinguished services to the Institute; the total number of Fellows is limited to twelve. Mr. Tasker was president of the Institute during 1950–51, and has been chairman of its Finance and General Purposes Committee (1940–44) and honorary treasurer (1945–47).

THE French Metallurgical Society will, as in former years, hold its "Journées Métallurgiques d'Automne" in Paris during October 25–30. Further information can be obtained from the Société Française de Métallurgie, 25 rue de Clichy, Paris 9e.

THE dates of the meeting of the Meteorologische Gesellschaft in Hamburg, to be held in Hamburg in honour of the centenary of the birth of G. Hellmann (see *Nature*, May 15, p. 896), have been changed to October 8–11.

THE Swiss Federal Commission for studying Hail Formation and Hail Prevention will hold an international symposium on experimental meteorology at the Swiss Federal Institute of Technology, Zurich, during October 4–6. The symposium will discuss primarily the question of the natural processes of rain and the methods of influencing it, as well as the problem of the formation of hail and its possible prevention. Further information can be obtained from the president of the Commission, Prof. R. Sänger, E.T.H., Postfach, Zurich 23.

ISSUED annually, with some interruptions, since 1915, the "Subject Index to Periodicals" is now being published quarterly with annual cumulations. The first of these quarterly issues covers January to March 1954 (pp. 71. London: Library Association), and the three hundred British periodicals indexed have been carefully selected to meet the needs of the smaller as well as the larger public library, and those of academic and special libraries. How far the greater frequency of publication enables the "Index" to keep pace more closely with the influx of material cannot fairly be judged from a single issue, and the full advantage will probably be derived in the annual cumulation.

THE BULGARIAN ACADEMY OF SCIENCES

By Dr. D. R. NEWTH

Department of Zoology, University College, London

ALTHOUGH it can be said to have its origins in the foundation, in 1869 at Braila in Rumania, of the Bulgarian Literary Society, the Bulgarian Academy of Sciences did not become a model of the traditional European academy until much later. The Literary Society moved to Sofia in 1878 after Bulgaria's liberation from Turkish rule; but it was not until 1911 that the intentions of its founders were realized and it became, in fact and in name, an Academy of Sciences. From then until 1944 it remained a body of scholars, with the publication of learned periodicals and the holding of scientific meetings as its main functions.

Plans for the extension of the work and responsibilities of the Academy were discussed between 1944 and 1947, and its present form was determined by a law passed in 1947 and a decree issued in 1949. These have turned the Academy into a body controlling the activities of a number of research institutes and exercising quasi-ministerial authority over a great deal of Bulgarian science. At present its work is carried on by seven sections, each with several institutes. These are: (1) Physics, Mathematics and Technology (with three institutes); (2) Geology, Geography and Chemistry (with three institutes); (3) Biology and Medicine (with twelve institutes); (4) History, Archæology and Philosophy (with seven institutes); (5) Law and Economics (with two institutes); (6) Linguistics, Ethnography and Literature (with three institutes); (7) *Beaux arts* (with three institutes). In the near future the section of Biology and Medicine is to be divided into two, a new section of Agrobiology with five institutes and a section of Medical Science with seven.

Not all these institutes are primarily research organizations. Thus the Zoological Gardens in Sofia and the Ethnographic Museum have the status of Academy institutes. In establishing new institutes it has been the policy of the Academy to proceed with some caution. Where the case for a new institute is held to have been made, it is started with a small nucleus of workers, perhaps as few as three, and probably not in quarters of its own. It is then allowed to grow, and if its work flourishes it will be given buildings designed for it, some years after its inception. Most of the fully fledged institutes have between fifteen and twenty scientific workers headed by a director (normally, but not always, an academician) and controlled by a council upon which are represented the sectional committee of the Academy, appropriate Ministries and the heads of the institute's research teams. Such institutes may publish an annual bulletin of researches; thus the Biological Institute (until his recent death directed by Prof. M. Popov) has just issued its fifth, while the younger Institute of Morphology, under Prof. Hadjiolov, has just published its first.

The bulletins and the other publications of the Academy are well produced and the use of French and German, and to a lesser extent English, is common.

The Academy is also represented at the conferences which plan the work of institutes other than its own, and through its Presidium, Council of Co-ordination and planning commissions is coming more and more to co-ordinate the scientific life of the whole country. University departments do not come under the Academy or receive grants from it; but university teachers may use the facilities of Academy institutes for researches that can best be carried on in them.

At the present time there are forty-eight academicians, forty-six corresponding members and approximately five hundred full-time qualified workers in the Academy's institutes.

The Academy is conscious of the fact that during its re-organization it has not paid as much attention as is desirable to developing working relations with scientists abroad, and particularly with those of the West. It hopes next year to take a first step in improving its international contacts by inviting numbers of foreign scientists to visit it.

INSTITUTE OF CHEMISTRY OF IRELAND

SUMMER SCHOOL IN ORGANIC CHEMISTRY

THE Institute of Chemistry of Ireland held its first summer school during July 6–9 in University College, Dublin, the school being a refresher course on organic chemistry, with ninety-four participants. In his opening address, the president of the Institute, Prof. T. P. Dillon, of University College, Galway, stressed the necessity for chemists during their careers to return to the university at intervals to obtain some knowledge of advances made in fields of chemistry outside their special interest.

A series of four lectures on stereochemistry was given by Prof. T. S. Wheeler, professor of chemistry, University College, Dublin. He showed how hybridization of *s* and *p* orbitals gives the shapes of the methane, ethylene and acetylene molecules. He described how sp^2 hybridization is involved in the Walden inversion and explained how the original Mills–Nixon theory was no longer applicable. In treating of the stereochemistry of tetrahedral carbon, he discussed the necessary and sufficient conditions for molecular dissymmetry. Fisher's system of projection and his ideas as regards relative configurations were explained. Rosanoff's glyceraldehyde standard and the manner in which it is related to the serine standard by the Ingold school were described. After a discussion of absolute configuration, the stereochemistry of *cyclo*hexane and the decalins was demonstrated by means of models, and the application of conformational analysis to steroids was shown. In his closing address, Prof. Wheeler outlined recent work on the absolute configuration of natural products such as the steroids. The fluorescent glass models of *cyclo*hexane, decalin and steroid systems made by Mr. W. Brady, of University College, Dublin, were greatly appreciated.

In two lectures Prof. Wesley Cocker, University professor of chemistry, Trinity College, Dublin, dealt with new reagents and techniques. He criticized the old idea that the aldehyde–Girard products are more stable than the ketonic adducts and went on to describe newer methods for isolating carbonyl compounds. He then described modern specific catalysts for reducing alkene and carbonyl compounds. Recent oxidizing agents which are specific for various groups were outlined, and in conclusion the work of Linstead and others who have produced long-chain fatty acids by a variation of the Kobe electrolytic synthesis of paraffins was described.

In the two hours allotted to him, Mr. P. W. D. Mitchell, Lasdon Fellow of the Medical Research Council of Ireland, described briefly the symbols and terminology used in absorption spectroscopy. He indicated how the positions of the regions of absorption and the intensity might be correlated empirically with the nature and distribution of chromophores and auxochromes in the molecule and then described some work in which he is engaged for the Medical Research Council of Ireland. In this work the ultra-violet absorption spectra are used as a means of determining molecular weights and also as a method for the identification of sugar osazones.

Dr. E. F. McCarthy, senior Fellow of the Medical Research Council of Ireland, outlined recent advances in electrophoretic technique and its application to the separation of high- and low-molecular-weight substances of biological importance. He discussed the relative merits of boundary and zone electrophoresis with reference to his own work on the identification of blood proteins. Dr. McCarthy also described the more recent refinements in the estimation of molecular weights by osmotic pressure measurements.

Two lectures on "Distillation" were delivered by Mr. F. T. Riley, lecturer in chemistry in University College, Dublin, dealing with liquid–vapour equilibria and with the theoretical basis of modern laboratory fractional distillation. Laboratory fractionation practice in the 1920's was contrasted with present-day methods. Mr. Riley emphasized the changes brought about by the introduction of controlled reflux, and packed columns. He then reviewed the factors influencing separation efficiency and described the high-efficiency column working in the Department of Chemistry of University College, Dublin. This column has a packed length of 9 ft., and its performance is equivalent to that of a column containing at least two hundred theoretical plates. A feature of this column is the intermittent vapour draw-off device which is useful with an azeotropic mixture that separates on condensation.

Prof. F. J. Coll, professor of chemistry in University College, Galway, gave two lectures on "Chromatography" and discussed this technique under the following headings: absorption chromatography, partition chromatography, paper chromatography, ion-exchange chromatography and electrochromatography. Many excellent paper chromatograms of sugars, prepared by Prof. Coll, were used for illustrating the points described. Other experimental demonstrations were much admired.

Two lectures on organic chemistry and analysis were given by Dr. Cecil L. Wilson, reader in analytical chemistry in The Queen's University, Belfast. Beginning with a review of the development of analytical chemistry, he went on to discuss the use of micro-methods in the laboratory. He described the application of organic reagents in gravimetric, titrimetric and colorimetric procedures and showed how the requirements for a 'classical' organic reagent have been modified by the addition to this class of the 'complexones', which cannot be regarded as following the accepted pattern. The inorganic analyst, in particular, is bound, in the future, to take more note of the methods of his organic colleague, since he will more and more be faced with problems of compound analysis rather than of ion analysis.

Mr. C. D. O'Briain, Department of Chemistry, University College, Dublin, organized an excellent display of scientific apparatus, the material being supplied by a number of manufacturers and agents.

EVA M. PHILBIN

PHYSICS IN ISRAEL

THE seventy-fifth birthday of Prof. Albert Einstein was celebrated in Israel by a scientific convocation which was held on March 14 in Jerusalem, under the joint auspices of the Hebrew University of Jerusalem; the Technion, Haifa; the Weizmann Institute of Science, Rehovot; and the Research Council of Israel. Tributes were paid to Prof. Einstein by Mr. Y. Ben-Zvi, the Israeli president, Mr. M. Sharett, the Israeli prime minister, and Prof. B. Mazur, president of the Hebrew University, and various aspects of Prof. Einstein's contributions to science were discussed by Prof. G. Racah of the Hebrew University (quantum theory), Prof. C. Pekeris of the Weizmann Institute (Brownian movement), Prof. N. Rosen of the Technion (relativity) and Prof. S. Sambursky, director of the Research Council (cosmology).

In addition, the March number of the *Bulletin of the Research Council of Israel* (3, No. 4; 1954) is dedicated "with the highest esteem and affection of the scientists of Israel" to Einstein in honour of his birthday, and contains a photograph of Prof. Einstein as frontispiece. The contents consist of twenty-four original contributions, mainly devoted to mathematics or theoretical physics, the abstracts of the papers presented at the inaugural meeting of the Israel Physical Society held during April 12–13, 1954, and six short research notes. The *Bulletin*, which is in English, contains, in addition, abstracts of the original contributions in both Hebrew and English.

The inaugural meeting of the Physical Society consisted of a general session, opened by the Society's first president, Prof. G. Racah, at which two addresses were delivered, one by E. D. Bergmann on the influence of modern physics on organic chemistry and the other by M. Chwalow on the role of physics in industry, and four other sessions devoted to general and industrial physics; theoretical physics; atomic, nuclear and molecular physics; and methods and instruments. The abstracts indicate that work in the experimental field of physics is gradually being built up alongside the numerous theoretical studies, and show that recent activities include the construction of a thin lens magnetic β-ray spectrometer, and of a Couette viscometer for precision measurement in the centipoise ranges, the measurement of the absorption and scattering of 1–3 cm. radiation by a d.c. discharge in helium and air using a low-powered klystron as microwave generator, and experiments on luminescence.

S. WEINTROUB

ONTARIO RESEARCH FOUNDATION

REPORT FOR 1953

IN the annual report for 1953 of the Ontario Research Foundation*, by the director of research, Dr. H. B. Speakman, to which is appended a list of papers published during 1953 and the financial statement, attention is directed to the increase of almost 100 per cent in the research work performed for industry and under contract for government agencies during the five years 1949–53. Income from such sources increased from 277,777 dollars to 506,189 dollars, and the Provincial grant was increased from 167,904 to 260,230 dollars, the Federal grant remaining at 25,000 dollars. Dr. Speakman urges that these grants should increase in accordance with the demands made on the Foundation. While there was no increase in administrative staff during the period under review, the scientific staff increased from fifty-one to sixty-seven and technical staff from thirty-eight to forty-six. In biochemistry, the laboratory dealing with canning problems was closed ; but the fellowship on the utilization of the hulls of rice has led to the commercial production of humidifier plates from rice hull ash and to a high-temperature, light-weight insulating refractory now under study by a large manufacturer of fire-bricks in the United States. The possibility of utilizing whey with inorganic and cheap ammonium salts for the production of a yeast high in complex proteins of nutritive value in the diets of domestic animals is being explored, and considerable progress has been made in the production of tanning materials from waste sulphite liquors and the waste phenolic liquors from petroleum refineries, as well as in the development, in the oils and fats laboratory, of formulæ and methods for a butter-like spread, with good keeping properties, which can be used by the Armed Services under a wide range of climatic conditions.

In chemistry the Air Pollution Laboratory is making a systematic study of atmospheric conditions in the Sarnia area, in which several refineries and chemical plants are operating, under varying climatic conditions, and similar surveys are in progress in Maitland and Millhaven. The Electroplating Laboratory made important progress in studies of the influence of the physical metallurgy and mechanical processing of the basic metal on the subsequent electroplating process. Encouraging results have been obtained with a tanning agent prepared by the Organic Section from lignin, and similar compounds are being tested as dispersing agents, while a similar product has shown promise as a relatively cheap thermo-setting resin with water-repellent properties for use in the manufacture of boards from sawdust and other wood waste.

The Department of Engineering and Metallurgy, which is still in urgent need of more space and facilities, has continued its fundamental work in physical metallurgy, and investigations in ferrous metallurgy have been extended to include the pretreatment and concentration of ores to provide concentrates for the basic process. The hypothesis that changes in the lay-length of a wire rope in service may provide reliable indications of weakness and ultimate failure has received considerable support from results obtained on experimental machines. The Department of Research Services continued to increase its contacts with industry and also the number of repeat requests for service.

In the Department of Parasitology more attention was given to basic research. Work on the tapeworms occurring in carnivorous animals, especially foxes, continued, that on a hydatid disease in moose and wolves was concluded, and the life-history of the bot fly which lives parasitically in chipmunks has been determined. The survey of the Algonquin plain by the Department of Physiography was carried forward from Espanola to Saulte Ste. Marie, but the mineralogical study of soils in southern Ontario was temporarily halted. An ecological study of the growth of soybeans in southern Ontario and the adjoining States of the United States has been started.

In the Textiles Laboratory the emphasis had passed to problems connected with product development, including fabrics for wearing apparel, household furnishings and industry. Pressing temperature studies of the maximum temperature to which fabrics may be submitted have included a comparative study of viscose and acetate rayon, cotton, linen, nylon and orlon. Under the Nylon Fellowship of Canadian Industries, Ltd., a study of available methods and instruments for measuring resistance to abrasion supports the view that abrasion resistance and wear cannot be correlated with confidence. The influence of chemicals and temperature on the tensile strength and bursting strength of filter cloths was being investigated, and apparatus and experimental techniques were being developed to investigate the influence of cloth construction on the efficiency of a filter press.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

ANNUAL REPORT FOR 1953

THE report for 1953 of the British Electrical and Allied Industries Research Association*, the thirty-third year of its operation, records, in addition to summarizing the results of the year's work, the inception of an important new development. This is the commencement of the erection at Leatherhead of buildings which will ultimately completely re-house the Association's laboratories, at present situated at Perivale. The cost of this project, amounting to some £400,000, will be met for the most part by special capital contributions from the members, together with a grant from the Department of Scientific and Industrial Research which will probably amount to £100,000.

The main fields of activity of the Association necessarily form a fairly stable pattern over a period of years. Work on high-power switch gear and on dielectric materials have long occupied prominent places in the research programme, and continue to do so. Both these branches illustrate a feature which is characteristic of much of the work of the Association, namely, that the investigation of problems of direct technological importance often stimulates investigations of a fundamental character and produces new knowledge in the field of pure science. Experimental and theoretical researches are being pursued into the fundamentals of arcing phenomena and into the breakdown processes of discharges in gases and in solid dielectrics where the breakdown is occasioned by internal discharges. Work on the general theory of electrons in solids has produced a canonical transformation which can be applied to the movement of slow electrons in ionic crystals and which permits an estimate to be made of the energy and mass of 'polarons', that is, electrons carrying some ionic displacements with them.

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* Ontario Research Foundation. Annual Report, 1953. Pp. 82. (Toronto: Ontario Research Association, 1954.)

* British Electrical and Allied Industries Research Association. Thirty-third Annual Report—1st January, 1953, to 31st December, 1953. Pp. 160. (Leatherhead: The Association, 1954.)

The work on surge phenomena has been concerned mainly with surges on systems and in transformers. Surges on transmission lines arising from lightning have been recorded on equipment installed for that purpose, and analyses have been made of large numbers of fault reports from the British Electricity Authority and area boards. It is noted, however, that the incidence of thunderstorms during the year under review was abnormally low, and in the London area two hundred magnetic link lightning detectors did not record a single disturbance. In the field of transmission and distribution the Association has continued its work on the continuous and short-circuit rating of power cables and has begun to extend these investigations to higher frequencies, in the first instance to 400 c./s.

In connexion with the research on generation by wind power which has been in progress for some time, the Association has carried out a wind-power survey of the British Isles and it is stated that this is now practically complete. A gust recorder installed at Costa Hill in Orkney, where there is a 100-kW. wind-power generator in operation, recorded during the gales at the end of January 1953 gust velocities of 125 m.p.h.

Under the Power Plant Section, work continues on the creep and corrosion resistance of steels at high temperatures, on condenser tubes, and on the properties of high pressure – high temperature steam. It is noted that a detailed study of the creep and tensile properties of a large molybdenum – vanadium steel turbine-rotor forging is in progress and is well advanced.

Associated with the researches on switch and control gear are programmes of work conducted in the laboratories of the Safety in Mines Research Establishments at Buxton and at Sheffield. One of the problems under investigation is that of 'pressure piling' in flameproof motors. This is a phenomenon in which the pressure generated on explosion is greater with the machine running than with the machine stationary. Determinations are also being made of safe flange gaps for inflammable mixtures. An important allied investigation is in progress on intrinsically safe apparatus.

Among the items reported under "Unclassified Researches" is a significant improvement in the life of the hydrogen–oxygen fuel cell resulting from the development of a method of diminishing the corrosion of the oxygen electrode. In the same section it is stated that further work has been done on the 'self adjusting welding arc' and that the extension of the practical application of the surge injection principle for arc maintenance is being pursued.

It is evident from many references in the detailed sections of the report that the work which is supported by the Association in university departments throughout Britain is being actively maintained. The report concludes with a list of some forty papers and articles published by the staff during the year and about half that number of publications based on technical reports of the Association. There is a further list of translations from foreign journals and of bibliographies which have been prepared.

The report taken as a whole gives the impression that the Association is not only carrying on a large volume of research which is of direct importance to the electrical industry and to the community, but also that its policy is one of vigilant surveillance of the whole field to ensure the effective co-ordination of its work with the general body of research activity throughout the industry and in government establishments. The presentation of the individual sections of the Association's work in the report is made in a very satisfactory way; but there is little to indicate the relative scale of effort associated with each. It would add appreciably to the interest and value of the report if some indication could be given as to the relative magnitudes of the Association's various fields of activity.

PYROPHOSPHATASES IN PLANTS DURING GROWTH

By DR. B. NAGANNA* and C. E. SRIPATHI

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THE occurrence of an alkaline pyrophosphatase, active only in the presence of added magnesium ions (0·02 *M*), was recently reported[1] in fresh potato extracts. Further studies have revealed its occurrence in many other plants. Unlike animal tissues[2], plant tissues show high acid pyrophosphatase activity also. With the same substrate concentration, the alkaline pyrophosphatase activity is found to be always greater than that of the acid pyrophosphatase in green leaves, whereas in seeds the reverse is observed. This unequal distribution of the two enzymes that act on the same substrate led us to consider whether any significant differences in their elaboration during plant growth could be observed which would throw some light on their specific metabolic functions.

Wheat (*Triticum vulgare*), a monocotyledon, showing more acid pyrophosphatase and less alkaline pyrophosphatase activities, and french beans (*Phaseolus vulgaris* L.), a dicotyledon, showing no alkaline pyrophosphatase but very high acid pyrophosphatase activities, were germinated on loose soil and analysed at intervals. When roots and shoots had developed, separate analyses were conducted with each part. The enzyme extracts obtained by maceration of weighed fresh tissues with ice-cold double-distilled water were centrifuged and kept in an ice-box. They were further suitably diluted (1 in 10 to 1 in 1,000) just before the assay of the enzymes. Both the acid and the alkaline pyrophosphatases and also the acid phosphatase were assayed as follows.

The incubation mixture (5 ml.) contained 0·5 ml. of the enzyme extract in each case, and 4 ml. of veronal–acetate buffer (Michaelis[3]), *p*H 5·32, and 0·5 ml. of neutralized sodium pyrophosphate (0·01 *M*) for acid pyrophosphatase, 3·9 ml. of buffer, *p*H 8·68,

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Table 1. ACID AND ALKALINE PYROPHOSPHATASES AND ACID GLYCEROPHOSPHATASE ACTIVITIES OF DIFFERENT PARTS OF WHEAT PLANT

Days after germination	Nature of the plant tissue	Enzyme activity in γP per min. per gm. fresh tissue		
		Acid PP-ase	Alk. PP-ase	Acid GP-ase
0	Wheat grains	390	150	96
1	"	360	96	55
2	Wheat seedling (roots 2–4 cm.; shoots 0·5–0·8 cm.)	420	175	145
4	Roots (6–10 cm.)	188	114	65
	Cotyledons	747	137	180
	Shoots (7–8 cm., with 1st leaf just protruding from the sheath)	285	714	125
	Whole seedlings*	333	390	123

* Values calculated from the weights and activities of the different parts of the seedlings.

0·1 ml. of magnesium chloride (1·0 *M*), and 0·5 ml. of unneutralized sodium pyrophosphate (0·01 *M*) for alkaline pyrophosphatase, and 4 ml. of buffer, *p*H 5·32, and 0·5 ml. of sodium-β-glycerophosphate (0·1 *M*) for acid phosphatase. The incubations were carried out at 40° C. for 10 min. in the case of the pyrophosphatases and for 20 min. in the case of phosphatase. The enzyme action was stopped by trichloracetic acid, and the liberated orthophosphate estimated by the method of Fiske and Subbarow[4]. The results are shown in Tables 1 and 2.

As these experiments were designed primarily for studying the comparative distribution of the three enzymes at different stages of plant growth, the activities are expressed as micrograms phosphorus liberated per min. by the enzyme present in 1 gm. of fresh tissue. The results with wheat show that all three enzymes are increased during germination, the increase in each being confined largely to a particular tissue. The french beans showed no alkaline pyrophosphatase activity even though the acid pyrophosphatase activity was unusually great. This high activity of the latter, exclusively confined to the cotyledons, gradually decreased with plant growth. Eight days after germination, when the primary leaves were fully developed, the acid pyrophosphatase of the cotyledons, which were very much shrunken, was reduced to about 10 per cent of the original value. These results suggest the participation of this enzyme in the catabolic processes in the cotyledons by which the reserve food materials are converted into simple metabolites suitable for utilization by the growing embryo. Further, the acid pyrophosphatase content of the green leaves is relatively high, indicating that it has a role in metabolic processes involved in the translocation of the food material in the plant. These facts explain the occurrence of large amounts of acid pyrophosphatase in vegetable tissues, whereas animal tissues contain only negligible amounts, even though both tissues contain appreciable amounts of the alkaline pyrophosphatase[3].

Table 2. ACID AND ALKALINE PYROPHOSPHATASES AND ACID GLYCEROPHOSPHATASE ACTIVITIES OF DIFFERENT PARTS OF FRENCH BEAN PLANT

Days after germination	Nature of the plant tissue	Enzyme activity in γP per min. per gm. fresh tissue		
		Acid PP-ase	Alk. PP-ase	Acid GP-ase
0	Seeds	21,000	nil*	140
1	Cotyledons	10,120	nil*	80
	Plumules	282	363	18
2	Cotyledons	11,800	nil*	173
	Hypocotyls	575	218	280
	Plumules	492	1,010	24
3	Roots	276	164	170
	Cotyledons	8,300	nil*	294
	Hypocotyls	512	253	210
	Plumules	816	1,384	350
	Whole seedling†	5,600	50	225
4	Roots	390	186	175
	Cotyledons	7,900	nil*	340
	Hypocotyls	600	360	300
	Plumules	620	1,850	320
	Whole seedling†	5,070	163	300
8	Roots	226	98	93
	Cotyledons	2,400	nil*	240
	Hypocotyl	290	68	150
	Leaves	710	1,320	510
	Whole seedling†	600	280	215
16	Primary leaves	120	440	80
	Secondary leaves	500	780	360
36	Primary leaves	129	244	—
	Secondary leaves	180	524	—
	Other leaves	848	906	—
—	Tender pods (one week old)			
	Seeds	426	378	122
	Pulp	168	96	62
—	Mature pods (skin dried up)	16,000	nil*	160

* Activity at *p*H 8·68 was less with magnesium chloride than without.

† Values calculated from the weights and the activities of the different parts of the seedlings.

Although the tender pods of the french bean had both the acid and alkaline pyrophosphatases in nearly equal amounts, the alkaline pyrophosphatase disappeared as the pods matured, and at the same time the acid pyrophosphatase was tremendously increased. The former, absent in the seed, developed in the plumule even in one day after germination. It rapidly increased as the primary leaves developed. The activity of the primary leaves decreased as the secondary leaves developed, which showed high activity. The high activities of the secondary leaves also decreased when other leaves appeared. The significant elaboration of the alkaline pyrophosphatase in the growing leaves, which are the sites of intense metabolic activity, indicates the important role of this enzyme in photosynthesis. Any actively respiring tissue requires the presence of adequate amounts of coenzymes to participate in the oxido-reduction processes. Reversible enzymatic mechanisms by which two very important respiratory coenzymes, diphosphopyridine nucleotide and flavin-adenine dinucleotide, could be synthesized have recently been reported[5,6]. Equivalent amounts of pyrophosphate ions are said to be formed with diphosphopyridine nucleotide (or flavinadenine dinucleotide) reversibly from adenosine triphosphate and nicotinamide mononucleotide (or riboflavin phosphate). Removal of pyrophosphate ions enzymatically would lead to a shift in the equilibrium towards formation of more nucleotide. The actual enzyme responsible for the removal of pyrophosphate ions must be the alkaline pyrophosphatase, since it acts at an alkaline *p*H, and it has an immeasurably high affinity for the substrate[2]. Its rapid elaboration in the leaves from plumules one day old onwards supports such an assumption.

It may therefore be concluded that the alkaline pyrophosphatase is associated with the anabolic processes in the leaf, while the acid pyrophosphatase participates in the catabolic processes taking place during translocation of the carbohydrates synthesized in the leaf.

[May 12.

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ATOMIC WEIGHTS OF THE MONOISOTOPIC ELEMENTS

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THE work of Aston in the measurement of isotopic abundances and masses made it possible to compute, for the first time, the chemical atomic weight from purely physical data. As a result of the development of modern mass spectrometers and mass spectrographs, the accuracy of these physically determined values has steadily improved to the point where they are now generally recognized as being more reliable than their chemically determined counterparts. This communication is concerned with the physical atomic weights of the twenty-two monoisotopic elements, and supplements a review published[1] two years ago by Scott and Bettman.

Accurate physical masses are known for seventeen of the monoisotopic elements. In the remaining five cases, namely, cæsium-133, terbium-159, thulium-169, tantalum-181 and gold-197, reliable estimates of the mass can be made in the following manner. If the points representing the stable odd-A nuclides on a graph of 'mass defects' (mass defect is difference between atomic mass of a nuclide and its mass number) be joined together, they are found to lie on a comparatively smooth curve, which shows abrupt changes in slope only at the positions of the major nuclear shells. This regularity has been demonstrated[2] for the region $80 < A < 130$ in a recent paper by Collins, Johnson and Nier. In order better to establish the position of this odd-A line in regions where few odd-A masses have been measured, as in the rare-earth region, a second curve may be drawn which is tangent to the series of curves joining the even-A isotopes of the even-Z elements. This second curve is based upon a much larger body of experimental data, and is shown in Fig. 1 as a solid line. The open circles lying above this line represent the stable odd-A nuclides in this region the masses of which are known, and they can be seen to be displaced from the solid curve by a regular amount. One can, therefore, obtain the masses of the unknown odd-A nuclides by interpolation: in no case would the error associated with such an estimate exceed 3 milli-mass-units, an amount shown in the lower right-hand corner of Fig. 1. The five interpolated values are shown on the graph as closed circles.

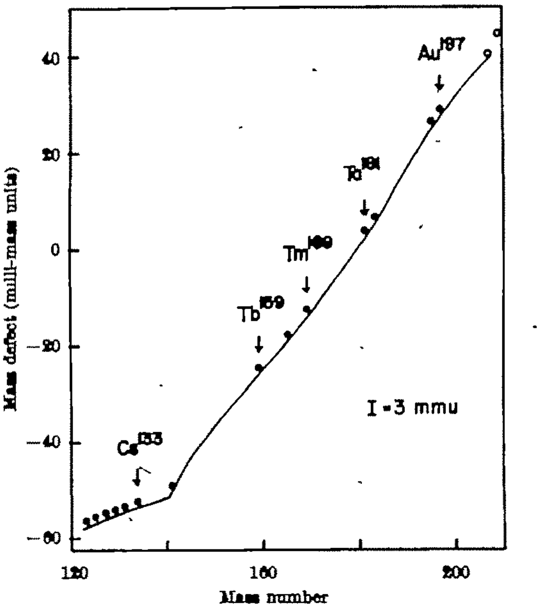

Fig. 1. Plot of mass defect versus mass number. The solid line is tangent to the curves formed by the even–even isotopes of the even-Z elements. The open circles represent odd-A nuclides the masses of which are known, while the closed circles are interpolated values for the five monoisotopic elements the masses of which have not been measured

COMPARISON OF PHYSICALLY AND CHEMICALLY DETERMINED ATOMIC WEIGHTS OF THE MONOISOTOPIC ELEMENTS

Element	Isotopic weight	Atomic weight Physical	Atomic weight Chemical*	Source of isotopic weight quoted
Be^{9}	9·01504 ± 3	9·01253	9·013	a
F^{19}	19·00446 ± 2	18·99917	19·00	a
Na^{23}	22·99706 ± 3	22·99066	22·997	b
Al^{27}	26·99007 ± 3	26·98256	26·98	b
P^{31}	30·98355 ± 4	30·97493	30·975	b
Sc^{45}	44·97010 ± 5	44·95759	44·96	c
Mn^{55}	54·95581 ± 10	54·94062	54·93	d
Co^{59}	58·95157 ± 10	58·93517	58·94	e
As^{75}	74·94570 ± 5	74·92485	74·91	Ref 2 and e
Y^{89}	88·9341 ± 2	88·9094	88·92	" "
Nb^{93}	92·9354 ± 1	92·9095	92·91	" "
Rh^{103}	102·9376 ± 5	102·9090	102·91	f
I^{127}	126·9453 ± 1	126·9100	126·91	g
Cs^{133}	132·948	132·911	132·91	†
Pr^{141}	140·9509 ± 4	140·9117	140·92	h
Tb^{159}	158·976	158·932	159·2	†
Ho^{165}	164·9622 ± 8	164·9163	164·94	h
Tm^{169}	168·988	168·941	169·4	†
Ta^{181}	181·004	180·954	180·88	†
Au^{197}	197·028	196·973	197·2	†
Bi^{209}	209·0446 ± 10	208·9864	209·00	h
Th^{232}	232·1093 ± 10	232·0447	232·12	i

* Taken from the 1951 Report of the Committee on Atomic Weights (Ref. 4).

† Estimated from Fig. 1.

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The masses of the twenty-two monoisotopic elements, with appropriate footnotes indicating their source, are shown in the accompanying table, and their values on the chemical scale are compared with the official chemical atomic weights. The value of the conversion factor from the chemical to the physical scale has been taken to be 1·0002783 ± 5, as recently determined[3] by Nier for atmospheric oxygen. There is seen to be exact agreement in the case of eleven elements; in three cases the approved value is too small; while for the remaining eight elements it is too large, sometimes by a substantial amount.

Some of these discrepancies have been recognized by the Committee on Atomic Weights. In its 1951 Report, the Committee remarked[4] that revisions appeared necessary in the cases of sodium, manganese, terbium, thulium and gold, and even suggested the direction and probable magnitude of the changes likely to be made at the time of the next formal report. These suggested revisions would remove the discrepancies for sodium, manganese, terbium and gold; but the proposed value of 169·0 for thulium would be slightly too high. It is desirable that the revisions indicated by the table should also be made for the elements arsenic, yttrium, praseodymium, tantalum, bismuth and thorium.

One is tempted to assess the adequacy of the chemical techniques for a given element by comparing its chemically determined atomic weight with that computed from physical data. For this purpose the table presents a somewhat over-optimistic picture, in that the official atomic weights of aluminium, phosphorus, scandium and iodine have already been revised by the Committee to coincide with the physical values. There is, therefore, exact agreement between the chemically and physically determined values for substantially less than half the elements in this group. It is not proper to generalize on the basis of this comparison since the monoisotopic elements are not, in a chemical sense, representative. With the exception of beryllium and thulium, they are all elements of odd atomic number and, hence, represent only some of the chemical families.

This work has been supported by the Office of Scientific Research, Air Research and Development Command, U.S. Air Force, and the National Research Council of Canada. [June 25.

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WHY USE INBRED LINES?

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THE use of inbred lines of both plants and animals has often been recommended in biological investigation. Recently, in order to find the basis of the recommendation, we have examined the literature. The purpose of this communication is to bring to general notice the present state of knowledge on the use of inbred lines. In communications which have appeared since the present article was first submitted for publication, Gruneberg[1] and McLaren and Michie[2] have dealt with the same problem. The genetic aspects of this problem have been discussed by Grüneberg and will not be considered further.

In the second decade of this century, inbred lines of guinea pigs and rats were developed; in the case of the rat, the descendants became the well-known Wistar strain. The inbred rats were characterized by a uniform body-weight and appearance, in contrast to randomly bred animals[3].

Soon after this period, the standardization of hormones and vitamins was developed. A unit of these substances was often arbitrarily defined in terms of a standard animal; for example, a unit of the parathyroid hormone was defined "as 1/500th of the amount required to produce in a dog of 20 kg. weight an increase of 5 mg./100 c.c. in serum calcium in 15 hours"[4]; the rat unit of oestrogen was defined as "the quantity of material necessary to induce oestrus as judged by the smear method in an ovariectomized, sexually mature rat weighing 140 ± 20 gm."[5]. These early definitions indicate that great value was placed on strains possessing uniform bodily characteristics, and it was for this reason that the Wistar rats were rapidly distributed[6].

Investigators soon recognized that the definition of the original 'animal units' of hormones and vitamins completely overlooks the effect of variation between animals. The establishment of international standards, in the mid-thirties, overcame this objection and at the same time led to the adoption of biometric techniques[7]. In these methods an estimate is made of the experimental error, and this is used for giving fiducial limits to relative potency estimates. In the wider field of biological experimentation, the estimate of experimental error is used to judge the significance of treatment effects[8]. Cochran and Cox[9] list three main ways of decreasing experimental error: (1) by increasing the size of the experiment, (2) by refining the experimental technique, (3) by handling the experimental material so that the effects of variability are reduced. We may include in the third of these methods the selection of homogeneous biological material. In many assays[10], for example, growth assays[11], the variability within litters is considerably less than the variability between litters. Since litters are genetically more uniform than the population as a whole and their use gives greater accuracy in bioassay, it was concluded that the use of genetically homogeneous inbred animals would also increase accuracy.

Thus over a period of about thirty-five years a traditional desire for inbred lines has developed, and these have been recommended in many modern text-books and many papers. We have not found one published investigation of the response to a treatment in which the advantage of inbred lines over randomly bred animals has been experimentally substantiated. In his recent book on the statistics of bioassay, Finney[10] gives two references on the subject.

The first reference is, through Gaddum[12], to the work of Winton[13] on the assay of red squills. In the original paper, Winton concluded that one inbred Wistar rat was equivalent to ten rats of mixed origin (black, black-and-white, and wild). No efficient statistical method was then available for the analysis of these results. In 1933 Gaddum[12] re-examined Winton's data using the newly devised normal equivalent deviate transformation, and he concluded that one Wistar rat was equivalent to six mixed rats. The statistical analysis applied by Gaddum is also inefficient, since iteration was not carried out to the maximum likelihood estimates and empirical weights were used. This procedure may seriously bias the estimates when the number of animals in an experiment is small and many 0 and 100 per cent responses occur, as in Winton's data. Consequently, we have re-examined his figures using the standard modern probit technique[14].

Winton's data have been grouped into intervals (range 0·2 gm./kgm.) for the purpose of analysis. Death (*D*) has been scored as a positive response, and survival (which includes unaffected (*N*) and convulsed (*C*)) has been scored as a negative response. A log dose/probit response regression line has been fitted by the method of maximum likelihood to each set of data, iteration being continued until successive values of the regression coefficient (slope) differ by less than one-tenth of the standard error[14]. An analysis of the slope differences has been made by a partitioning of χ^2 (Table 1). Since slope is the

Table 1. PARTITIONING OF χ^2 FOR THE DATA OF WINTON (ref. 13)

Source of variation	D.f.	χ^2	P
Between strains	(2)		
Inbred ♀ v. Inbred ♂	1	0·01	$0·95 > P > 0·90$
Inbreds v. Mixed	1	1·24	$0·3 > P > 0·2$
Heterogeneity	26	23·51	$0·7 > P > 0·5$

reciprocal of the square root of the variance of the individual effective doses of the population, this analysis is an examination of variability. Although the estimates of slope suggest a difference between the inbred and mixed animals, the analysis indicates that the differences are those of random sampling. This efficient analysis provides no evidence of a significant difference between the mixed and inbred animals and therefore the conclusions of Winton and Gaddum are incorrect. Furthermore, it must be emphasized that the mixed stock of rats used by Winton is a heterogeneous collection and not a randomly bred strain, and had a significant difference been found its interpretation would still be difficult.

The second reference given by Finney is to the work of Morrell and Allmark[16] on the toxicology of neoarsphenamine in rats. While it is doubtful if the animals used in this investigation fulfil the definition of inbred, they were not found to be significantly better than randomly bred animals.

Emmens[17] studied the action of œstrone in Strong's *CBA* strain of mice and found, to his surprise, that they were significantly more variable in response than the randomly bred colonies normally used. Recently this finding has been confirmed in *CBA* and *C57* mice, using œstrone and œstradiol-3 : 17β [18]. In both these investigations the mice were inbred to at least thirty generations and may thus be considered homozygous. Since inbred lines are so often recommended, it is very surprising that little work can be found on the comparison of the variability of inbred and randomly bred animals. The experimental work reviewed above offers no evidence that inbred lines may be advantageous and even suggests they may be disadvantageous.

A considerable and well-established disadvantage of inbred lines is the decline in vigour often associated with inbreeding[19]. This is manifested in a decline in fertility, fecundity and health. When a large colony is required, many breeding animals need to be maintained in order to produce the colony in a reasonable time.

It has been known for many years that F_1 hybrids between inbred lines are characterized by high vigour. This phenomenon is known as heterosis or hybrid vigour, and has been discussed extensively in recent times[20,21]. In addition, the hybridization of inbred lines leads to two other phenomena: (1) the mean response of the F_1 generation often lies outside the interval between the mean responses of the parental stocks; (2) the F_1 generation is less variable than the parent inbred populations. The first phenomenon has often been described and studied because of its economic importance. The second phenomenon, however, has been studied very little and only an occasional reference may be found.

McLaren and Michie[2] have recently demonstrated that the variability of inbreds is 3·5 times greater than that of F_1 hybrids, using the duration of narcosis to sodium pentabarbital as the test criterion. Claringbold and Biggers[18] have studied the vaginal response to œstrogens of reciprocal F_1 hybrids of *C57* and *CBA* mice and found the hybrids to have 25 per cent of the variability of the inbreds, and they were always less variable than the randomly bred albino stock. Thus in studies of œstrogens the use of these F_1 hybrids has tremendous advantages because of the large reduction in biological variation.

Strong[22] states that the use of F_1 crosses deserves consideration. However, his reasons are based on the fact that F_1 hybrids are superior to inbreds in health and longevity, and that "animals of any particular hybrid type show as great uniformity as the inbreds do". This latter statement is true so far as genetic variability is concerned, but ignores the possibility of interaction between genotype and environment. Fisher[23], too, suggests the out-crossing of two inbred lines to produce a large number of genetically uniform mice in a short time. The low vigour of inbred animals results in a low weaning-rate, but following hybridization the weaning-rate is high. In the case of mice the litter size of hybrids may be two to three times greater than the litter size of inbreds. Thus the F_1 hybrids are much the easier to breed in large numbers, and only a small stock of inbred animals need be maintained for their production.

In view of the above considerations, the automatic use of inbred lines may well be an inefficient procedure in biological experimentation. Investigators should examine their material to see whether inbreds, F_1 hybrids or randomly bred animals are the most suitable for their work. It is probable that the best use of inbred lines is to produce F_1 hybrids. The manifestation of heterosis, however, will depend on the material studied and no general rule can be laid down. In the concluding paragraphs of his book, "The Theory of Inbreeding", Fisher[23] discusses the necessity of having many inbred lines so that suitable crosses can be made for special environments and purposes. Although this was written with particular reference to livestock and plant improvement, it is possible that these ideas could be exploited in experimental procedures.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Psalliotin, the Antibiotic of *Psalliota xanthoderma*

THE antibiotic activity of the edible mushroom *Psalliota xanthoderma* was first described in some detail by Atkinson[1] in Australia. Wilkins[2] in England also recorded this mushroom as being antibiotic. Atkinson gave a number of characteristics of the antibiotic substance and also a list of sensitive and insensitive bacterial species, but refrained from naming the substance as a new antibiotic. Its peculiar and haphazard lability defeated attempts to concentrate and purify it, and the work was temporarily abandoned as the mushroom supply ran out.

This year a good crop of *Psalliota xanthoderma* appeared in and around Adelaide and work on purification of the antibiotic was recommenced using paper chromatography of aqueous extracts of mushroom stipes. Erratic results were obtained, some papers showing a good antibiotic zone near the solvent front, others showing no zone. The amount of activity on the paper was shown to depend upon the extent of exposure to daylight during the preparation of the spot of mushroom extract (100 μl.) and during the running and subsequent handling of the chromatogram. Spots prepared in dim light, run in the dark and afterwards handled in dim light, invariably produced antibiotic zones near the solvent front.

The sensitivity of the antibiotic in crude extracts to different types of light was investigated by exposing dried spots of extract (100 μl.) for various times to the diffuse daylight (not direct sunlight) of the working bench under the window. At the same time, and in the same position, similar spots were exposed under various Wratten filters, and a control spot was kept in a light-proof box.

This box control spot tested after four hours and twenty-four hours on the bench at room temperature showed excellent activity comparable to that of a similar spot kept in the dark in the refrigerator. Thus no deterioration occurred in twenty-four hours at room temperature in the dark. Rapid deterioration occurred, however, in diffuse daylight, as little or no activity was detected in the spots exposed directly to daylight for one to four hours. Good activity similar to the box control was found in spots exposed up to four hours under Wratten filters *A*, *B*, *C*, *E*, *F*, *G*, *H* and *Kl*, which were thus protective. The *D* filter (dark violet) was not protective, however. Spots exposed under it for one to four hours showed reduced or barely detectable activity.

Exposure to short-wave ultra-violet also inactivated the antibiotic extract. With the lamp used at present, emitting mainly in the 250 mμ region, complete inactivation of dried spots occurred at 18 cm. distance in one hour, and considerable reduction of activity in twenty minutes. Long-wave ultra-violet was probably responsible to a large extent for the inactivation produced by daylight, as spots placed under glass, which blocked short-wave ultra-violet, showed little or no activity after exposure to daylight in the usual place on the bench for one to four hours.

As the yellow Wratten filters protected the antibiotic activity and gave good light transmission, a suitable source of yellow light was sought for use during experimental work on the antibiotic extracts. Of various sources tried, a Philips yellow dark-room globe was found most satisfactory. Spots exposed up to six hours under this light in a black box showed no reduction in activity. Thus work on this antibiotic mushroom may be safely carried out in this yellow light in an otherwise darkened room.

The conclusion arising from this work is that the main destructive agent for the *Psalliota* antibiotic in crude extracts is bright light. Success can only be achieved by continually protecting it from bright light. Earlier work must therefore be repeated under suitable lighting. Many earlier results have already been checked and purification procedures are being carried out either in the dark or in the yellow light.

Because of its light sensitivity in crude extracts, the antibiotic of *Psalliota xanthoderma* appears to be new and unique. Therefore it may justifiably and conveniently be given the new name psalliotin.

A detailed account of this work will be published elsewhere.

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Antibiotic Production by Actinomycetes in Soil demonstrated by Morphological Changes induced in *Helminthosporium sativum*

IT has often been suggested that the production of antibiotics in soil is at least partly responsible for the antagonistic relationships between actinomycetes and plant pathogenic fungi; but little direct evidence has been obtained to offset the fact that these substances have rarely been extracted from soil.

A number of soil actinomycetes were selected for their antibiotic activity towards *Helminthosporium sativum*. These actinomycetes were shown to reduce root-rot of wheat when inoculated simultaneously with the fungus into sterile soil. Reduction in disease incidence was correlated with the degree of antagonism exhibited by the actinomycetes *in vitro*, suggesting that antibiotics were responsible for the disease control. In these experiments we were unable to extract the active antibiotic from the soil, but the possibility remained that antibiotics were present in sufficient concentrations to cause localized effects in soil.

A number of workers have described morphological changes in fungi caused by antibiotics, and it appears that these substances affect the morphological development of a given fungus in a characteristic and reproducible manner[1-4].

In vitro experiments were carried out to determine the effects of the antibiotics produced by the selected actinomycetes on the spores and hyphæ of *H. sativum*. Inhibition of development and morphological changes of the fungus varied with the actinomycete, but the effects noted were quite characteristic. *H. sativum* spores either failed to germinate or were inhibited at a point just subsequent to germination. Antibiotic effects on the hyphæ of *H. sativum* were determined by germinating the fungal spores for twenty-four hours before placing them in the presence of the actinomycetes. Hyphal changes ranged from the stoppage of further mycelial development to such characteristic morphological effects as stunting, distortion or the formation of hyphal protuberances.

To demonstrate the effects of the actinomycetes on *H. sativum* in soil a buried-slide technique was employed[4]. Microscope slides dipped into a plain agar suspension of *H. sativum* spores were placed in pots of sterilized soil inoculated with one of the actinomycetes. In a similar manner the effect on the fungal hyphæ was determined by incubating the agar slides prior to placing in the soil. It was possible to determine the effects of the actinomycetes on the fungus by periodic removal and microscopical examination of the slides. In all cases the characteristic morphological effects caused by the actinomycete antibiotics *in vitro* were noted in the soil. Extraction procedures again failed to demonstrate the presence of antibiotics in the soil.

Further proof of the activity of antibiotics in soil was obtained using the antibiotic actinomycin and *Actinomyces antibioticus*, the organism responsible for its production. In Petri-dish culture both crystalline actinomycin and *A. antibioticus* produce a characteristic swelling, distortion and stunting of the fungal hyphæ. When introduced into sterile soil identical morphological changes are evidenced by *H. sativum* in the presence of either the pure antibiotic or *A. antibioticus*. Extraction of the soil containing the actinomycete yielded no antibiotic, strongly suggesting a localized antagonism due to a relatively high concentration of antibiotic in the immediate vicinity of the actinomycetes.

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Isolation and Characterization of Biosynthetic Arylsulphates

ALTHOUGH most phenols are known to be partially excreted as the corresponding sulphate esters, few arylsulphuric acids have actually been isolated from urine, mainly because of the great solubility of the compounds and their sodium and potassium salts. The *p*-toluidine[1] and *p*-bromoaniline[2] salts are less soluble and can be used to isolate arylsulphates after some preliminary purification of the urine[3], but are not very satisfactory when the arylsulphates are present in small amounts.

The findings of Egami[4] that trypaflavin (10-methyl 2 : 8-diaminoacridinium chloride) gave insoluble salts with many different sulphate esters suggested to us that this type of compound might be used to separate arylsulphates from urine. A number of amino-acridines, aminoquinolines and aminopyridines were found to give insoluble salts with arylsulphates, and of the compounds tested 5-aminoacridine was particularly suitable because of its availability and the great insolubility of its readily crystallized arylsulphate salts. The solubilities of these salts in water is of the order of 0·03 gm./100 ml. at 4° C., and they were therefore much less soluble than the *p*-toluidine and *p*-bromoaniline salts mentioned earlier. Unfortunately, the salts do not melt sharply.

A large number of urinary constituents, including some detoxication products, do not give insoluble salts with 5-aminoacridine with the exception of the glucuronides of stilbœstrol and dienœstrol, both of which are known to form relatively insoluble sodium salts[5]. Other compounds which readily gave insoluble 5-aminoacridine salts included dehydro-*iso*androsterone sulphate, di-*iso*propylidene glucose 3-sulphate and the polysaccharide sulphates, carragheenin, laminarin, fucoidin and chondroitin sulphate.

Use has been made of 5-aminoacridine to isolate the monosulphate of 4-chlorocatechol from the urine of rabbits receiving this compound. Methylation of the free hydroxyl group of the 5-aminoacridine salt and identification of the methylated phenol liberated by subsequent acid hydrolysis established the structure of 4-chlorocatechol monosulphate as 2-hydroxy 4-chlorophenyl sulphate. This confirms the suggestion of Dodgson and Williams[6] that sulphate conjugation of 4-chlorocatechol occurred on the hydroxyl group para to the substituent chlorine atom.

An arylsulphate isolated as the 5-aminoacridine salt from the urine of rabbits receiving chlorobenzene, and the monosulphate resulting from the treatment of 4-chlorocatechol with half the theoretical amount of chlorosulphonic acid, were shown in the same way to be identical with the arylsulphate obtained after feeding 4-chlorocatechol.

A detailed account of this work will be published elsewhere.

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Effect of Temperature on the Inactivation of Phage labelled with Phosphorus-32

IN the course of investigations on phage *BM* labelled with phosphorus-32, we have had occasion to study its inactivation at a temperature of 2–4° C. and at that of 'dry ice' (– 79° C.). In this way an effect of temperature on the rate of inactivation has been observed, a result which may be of interest in wider investigations recently made by various authors[1] on the combined effects of temperature and ionizing agents on viruses and protein molecules.

The investigation has been carried out with the phage *BM* active on *Bacillus megatherium* which has been studied for some years in our laboratory[2]. The labelled phage was prepared by infecting cells of *B. megatherium* which had been grown in semi-synthetic medium containing about 3 mc. of phosphorus-32

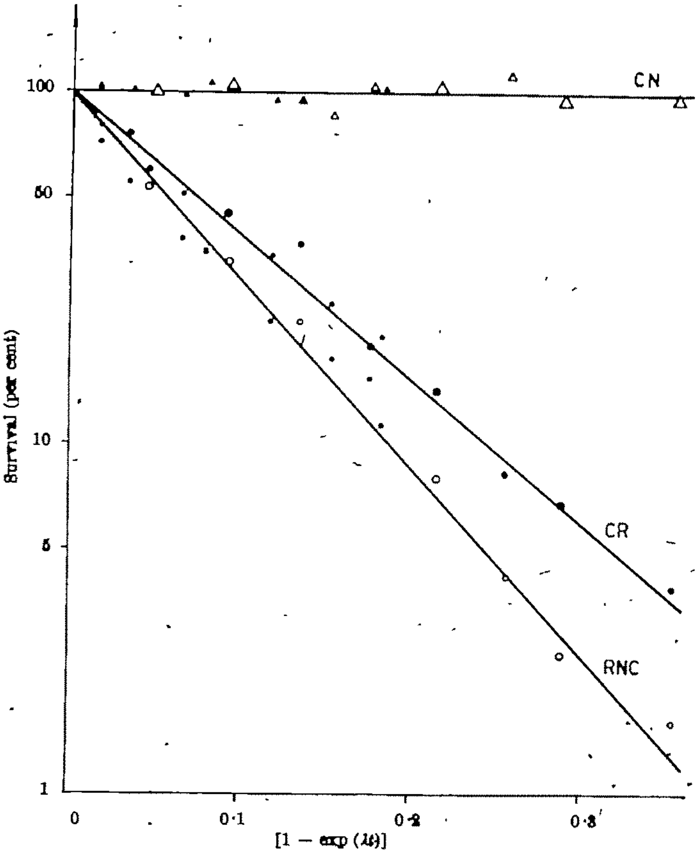

Fig. 1. RNC = labelled phage not frozen (2° C.), equation being $y = \exp\{-12\cdot 3\,[1 - \exp(-\lambda t)]\}$; CR = labelled phage frozen (− 79° C.), equation being $y = \exp\{-9\cdot 3\,[1 - \exp(-\lambda t)]\}$; CN = unlabelled phage frozen (− 79° C.). The three sizes of circles and triangles represent respectively the weighted mean values of three experiments, weighted mean values of two experiments and the values of one experiment respectively

per ml. and with a phosphorus-32/phosphorus-31 ratio which varied from 1×10^{-3} to 4×10^{-4} in the various experiments. The concentration of the phage obtained in this medium was 10^{10} particles per ml. of labelled phage, with an increase by a factor of 10^{3} with respect to the unlabelled phage introduced for the infection.

Immediately after the lysis, dilution to about 10^{-4} is carried out with broth to exclude any action of the unassimilated phosphorus-32.

The phage particles obtained under these conditions undergo a rapid inactivation caused by the decay of the phosphorus contained chiefly in their deoxyribonucleic acid. According to Hershey *et al.*[3], this inactivation can be attributed largely to the transformation of phosphorus-32 to sulphur-32, which takes place in the genetic structures of the phage, and only to a negligible extent to the passage of the β-particles through the vital structures.

Samples of radioactive phage suspended in broth were frozen to − 79° C. by techniques which will be described in a later publication, and kept at this temperature for days or weeks. Samples of non-radioactive phage were also frozen by the same procedure, and from Fig. 1 it is evident that the technique adopted excludes any mortality due to freezing.

Samples were taken periodically to check the value of the inactivation and for control. At the same time suspensions of radioactive phage were kept at a temperature of 2–4° C. and tested periodically for inactivation.

The duration of our experiments, the temperature and the medium in which the particles were suspended exclude any mortality independent of the radioactivity.

As can be seen clearly from Fig. 1, our results (which refer to three experiments giving very consistent results) suggest a highly significant difference in the rate of inactivation, a difference which can be calculated as about 25 per cent less for the frozen radioactive phage.

This difference can be attributed to various possible causes including: (1) a diminished rate of diffusion of the toxic ions produced by β-rays inside the phage particles when kept at a low temperature and in the solid state; in fact in this case toxic ions produced inside non-sensitive structures tend to remain localized and have no lethal effect in structures farther away[4]; (2) a lower production at low temperatures by electrons of hydrogen peroxide, with a consequent diminution of the lethal action[5]; (3) a contraction of the sensitive structures[4]; that is, a decrease with temperature of the length of certain chemical bonds with a consequent increase in their stability with respect to β-ray action and a decrease of the radiosensitive volume.

Since the effect of temperature observed by us cannot in any event be attributed to radioactive decay, it suggests that the transformation of phosphorus-32 to sulphur-32 contributes only to a limited extent, which cannot be evaluated at present, to the causes of death. The experiments now in progress on the inactivation of labelled *BM* phage after its penetration into unlabelled cells may give more suitable results for this evaluation.

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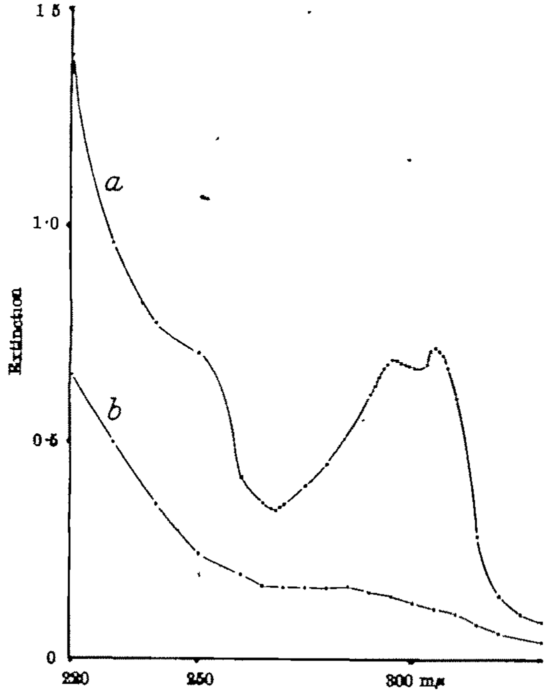
A Constituent of Male Sperm Antagglutin related to Vitamin E

Through a number of unknown factors in the male and the female genital apparatus, the head surface of mammalian spermatozoa is influenced in such a way as to bring about agglutination. This state of the cell surface is probably in some way important for the fusion at fertilization. On the other hand, agglutinated spermatozoa are unable to fertilize[1], and the tendency to agglutinate is normally opposed by a special protein produced in the prostatic gland. This was called 'sperm antagglutin'[2]. From this



proteid a group may be split off with the same biological potencies as the native substance. Sperm antagglutin, as well as its active group, occurs in reduced and oxidized forms, which may be reversibly transformed into each other. In both cases only the reduced form is biologically active. The active group was shown, *inter alia*, to contain sugar[3] and probably also sulphuric acid residues[3].

Further, we have now isolated from male sperm antagglutin a substance which is very slightly soluble in water and easily dissolved in ethanol and ethyl ether. The general type of the extinction curve of this substance in ethanol (Fig. 1*a*) very nearly conforms to that of α-tocopherol in hexane (cf. ref. 4). Oxidation with nitric acid according to Ungnade and Smith[5] yields a yellow colour, however, with the absorption maximum at 405 mμ, typical of the red oxidation product of α-tocopherol[6]. When dissolved in *n*-hexane, the conventional solvent for spectroscopical examinations on this group of substances, the material showed an extinction curve of quite another type (Fig. 1*b*). Samples brought back into ethanol after being examined in *n*-hexane give extinction curves the form of which was now exactly the same as in hexane. This indicates the occurrence of some interaction between the substance in question and some constituent of the 'hexane'. This change of the extinction curve was brought about by all kinds of commercial *n*-hexane (also that "for spectroscopical use" from the British Drug Houses, Ltd.). Only when freshly purified hexane was used was the change more or less reversible.

Under certain conditions a product with absorption maxima at 292 and 325 mμ in ethanol has been obtained, showing the same type of curve in *n*-hexane. In this solvent the maxima are at 289 and 315 mμ. Postulating a corresponding displacement of the maxima of curve *a* in Fig. 1 in the transfer from ethanol to *n*-hexane, these two maxima would be expected to occur at 292 and 298 mμ in the later solvent. These figures are identical with those given for α-tocopherol in *n*-hexane (cf. ref. 4).

This tocopherol derivative probably is the reversibly oxidized and reduced component of the male sperm antagglutin and its active group. The abolition of the absorption maxima in hexane gives a clue as to the mechanism by which those of tocopherol are being suppressed in the native antagglutin (cf. Fig. 1 of ref. 2).

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A Comparison of some Natural and Synthetic Melanins

The identity of natural and synthetically prepared melanins is still not proved[1–3]. My investigations suggest that some of the members of these two classes of melanins possess a similar structure.

Preparation *A* was a natural melanin prepared from the choroid of the ox eye. After careful removal, the choroids were refluxed with 2 *M* hydrochloric acid for 50 hr. Most of the tissue dissolved to give a yellow solution, whereas the pigment remained as an acid-insoluble, red-brown mass. This was dissolved in 5 *M* sodium hydroxide. Some of the acid-insoluble residue did not dissolve in the alkali and was discarded. The alkaline solution was acidified with hydrochloric acid, whereupon the pigment was precipitated. Repeated solution in *M* sodium hydroxide and reprecipitation with acid, followed by washing with distilled water, was performed until a constant nitrogen percentage was obtained from the dry precipitate. Three such precipitations were usually sufficient to obtain such constancy. The final precipitate was redissolved in 0·01 *M* sodium hydroxide.

Preparation *B* was a synthetic melanin prepared by the autoxidation of β-3 : 4 dihydroxyphenylalanine ('dopa') according to Arnow[4]. A thrice-reprecipitated preparation was used. This was considered to be the purest melanin and was used as a standard. The pigment was dissolved in 0·01 *M* sodium hydroxide.

Preparation *C* was a synthetic melanin prepared according to Raper[5] from tyrosine, using potato tyrosinase buffered at *p*H 6·8.

Preparation *D* was a synthetic melanin prepared from tyrosine and potato tyrosinase buffered at *p*H 7·4. In both *C* and *D* a thrice-reprecipitated preparation was obtained and was dissolved finally in 0·01 *M* sodium hydroxide.

Fig. 1 shows the ultra-violet absorption spectra (obtained using a Beckman spectrophotometer) of the sodium hydroxide solutions of the four melanins. A 'bump' in the region of 270 mμ is just noticeable in curves for *A* and *B*, whereas those for *C* and *D* show

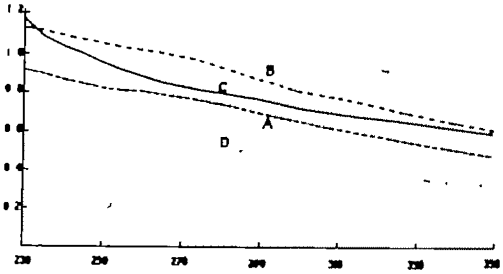

Fig. 1

a bump at 285 mμ. The *p*H has little effect on the shape of the curve.

Such a bump is also evident in the absorption curves of the melanin from dihydroxyphenylalanine of Clemo *et al.*[3], and in those for melanin from tyrosine of Florence *et al.*[6], but was not commented upon by these workers. Bowness *et al.*[7] obtain similar bumps (at 280 mμ) using an enzymic oxidation procedure, but ascribe them to the presence of dihydroxyphenylalanine. Mason[8] showed, however, that solutions of dihydroxyphenylalanine do not possess such an absorption maxima after a short exposure to air, an observation confirmed during the present work. The similar bump in the curve for the natural melanins is not depicted on the curves for preparations made by Florence *et al.*[6], presumably due to masking by contaminants in a less pure preparation.

The curves obtained here suggest that melanin from dihydroxyphenylalanine and the natural melanin have a similar chemical structure which, however, appears to differ from that of melanin prepared enzymatically from tyrosine, whether the latter is prepared in an acidic or an alkaline medium. It appears likely therefore that the enzymic oxidation of dihydroxyphenylalanine and the aerobic autoxidation of this substance involve different reaction sequences, and that a reaction sequence similar to the aerobic autoxidation is followed by dihydroxyphenylalanine during its oxidation in the environment of the ox eye choroid.

Further work in progress indicates that a melanin, prepared in a manner similar to the above, from human black hair, has an almost identical absorption spectra to that of the melanin isolated from the ox choroid. It exhibits a similar bump at 270 mμ. Thus melanin from dihydroxyphenylalanine, from ox choroid and from human black hair, appear to be formed by similar reaction sequences.

I wish to thank Prof. Joseph Gillman for suggesting this problem to me, and to thank him and Drs. P. R. Levy and G. N. Festenstein for their advice and criticism.

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Ketose Oligosaccharides in the Apricot Fruit

OLIGOSACCHARIDES composed of glucose and fructose units have been detected by various workers recently in extracts of Jerusalem artichoke, wheat flour, barley and agave. A number of oligosaccharides which are hydrolysed by invertase to glucose and fructose have now been found in ripe apricots. In one case a hexitol was also detected in the hydrolysis products.

A de-ionized aqueous solution was prepared from an 80 per cent alcoholic extract of apricot fruit (variety, Trevatt). Aliquots were chromatographed on a cellulose column using *iso*-propanol–*n*-butanol–water (7 : 1 : 2), or on a charcoal column using increasing concentrations of aqueous ethanol; the fractions containing oligosaccharides were re-run on charcoal columns. It then became clear that at least six ketose oligosaccharides were present.

The predominant oligosaccharide (*K*3; see Table 1) was present in sufficient quantity to be detected on paper chromatograms of the original fruit extract. It appeared to be homogeneous after the second fractionation on charcoal but did not crystallize. The dried syrup (yield, 0·07 per cent of the fresh fruit) had an optical rotation $[\alpha]^{20}_{D} = 24\cdot3°$ (c. 4·94 in water). The sugar behaved like a trisaccharide on charcoal columns and paper chromatograms. It was hydrolysed by invertase to glucose and fructose, which were separated on paper and estimated with anthrone[1]; the ratio glucose : fructose was 1 : 2. Hydrolysis with *N* sulphuric acid at 100° C. for 4 hr. also gave glucose and fructose; with 20 per cent acetic acid for 4 hr. at 50° C., glucose, fructose and sucrose were formed. The sucrose was eluted from paper chromatograms and its identity deduced from hydrolysis with invertase, R_F values, and colour reactions. *K*3 is probably a trisaccharide of the type O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(?)-β-D-fructofuranoside. The β-fructose link is deduced from the known specificity of yeast invertase. Two similar trisaccharides have been isolated recently from the sugar mixtures obtained by the partial hydrolysis of sucrose with yeast invertase[2] and mould invertase[3]. These are O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(6→2)-β-D-fructofuranoside, (kestose, $[\alpha]^{20}_{D} = +27\cdot3°$)[2], and O-α-D-glucopyranosyl-(1→2)-O-β-D-fructofuranosyl-(1→2)-β-D-fructofuranoside ($[\alpha]_D$ between + 30·5 and 32·6°)[3]. The apricot sugar, *K*3, ran farther on paper chromatograms than the major component (presumed to be kestose) in a mixture obtained by the partial hydrolysis of sucrose with yeast invertase; it has not been compared with pure kestose.

The other ketose oligosaccharides were further purified by elution from paper chromatograms developed with ethyl acetate–pyridine–water (8 : 2 : 1). Their R_G values are recorded in Table 1. With the exception of *K*1, they were all non-reducing (3 : 5-dinitrosalicylic acid reagent). The action of invertase on *K*1 gave, as well as glucose and fructose, a substance which, from R_F values and reactions on paper, appeared to be a hexitol (probably sorbitol). *K*1 has now been resolved, by a long run in *n*-butanol–acetic acid–water (4 : 1 : 1), into two components (R_G = 0·72 and 0·86), both containing fructose, the component with the lower R_G value being a reducing compound.

The oligosaccharides from the apricot (*K*1–*K*6) were compared directly on paper chromatograms with

Table 1. R_g* VALUES OF APRICOT OLIGOSACCHARIDES IN TWO SOLVENTS

Oligosaccharide designation†	R_g	
	n-Butanol–ethanol–water (10 : 1 : 2 v/v)	Ethyl acetate–pyridine–water (8 : 2 : 1 v/v)
*K*1‡	0·74	0·66
*K*2	0·29	0·21
*K*3	0·41	0·24
*K*4	0·40	0·45
*K*5	0·22	0·17
*K*6	0·17	0·12

* Ratio of the distance travelled by the oligosaccharide to the distance travelled by sucrose, the spots being superimposed on the starting line.

† Numbered in order of displacement from a charcoal column.

‡ *K*1 was not resolved by these solvents.

those synthesized from sucrose by yeast invertase (components I–IV[4]) and *K*2, *K*4, *K*5 and *K*6 were shown to differ from the sucrose-invertase products. *K*3 and component II had the same *Rg* values in several solvents; but this is of small significance as component II is a mixture of two sugars[5] unresolved by paper chromatography.

The occurrence of these fructose-containing oligosaccharides in the apricot suggests the presence of a transfructosidation system. Similar oligosaccharides in the artichoke are apparently formed by enzymic transfer of fructose from inulin to sucrose[6]. In the apricot, sucrose itself is the most likely source of fructosyl radicals.

There are indications that some of these oligosaccharides occur in other fruits. A ketose with an *Rg* value similar to that of the *K*1 mixture has been detected on paper chromatograms of pear sugars, and traces of a ketose similar to *K*3 have been found in extracts of some pears and peaches.

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Occurrence of Fatty Acids with Uneven-numbered Carbon Atoms in Natural Fats

ALTHOUGH the occurrence in natural fats of fatty acids containing odd-numbered carbon atoms, including *n*-heptadecanoic acid and *n*-pentadecanoic acid, has been claimed by various investigators, subsequent work has invariably revealed that such acids are actually equimolecular mixtures of adjacent members of even-numbered fatty acids. The generally accepted view at the present time is expressed by Hilditch[1] as follows: "With the solitary exception of isovaleric acid (found only in the depot fats of the dolphin and porpoise) the molecules of all natural straight-chain fatty acids, saturated or unsaturated, contain an even number of carbon atoms". Work in this laboratory, however, suggests that this view is not correct, and that fatty acids containing odd-numbered carbon atoms do, in fact, occur in some natural fats.

Following the isolation of pure *n*-heptadecanoic acid from hydrogenated mutton tallow as previously described[2], we have now prepared pure *n*-pentadecanoic acid from the same source as well as from hydrogenated shark (*Galeorhinus australis*) liver oil. It has also been shown[3] that hydrogenated ox perinepheric fat contains a consecutive series (including odd-numbered carbon acids) of volatile acids from C_4 to C_{18}. This indicates the probable presence of normal uneven-numbered saturated or unsaturated acids in natural fats. Further, without recourse to hydrogenation, pure *n*-pentadecanoic acid has been isolated from butter-fat.

This work is still in progress, and the detailed results will be published elsewhere.

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Basic Amino-acids of Silk Fibroin

IN studies of the constitution of proteins, the basic amino-acids are of particular interest. With silk fibroin, for example, the basic amino-acids are the least frequent of the constituent amino-acid residues and are therefore indicative of the approximate minimum molecular weight. Coleman and Howitt, deduced from the available analytical data that, assuming the molecule to contain one histidine residue, there was present a total of some 390 residues which, accepting the experimental mean residue weight of 78, implied a molecular weight of approximately 30,000; a molecular weight of this order was found by osmotic pressure measurements made on the renatured protein. In the latter connexion, however, Holmes and Smith[2], by ultracentrifuge and diffusion methods, found a mean molecular weight of 60,000–150,000 (average 84,000) for water-soluble fibroin. This higher value of the mean molecular weight suggests that, assuming no great error to exist in the value of about 0·4 per cent for the histidine content of fibroin, there are at least two histidine residues in the fibroin molecule. In order to strengthen the available experimental evidence on this point, a careful determination has been made of the basic amino-acids in silk fibroin.

A sample of degummed silk (*Bombyx mori*) was exhaustively extracted with the azeotropic mixture of benzene and methanol, repeatedly washed with distilled water, and finally air-dried. Two samples of about 1·0 gm. were accurately weighed and hydrolysed by refluxing with 25 ml. of 5 *N* hydrochloric acid for 24 hr.; a third sample was examined for moisture content. Hydrochloric acid was removed from each of the hydrolysates by distillation *in vacuo* and the residue made up to 10 ml. with distilled water. Aliquots (0·20 ml.) equivalent to 20 mgm. of the original silk fibroin were fractionated on a 0·9 cm. × 15 cm. 'Dowex 50' ion-exchange resin column under the conditions described by Moore and Stein[3] for the separation of basic amino-acids, 2 ml. fractions being

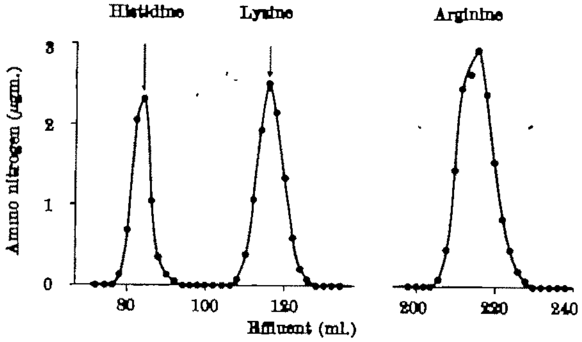

Fig. 1

collected. The histidine, lysine and arginine peaks thus obtained are shown in Fig. 1; the ammonia peak appearing between lysine and arginine was not estimated.

Two determinations were made on each of the two hydrolysates and gave the following values (corrected to a dry protein basis):

	Amino-acid (gm.)/100 gm. of fibroin
Histidine	0 370 ± 0 008
Lysine	0 537 ± 0 006
Arginine	1 000 ± 0 007

These values correspond (within ± 4 per cent) to an integral molecular ratio of 2 : 3 : 5, and indicate that the molecular weight of fibroin is of the order of 84,000 and that the number of amino-acid residues in the molecule is slightly greater than 1,000 (for an equivalent residue weight of 78); this agrees with the value for the molecular weight found by Holmes and Smith[2].

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Olefinic Nature of Anacardic Acid from Indian Cashew-nut Shell Liquid

ANACARDIC acid, the major component of the liquid extracted by solvent from cashew-nut shells[1], was regarded as a homogeneous chemical entity containing in its aliphatic side-chain of fifteen carbon atoms two double bonds until recently, when it was shown by Izzo and Dawson[2] to be in fact a mixture of olefinic components of which they identified the mono-olefin in the form of a crystalline glycol of the methylated anacardic acid. The present communication reports the complete separation of the mixture into its several components and the determination of their olefinic structure.

A sample of anacardic acid, prepared from Indian cashew-nut shells, was subjected to fractional crystallization, using as solvents acetone, methanol and petroleum ether, at temperatures of 0° to − 80° C., whereby pure specimens of four components were isolated, namely, a saturated one, and a mono-, di- and tri-olefin.

The saturated component (m.p. 91·5° C.)[3] was identified as 1-hydroxy 2-carboxy 3-pentadecyl benzene from a mixed melting-point determination with a pure sample of the compound obtained by catalytic hydrogenation of anacardic acid and carbon-hydrogen analysis.

Oxidation of the mono-olefin (m.p. 44–45° C.) with potassium permanganate in acetone gave azelaic, heptylic and oxalic acids, from which its structure was deduced as 1-hydroxy 2-carboxy 3-(8′ pentadecenyl) benzene, identical with the olefinic structure reported previously[3].

The di-olefin (m.p. 25–26° C.) on oxidation with permanganate in acetone at − 20° C. gave azelaic, butyric and oxalic acids. Further, the monophenol obtained by decarboxylation of the acid at low pressure, on methylation and subsequent oxidation with permanganate, yielded ω-(3-methoxy phenyl) caprylic acid[4,5], and butyric and oxalic acids. From these results, the di-olefin was assigned the structure 1 - hydroxy 2 - carboxy 3 - (8′,11′ pentadecadienyl) benzene.

A similar oxidation of the tri-olefin yielded azelaic, oxalic and formic acids; the methyl ether of the decarboxylated sample resulted, on oxidation, in ω-(3-methoxy phenyl) caprylic acid, and oxalic and formic acids. Tests for presence of conjugated double bonds were negative. On the basis of these observations, the tri-olefin was given the structure 1-hydroxy 2-carboxy 3-(8′,11′,14′ pentadecatrienyl) benzene.

A comparison of these results with those obtained recently on the monophenol from commercial cashew-nut shell liquid[5] points to the identity of the olefinic characteristics of the solvent-extracted and the commercial liquids. The composition of the heterogeneous mixture of the anacardic acid studied by us was found, on the basis of a typical careful fractionation, to be: saturated component, 4; mono, 15; di-, 44; and tri-olefin, 37 per cent.

A full account of this investigation will be published elsewhere.

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Bacterial Soft Rot of Avocado Fruit

SOFT-ROT diseases of avocado fruit are recorded in the literature as associated with fungi. So far, the only bacterial disease reported to affect avocado fruit is a dry rot caused by *Pseudomonas syringae* Van Hall[1]. In December 1953, however, a bacterial soft-rot disease in avocado fruits was found in Israel on several fruits picked from a single tree of the Californian variety, H. L.

In infected specimens of unripe, hard, green fruits a third or more of the fruit area had been turned dark and soft by a spreading decay. The flesh underlying such areas was soft, light to dark-brown in colour, and smelled putrid. Microscopic examination of Gram-stained affected tissues revealed numerous Gram-negative rod-shaped bacteria.

The organisms were isolated in pure culture on nutrient agar + 1 per cent glycerol plates and a distilled water suspension of 48-hr. old slant cultures was made. Healthy unripe fruits were inoculated by pricking through drops of the suspension placed on the fruit surface, and were kept in bell-jars over water at temperatures of 14–37° C. Within four to eight days, inoculated fruits developed lesions similar to those found on the original specimens. The lesions appeared as soft, dark, flat spots which spread far beyond the centre of inoculation. The spots coalesced and covered the entire fruit eight to nine days after inoculation at 32° C. Infection experiments with re-isolations from lesions gave similar results. No infection resulted when drops of suspension were not pricked into the fruit. Controls pricked through drops of sterile distilled water did not develop any sort of infection. Various vegetables inoculated with the organism under laboratory conditions developed a typical soft rot of the parenchyma ; no infection was induced on avocado leaves, or on lemon fruits.

The organism is closely related morphologically, physiologically and pathologically to the group of organisms originally identified as *Erwinia aroideae* (Townsend) Holland[1], and later identified by Rudd Jones, Dowson and others as a non-gas-forming strain of *Bacterium carotovorum* (L. R. Jones) Lehmann and Neumann[2], or *Erwinia carotovora* (Jones) Holland[3]. Like other organisms of this group, it is a wound parasite and requires relatively high humidity to induce infection. Its optimal growth and pathogenicity temperature is 30–32° C. ; no infection occurs above 38° or below 12° C. ; good, though slow, infection is induced at 14° C., and very good infection is produced at 36–37° C.

A detailed report on this organism and on other isolates of *E. carotovora* and *E. atroseptica* (Van Hall) Jennison will be published elsewhere.

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'Browning' Reactions in Freeze-dried Extractives from the Skeletal Muscle of Codling (*Gadus callarias*)

TARR[1-3] has shown that the 'browning' of flesh observed in many Canadian fish species when autoclaved for 1 hr. at 120° C. results from a Maillard reaction[4] between the various muscle amino-compounds and reducing sugars—primarily ribose. The present communication reports a study on the 'browning' of extract preparations of codling muscle under milder conditions such as are encountered during vacuum contact plate drying of fillets[5], dry salting and the storage of dehydrated codling muscle.

Codling muscle (1 hr. post mortem at 15° C.) was repeatedly extracted into cold 75 per cent v/v ethanol. Chloroform was added to the filtered extract to 75 per cent v/v and the emulsion shaken for ten minutes. After separation the upper, aqueous layer was freeze-dried. This preparation contained more than 90 per cent of the free amino-acids[6] and 70 per cent of the muscle reducing substances as determined by copper reduction. (Parallel chloroform separations of hexose and pentose sugar solutions in 75 per cent ethanol gave freeze-dried preparations with recoveries of the same order as amino-acids.) The white, deliquescent powder was ground at – 30° C. and stored over phosphorus pentoxide under high vacuum at 0° C. A yield of 1·9 per cent powder was obtained : nitrogen content, 13·72 per cent ; reducing activity, 1·60 per cent glucose equivalent.

The nitrogenous fraction was found to include (nitrogen basis, per cent in powder): creatine + creatinine, 6·2 ; trimethylamine oxide, 3·2 ; taurine, 1·7 ; anserine, 0·98 ; volatile amine, 0·365 ; aspartic acid, 0·041 ; glutamic acid, 0·055 ; glycine, 0·24 ; serine, 0·026 ; α-alanine, 0·10 ; β-alanine, 0·051 ; lysine, 0·061 ; histidine, trace ; 1-methylhistidine, 0·062 ; proline, trace ; valine, 0·020 ; leucine, 0·033 ; cysteic acid, 0·05 ; glutathione, trace ; phosphorylethanolamine, trace ; glucosamine, trace ; tyrosine, trace ; threonine, trace. Chromatography failed to detect free ribose. Traces of glucose, glucosamine and another compound, probably galactose, were found, but most of the reducing substances remain to be identified. Few observations are available on phosphorylated glycolysis intermediates in fish muscle, and some of these are probably implicated. Tarr[1] has shown that addition of hexose phosphates increases browning in fish muscle at high temperatures.

Effect of water relations on browning. Tubes containing 20 mgm. freeze-dried extractives were equilibrated[7] in bottles of different relative humidities over a complete range given by phosphorus pentoxide, sulphuric acid – water mixtures and water. Such systems turned first pink and then brown in colour, changes strictly analogous to those found in intact fillets dried during storage. Fig. 1 illustrates typical effects of relative humidity and temperature on browning as estimated by the optical densities of diluted reaction-mixtures at 430 mμ. In the experiment at 25° C., the overall reaction series had not proceeded so far as those at 60° C., which gave poorer definition at 'peak' level but showed a marked shift of peak towards higher relative humidities. At both temperatures the peak was at a lower relative humidity than the 70 per cent reported by Lea and Hannan[7] for simple glucose–casein mixtures. Fig. 2 illustrates a 'browning' nitrogen concentration curve calculated from water uptake/relative humidity data obtained in other 60° C. experiments at a 100 mgm. extractive level. An extension for lower concentrations was obtained from experiments with extractive

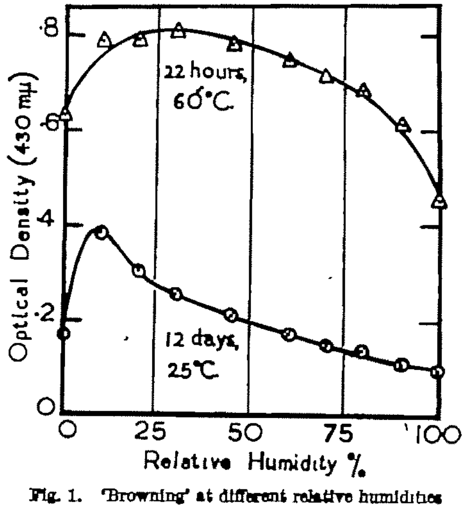

Fig. 1. 'Browning' at different relative humidities

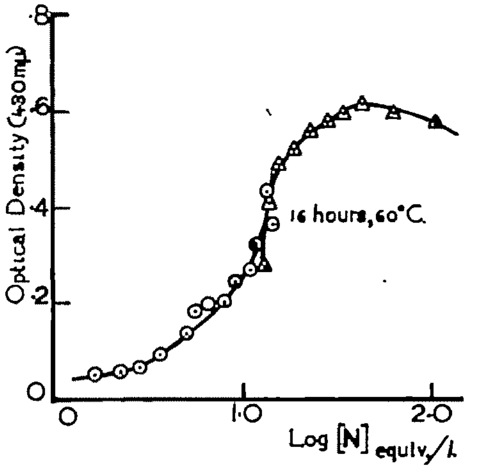

Fig. 2. 'Browning' at different concentrations of reactants

solutions at the same temperature and time in sealed tubes. This form of curve appears to be of greater value in relation to implications for the browning of whole fish than those in Fig. 1, as the linear uptake/relative humidity relation found for extractives differs appreciably from a sigmoid curve reported for intact muscle[8].

Effect of temperature. Aliquots of freeze-dried extractive solution (0·69 NN), with a drop of chloroform to inhibit bacterial growth, were allowed to react in sealed tubes at different temperatures. Table 1 shows that 'browning' is highly dependent on temperature under these conditions. Figures relate to the initial linear sections of 'browning'/time curves.

Table 1 'BROWNING' AT DIFFERENT TEMPERATURES

Temperature (° C.)	Units optical density increase/hr.
0°	$2·97 \times 10^{-5}$
15°	$6·30 \times 10^{-4}$
37°	$2·00 \times 10^{-2}$
60°	$3·01 \times 10^{-1}$

These figures give an approximately linear plot for $\log_{10}$ 'browning' rate/reciprocal absolute temperature.

Effect of pH. Solutions of the preparation had a pH of 6·8 and were strongly buffered. This accounted for the percentage 'volatile' amine held in salt form. Preliminary results indicate that 'browning' is at a maximum at pH 7 at 60° C. This has not been the finding with simple sugar – amino-acid[6] and sugar – protein[7] mixtures, and can be accounted for by a loss of reactive volatile amine from the reaction phase at higher pH levels. Such behaviour may well represent an important practical difference between such reactions of simple mixtures and complex volatile amine-containing systems.

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Uptake of Phosphorus-32 by Mycorrhizal Plants

INVESTIGATIONS based on chemical analyses have indicated that the absorption of phosphorus by pine seedlings is increased by the presence of ectotrophic mycorrhizas[1]. Harley *et al.*[2] have shown, however, that when labelled phosphorus is supplied to excised roots of beech the presence of a mycorrhizal sheath presents a partial barrier to phosphorus uptake by the tissues of the root. This communication reports the result of an experiment in which phosphorus-32 was used to indicate how far the mycorrhizal habit influences the uptake of phosphorus by intact plants of *Nothofagus menziesii* (mycorrhizas ectotrophic, typical of the Fagaceae) and *Pinus radiata*. The presence of mycorrhizas had no apparent effect on the rate of growth of these two species under the conditions employed in the experiment.

Individual mycorrhizal and non-mycorrhizal seedlings were transplanted in February, 1954, into separate glass pots containing 360 gm. (moist weight) of a chemically sterilized meadow loam of pH 5·3, known to be deficient in phosphates. Six weeks later all the plants were supplied with radioactive phosphorus. This was added to the soil as 200 ml. of a solution in distilled water. Two concentrations were employed to give activities of 50 μc. and 100 μc. per pot, respectively. After fourteen days the leaves of the plants were assayed for relative activity.

For each of the two species, comparable samples of leaf tissue were obtained by taking equal numbers of leaf segments (thirty segments, 2 cm. in length) in *Pinus*, or equal numbers of leaf disks (twelve disks, 5 mm. in diameter) in *Nothofagus*, from the upper leaves of the plant. The leaf segments or disks, representative of each plant, were arranged beneath an end-window Geiger–Müller counter connected to a 'Dynatron' electronic scaling unit.

Table 1 RELATIVE ACTIVITY (IN COUNTS PER MINUTE) OF LEAF SAMPLES FROM MYCORRHIZAL AND NON-MYCORRHIZAL PLANTS SUPPLIED WITH PHOSPHORUS-32

Phosphorus-32 per pot	*Pinus*		*Nothofagus*	
	Mycorrhizal	Non-mycorrhizal	Mycorrhizal	Non-mycorrhizal
50 μc.	59 457 128 765 536	11 0 9 0 1 0	7 64 22 95 18	41 1 0 28 44
100 μc.	1,003 215 193 879 1,584	12 13 2 1 5 3	293 8 199 28 37	64 0 26 72 61

Table 1 shows that in *Pinus*, despite the variability between plants, the leaves from the mycorrhizal plants were, without exception, markedly more active than those from non-mycorrhizal plants. In *Nothofagus*, however, no similar consistent difference was observed. The results indicate that the mycorrhizal habit enhanced the uptake of phosphorus to the leaves in seedlings of *Pinus*, while exerting relatively little influence on this process in seedlings of *Nothofagus* grown under the same conditions.

I wish to thank Mr. H. D. Jamieson and Dr. G. P. Harris for help and advice, and the Department of Physics, University of Otago, for facilities provided in making the counts. Financial assistance was

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Antagonist Inhibition as the Earliest Sign of a Sensory-Motor Reaction

REACTION time is defined as the interval of time between a sensory (optic, acoustic, tactile, etc.) stimulus and the voluntary reaction of muscular contraction. The values of reaction time for a given sensory-motor reaction show the smallest variation when the subject is alertly expecting the sensory stimulus. Even so, there is considerable variation of reaction time between different subjects. Individual differences are of less interest, however, than the lowest value of reaction time obtainable in optimal circumstances if the minimum time of cortical integration for a sensory-motor reaction is to be studied. The time of cortical integration is obtained by subtracting the afferent and efferent conduction times from the reaction time[1].

So far, only the electrical or mechanical manifestations of muscular contraction in agonists have been studied as examples of voluntary reaction[2]. We have undertaken a study of the simultaneous changes in muscles antagonistic to the voluntary movement of the reaction.

In our experiments, the sensory stimulus was evoked by an electric shock to the N. medianus in the fossa cubiti, of a strength which gave only a tactile perception. The electrical activity of the M. biceps and triceps of the same arm were separately recorded by means of an electroencephalogram apparatus (Schwarzer). The subject held his M. biceps in strong tonic contraction and reacted to the sensory stimulus by a contraction of his M. triceps.

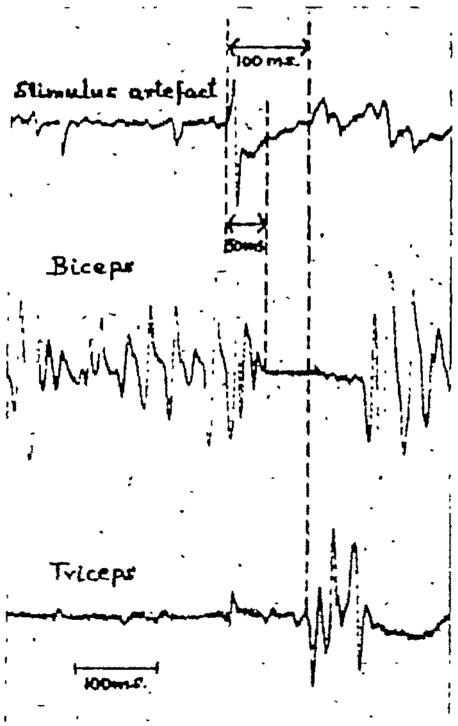

Fig. 1

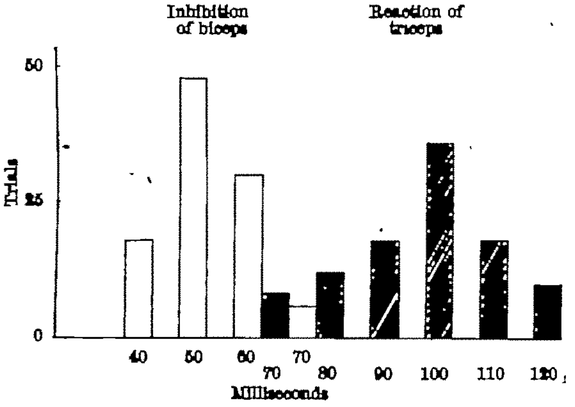

Fig. 2

With this arrangement, the voluntary reaction of triceps contraction was usually preceded some 50 m.sec. earlier by inhibition of the tonic biceps contraction (Fig. 1). Fig. 2 shows in diagrammatic form the reaction times for antagonist inhibition and agonist contraction. The reaction time for antagonist (biceps) inhibition may be as short as 40 m.sec.—a surprisingly low value if the reaction is accepted as being cortically integrated (voluntary). The antagonist reaction could scarcely be an example of spinal reciprocal inhibition[3]; it is interpreted by us as part of the voluntary reaction, although the actual inhibitory influence may be exerted at the cortical or spinal level.

The afferent conduction time from the peripheral nerve to the sensory-motor cortical area has been estimated as about 18 m.sec. (after Dawson[4]). The efferent conduction time, from the motor cortex to the peripheral muscle, has been estimated as at least 12 m.sec., due regard being taken to interneuronal spinal transmission (Lloyd[5], cf. ref. 6). By subtraction, an interval of only 10–20 m.sec. is left for cortical integration of the reaction of antagonist inhibition. This time interval is of the same order of magnitude as the duration of an 'evoked potential'[7].

The present observations therefore indicate that even a voluntary sensory-motor reaction may take place within restricted cortical fields without necessarily engaging more complicated cortical or subcortical reverberating circuits.

A detailed description of the results will appear in the *Zeitschrift für Biologie*. The investigation was supported by a grant from the Deutsche Forschungsgemeinschaft.

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A Simplified Method for spreading the Chromosomes in the Rabbit Blastocyst

It is well known that great difficulties are involved in counting the exact chromosome numbers from mammalian species which have a large number of chromosomes. In the past decade different results have been presented which indicate a variation in the chromosome number in different tissues even within a single mammalian species, including man[1]; but in many cases the variation shown is apparently a result of errors in the counting or in the technique used, for example, in making squashes, or in both as discussed by Fischberg and Beatty[2] and Venge[3].

For some years we have been studying the variation in the chromosome number in the rabbit, in testicular tissue as well as in blastocysts. During the course of the experiments it became clear that much of the variation in the chromosome number was due to counting errors if only gentle squashes were applied; but if the squash was made with a high pressure in a vice, mechanical disturbances were introduced[3]. We therefore tried to find a method of spreading the chromosomes without breaking the cells.

Continuing our experiments, we treated rabbit blastocysts in saline solutions of different concentrations for twenty minutes at a temperature of 37° ± 1°, with the result that many more cells could be used for counting the number of chromosomes (Table 1).

Table 1. NUMBER OF CELLS COUNTED IN TREATED BLASTOCYSTS

Concentration of sodium chloride	0	0·30	0·45	0·67	0·90 per cent
No. of blastocysts	2	19	44	27	24
No. of cells counted	1	186	425	147	21
No. of cells per blastocyst	(0·5)	9·8	9·7	5·4	0·9

We are aware that subjectivity enters into the decision whether a cell should be counted or not. However, once the decision was made, the cell was used in the chromosome counts. The results indicate the increase in number of countable cells due to our method.

By the treatment in the hypotonic solution and applying squash in making the preparation the spindle is disturbed; but the split between the chromatids is not so exaggerated as described by Manna[4]. In Fig. 1 is shown a metaphase plate where the chromosomes are well spread due to treatment of the blastocyst in 0·45 per cent solution. Only a gentle squash was applied. The chromosome number (44) is easily counted. The risk of producing artefacts is in our experience very small. In addition, the staining of the chromosomes is often better than with untreated blastocysts. The main result is therefore that a higher number of cells can be counted with greater exactitude.

Treatment in water (0 per cent sodium chloride) was only carried out with two blastocysts, as it immediately became clear that most of the metaphases pass on to ana- or telo phase. By treating the blastocysts in common physiological saline solution only one cell per blastocyst, approximately, could be used. The best results are obtained by using a 0·45 per cent saline solution, but next to this comes the 0·67 per cent despite the lower number of cells per blastocyst. It is more difficult to handle the blastocysts which have been treated in a 0·30 per cent solution as the tissue becomes too soft. In all the treatments the time was kept constant at 20 min., the age of the blastocysts was five days after mating, the fixative was alcohol–acetic acid (3 : 1) and the staining was done according to the Feulgen method, with 6 min. hydrolysis at 60°.

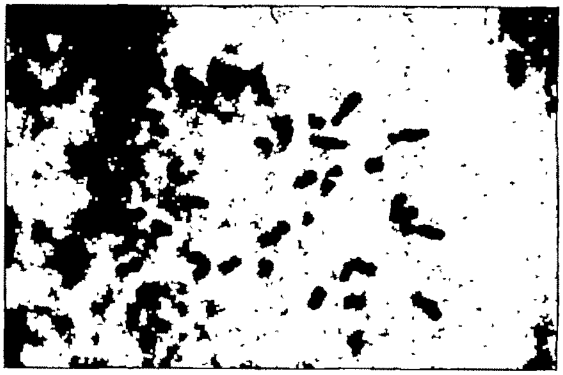
Fig. 1. Metaphase plate from a blastocyst treated in 0·45 per cent saline solution for 20 min. at 37° ($2n = 44$)

It should be mentioned that about 95 per cent of the cells have a chromosome number of $2n = 44$, which is the normal diploid number of the rabbit. However, a few cells have been found to be haploid, while others must be classified as polyploid cells with $3n$ or $4n$ chromosomes. Details of these chromosome numbers will be published elsewhere, when the experiments have been finished.

I am indebted to Mr. P. J. Åstrom for his help throughout the experiment.

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Breeding Season of the Wild Rabbit in New Zealand

Little reliable information is available on the breeding cycle of the wild rabbit (*Oryctolagus cuniculus*) in New Zealand, though there is a widely held popular belief, quoted by Marshall[1], that in certain localities the animal breeds throughout the year. An investigation of the reproduction of the wild rabbit has been carried out on the Gwavas Forest area, thirty miles south-west of Napier in the Hawkes Bay Province of the North Island of New Zealand over the period March 1950–February 1952. During this time, 1,766 adult females were examined: a female having a paunched weight of more than 700 gm. was taken as adult, this being the lightest weight of any pregnant animal found.

The percentage of adult females pregnant in each period of four weeks over the two years is shown in the top half of Fig. 1. Some pregnant females can be found at any time of year; but there is, nevertheless, a well-defined breeding season, starting in mid-winter (June) and lasting four or five months, when

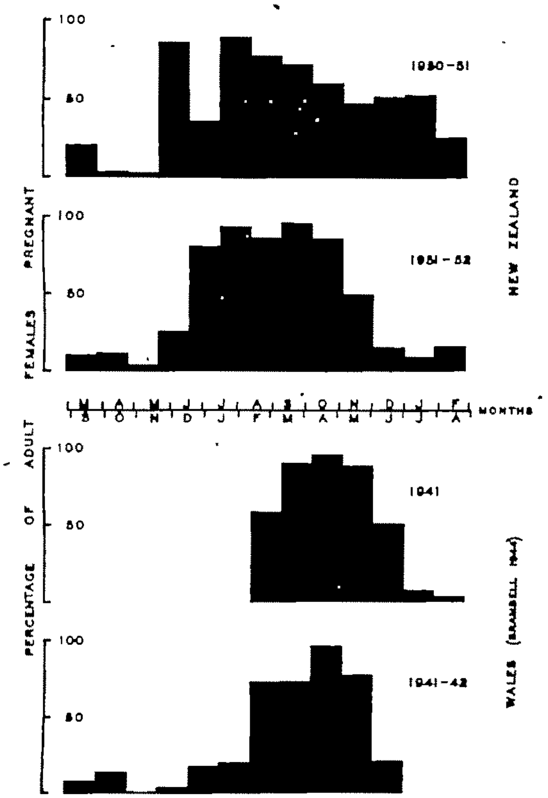

Fig 1

reproductive activity is very high; but from February to May little breeding occurs. There were a number of quite marked differences between the two years; in 1950 the rabbits started breeding about a month earlier than in the following year, and the end of the breeding season was more drawn out, more than 50 per cent of the adult females being pregnant throughout December and January. It was suspected that many of the females breeding at this time had themselves been born earlier in the season; but the method that was later developed[2] for distinguishing fully grown animals of up to nine and a half months old from older ones had not then been worked out. In the following year most of the rabbits that were breeding at this time were less than nine months old; thus it is possible that the duration of the breeding season may be largely determined by the survival-rate in the early litters. The reduction in male fertility which brought to an end the breeding season in Wales[3] was not so apparent in Hawkes Bay.

Brambell[3] carried out a detailed investigation of the reproduction of the rabbit at Bangor in North Wales: in the lower half of Fig. 1 his figures have been grouped in four-weekly periods that correspond seasonally with the New Zealand ones, so that the variations in pregnancy-rate throughout the year can be directly compared. It is apparent that in Hawkes Bay the period of high breeding activity lasts longer than in Wales: and the most striking difference is in the time of onset, which occurs eight to ten weeks earlier. Other European mammals, particularly ruminants and ferrets, introduced into the southern hemisphere, adhere very closely to the corresponding breeding season[4].

In many spring-breeding animals the increasing length of daylight is supposed to be the proximate factor responsible for the start of the breeding season. This cannot be so for the rabbit, since in Hawkes Bay the breeding season starts on or before the winter solstice. Hart[5] has suggested that it is the ratio of light to dark rather than increasing planes of light that is important in stimulating the onset of œstrus; it is therefore interesting that the length of day at Gwavas (lat. 40° S.) in June, and at Bangor, North Wales (lat. 52° N.) in February is approximately the same—between nine and ten hours; though this may be purely coincidental, as the rabbit also breeds in lower latitudes where the day-length is always longer than this. It is, however, likely that other factors such as the level of nutrition may also play an important part, though this could not be assessed in the present case. Baker[6] found that the onset of the breeding season in related species of birds in temperate regions tended to be twenty to thirty days earlier for each ten degrees of latitude towards the equator; similarly with sheep[7], the breeding season tends to start earlier and last longer in lower latitudes. It is therefore possible that the rabbit may be found to have a similar pattern.

A detailed account of this investigation on the reproduction of the rabbit in New Zealand is being prepared for publication.

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Environmental Control of Coat Changes in Cattle

CATTLE of European origin usually possess a long, woolly coat of hair in the winter; in spring the long hairs are shed and by summer the coat is smooth and sleek. These seasonal changes occur with great regularity, and as they are an aid to the animal in preserving thermoneutrality, it is commonly supposed that they are regulated by environmental temperature.

However, regulation through a photoperiodic mechanism is suggested by the fact that coat changes in the mink[1], fox[2], and horse[3] are now known to be influenced by light. Further, Laing[4], using increased light during winter in England to stimulate œstrus in cattle, noted a tendency for shedding of the hair to occur.

In the absence of definite knowledge on the matter, an experiment was designed and is now in progress at the Physiology Department, University of Queensland, to test the possible importance of light in regulating seasonal coat changes in cattle.

Eight Poll Shorthorn calves, aged two weeks to two months, were divided into two similar groups, control and experimental, of four animals each. After a six-week period of conditioning to their surroundings and feed, the experiment, involving for the experimental group complete reversal of the seasonal trend of daylight hours, commenced on February 2, 1954.

Each group occupied a separate stall but was similarly treated except for the daily quota of light provided. The control stall was open to natural daylight and, as no other light was allowed, the calves in it received the daily duration of light normal for the latitude of Brisbane. This amounted to just over 14 hr. of light a day at the start, the level decreasing gradually with the approach of winter to just over 11 hr. at the time of writing (June 7). The experimental stall was also open to daylight, but in it day-length could be either shortened, using black-out arrangements, or increased by switching on four 250-watt electric lights in the evening and early morning. Using these facilities, the experimental calves were started in the experiment at a daily light-level of a little more than 10 hr. This was raised gradually, changes being made weekly, to the present level of 16½ hr. Thus the experimental calves were placed on an increasing plane of light while the controls received decreasing light.

Temperature differences in the two stalls have at no time exceeded 3° F. All eight calves have increased in weight at a similar satisfactory rate.

Monthly hair samples have been taken from separate standard areas of skin on the flank for use in the quantitative assessment of any changes. Photographic records have also been made.

The first effect of the experimental treatment became apparent on May 5, three months after the start of the experiment, when, during the hair sampling, it was noticed that swathes of long hair could be rubbed off the neck and shoulders of the experimental calves. This process of shedding has continued in all four calves of the experimental group. Their heads and necks are now smooth and glossy, and the shedding is extending posteriorly.

The hair of the control calves, on the other hand, is firmly attached and the coats of these animals have become long and woolly, typical of the appearance to be expected with the approach of winter. These visible changes are reflected quantitatively by the monthly hair sampling results (see Fig. 1).

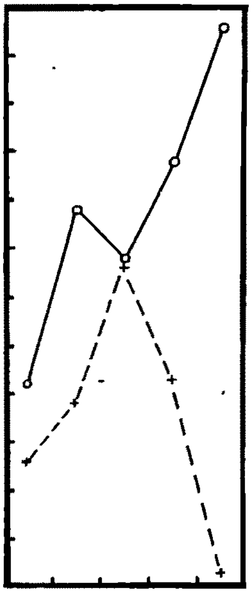

Fig. 1. Group average weights of hair samples, plotted for each month. —O—, control; – – – + – – –, light treated

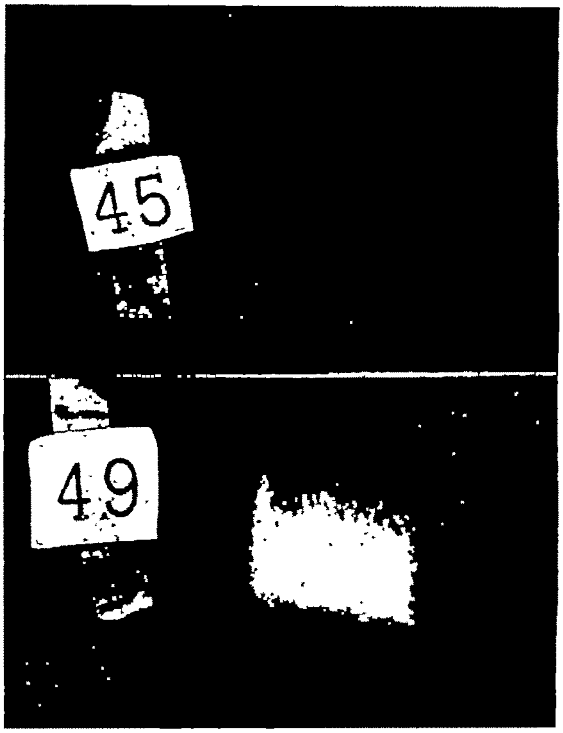

Fig. 2. Regrowth of hair on square patches of skin which had been clipped bare 20 days previously is greater on control (45) than on experimental calf (49). Photographs taken on May 25, 1954

Another point now noticeable is that on the areas of skin from which recent monthly hair samples have been clipped, the experimental calves have grown less hair than the controls (see Fig. 2).

From the results so far available, it is clear that the light environment exercises an important influence on the seasonal coat changes of cattle. A rising plane of light initiates shedding of long hairs and, with cattle of the type used in this experiment, shedding commences after approximately twelve weeks of increasing light. Growth of new hair also appears to be less on a rising plane of light than it is in decreasing light.

This experiment forms part of an inquiry into adaptation of cattle to tropical environments being undertaken co-operatively by the Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, and the Department of Physiology, University of Queensland. Thanks are due to Prof. W. V. Macfarlane for advice and encouragement.

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Production of Worm-free Lambs at Pasture

RECENT research has shown that a considerable loss of productivity occurs in sheep carrying a sub-clinical infestation of nematodes parasitic in the alimentary tract[1,2]. This work has depended upon comparisons of worm-free and lightly infected groups of animals and has therefore been carried out in indoor pens. It has been concluded that infected sheep gain weight at less than their optimum rate; but it is not clear how valid these results are for sheep at pasture, under normal conditions of continual reinfection by grazing. In order to measure the actual loss due to sub-clinical parasitism it is necessary to compare normally infected sheep with similar, worm-free animals under grazing conditions. An investigation was therefore carried out during March–July 1954 at the Grassland Research Station, Stratford-on-Avon, into the possibility of raising worm-free lambs at pasture.

As previously indicated[3], two essential requirements are (*a*) a worm-free pasture and (*b*) a grazing management capable of preventing infection of the lambs from their infected ewes.

The pasture used was a newly sown ley following two successive corn crops. The land had not been grazed by either sheep or cattle for two years. The grazing management adopted was based on the fact that the majority of the nematode eggs passed in the fæces of the host do not reach an infective larval stage for at least three days.

Nine ewes and fifteen lambs were transferred to the pasture when the lambs were less than twenty-four hours old and folded over it, using movable fences. The animals were moved in such a way that they never remained on the same area for more than two days and were never pastured on a previously grazed area. Regular fæcal egg-counts were carried out on both the ewes and lambs, 5–10 gm. samples being taken. The average egg-count for the ewes during this period was 300 eggs per gm. No anthelmintic was administered to either ewes or lambs during the time these were in the experiment.

The lambs were weaned at fifteen weeks and their egg-counts at this time were as follows: No eggs of *Nematodirus* spp. were found at any time; two lambs had counts of 2 and 1 *Trichuris ovis* eggs per gm., respectively; five lambs had negative counts for *Strongyloides papillosus*, and of the remainder 12 eggs per gm. was the highest count; the counts for 'other strongyles' were negative for twelve lambs and 1, 3 and 27 eggs per gm. respectively for the remaining three animals.

During the first thirteen weeks only an occasional *T. ovis* egg and low counts for *S. papillosus* were recorded. One lamb appeared to acquire a slight infection shortly before weaning. The complete absence of 'other strongyle' eggs in twelve of the lambs shows that it is possible to raise 'worm-free' lambs in the field. The negligible counts for other species compare favourably with 'worm-free' lambs raised in indoor pens. For comparison, an equivalent group of ewes and lambs were grazed on the re-growth of pasture following the first group and managed in a similar manner on such infected pasture.

It may be noted that at weaning time the average egg-count (excluding *S. papillosus*) of these lambs was 90 eggs per gm. Their peak of 400 eggs per gm. was reached in June, at which time they were dosed with phenothiazine. The worm-free lambs gained weight more rapidly than the sub-clinically infected animals.

The experiment has confirmed that a ley sown on land ungrazed for two years is worm-free. The possibility of retaining 'worm-free' ewe lambs and maintaining them as a 'worm-free' breeding unit, and the effect of age on the development of resistance to infection, are under investigation.

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Normal Hæmatological Values in the Buffalo

IN view of the wide range in the characteristics of the blood constituents of various animals, an investigation has been carried out to determine the normal values for various blood constituents of the domestic buffalo (*Bos* (*Bubalus*) *bubalis*).

Twenty adult Egyptian buffalo-cows were available at the Animal Breeding Research Farm, Giza, Egypt. They ranged in age from three to ten years and were healthy and non-pregnant. Samples of oxalated blood were taken during the period, January–April 1953. Red, white and differential counts were carried out and the diameter of the corpuscles was determined in dry stained smears. The following determinations were made: sedimentation-rate (using Westergren method), clotting time (Sabraz's capillary tubes), hæmoglobin content (Halden hæmoglobinometer), specific gravity (Weiss copper sulphate method), *p*H (Beckman *p*H meter) and the hæmatocrit (using the Winthrop technique). The following chemical constituents were also determined: blood sugar (Folin and Wu method), plasma proteins and non-protein nitrogen fraction using a semi-micro Kjeldahl method (Van Slyke technique), sodium (Weinback's method), calcium (Roe and Kohn technique) and phosphorus (Fisk and Subba Row's method).

The erythrocyte count was $6 \cdot 8 \times 10^6/\text{mm.}^3$, while the leucocyte count was $6 \cdot 7 \times 10^3/\text{mm.}^3$. In a differential leucocytic count, the percentages of lymphocytes, neutrophils, monocytes, eosinophils and basophils were 51, 36, 8, 5 and less than 1 respectively. The average diameter of erythrocytes was 5·5 μ, while the diameters of lymphocytes, neutrophils, monocytes, eosinophils and basophils were 6·8, 11·3, 15·7, 11·8 and 11·8 μ respectively.

The physiological and chemical characteristics of buffalo blood are shown in Table 1.

In the buffalo, the erythrocyte count is higher than in cattle and lower than in sheep and horse, whereas the leucocyte count is less than in cattle, horse and sheep. The percentage of lymphocytes, monocytes and eosinophils (in the differential count) in the buffalo is higher than in sheep and horse and lower than in cattle. The percentage of neutrophils in the buffalo is less than in sheep and horse and higher than in cattle. The basophils have almost the same frequency (less than 1 per cent) in all farm animals. The sedimentation-rate in the buffalo is higher than in cattle and lower than in horse, while the hæmoglobin content is higher in the buffalo than in all other farm animals. The clotting time of buffalo blood is longer than in sheep, shorter than in horse and similar to that of cattle. In general, buffalo blood is characterized by a relatively (to other farm animals) high

Table 1. PHYSIOLOGICAL AND CHEMICAL VALUES OF BUFFALO BLOOD

Items	Unit	Range	Mean ± S.D.	C.V. %
Specific gravity	gm./ml.	1·05–1·07	1·058 ± 0·012	1
pH		7·35–7·6	7·45 ± 0·0382	0·5
Sedimentation-rate	mm./1 hr.	2–8	6·0 ± 1·65	29
Clotting time	min.	6–7·25	6·75 ± 0·065	1
Hæmoglobin	gm./100 ml.	11·04–15·18	12·98 ± 1·236	10
Hæmatocrit	percentage	38–52%	44·3 ± 3·028	7
Sugar	mgm./100 ml.	72–90	81·4 ± 3·411	4
Plasma proteins	gm./100 ml.	6·62–7·62	7·42 ± 0·266	4
Plasma non-protein nitrogen	mgm./100 ml.	25–42	36 ± 3·142	8
Plasma sodium	mgm./100 ml.	400–430	415 ± 6·53	2
Plasma calcium	mgm./100 ml.	9–11	10 ± 0·156	2
Plasma phosphorus	mgm./100 ml.	26–31	28 ± 1·032	3

content of sugar plasma proteins and phosphorus and low content of calcium and sodium.

The blood picture of the animal is a result of an interaction between environmental (mainly domestication) and hereditary factors. The blood picture of the Egyptian buffalo falls among that of the Kumeoni, Hariana and Dhanni breeds of the Indian buffalo reported by Kehar and Murty[1]. A comparative study of normal hæmatological values is of great significance in studying the origin and evolutionary trends of species and breeds; such studies are also of particular interest for practical animal husbandry in the tropics, since certain features may be correlated with heat tolerance, environmental stress and disease immunity.

Thanks are due to Prof. A. L. Badreldin, chairman of the Animal Breeding Department, Faculty of Agriculture, and to Dr. M. H. Maghraby, of the Ministry of Agriculture, for providing facilities and help.

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In vitro Production of Tropical Black Earth

THE term 'grumusol' was proposed by Oaks and Thorp[1] for the dark-coloured clays which occur in many tropical and sub-tropical regions. Much is known concerning the chemistry[2,3], mineralogy[4] and fertility[5] of a number of these soils; but, as pointed out by Joffe[6], "the source of the black colour has been a kind of an enigma".

During the course of an investigation into the origin of the colour of Gold Coast black Akuse clay, the following experimental approach was adopted. Experimental pedology (the production of characteristic soil types under controlled laboratory conditions) is still a neglected section of soil science, and apart from the *in vitro* production of podsols[7] there has been scarcely any published work on this approach. The success met with here has prompted us to publish the results obtained, in order to indicate the potentialities of the method for studying tropical soil formation.

The three substrates used were kaolin (white), Bunso clay (yellow-red), and Akuse clay from which the organic matter had been removed by heating to 600° C. (yellowish-brown). 40-gm. samples of each of these substrates were placed in a series of 12-oz. bottles. These were then amended so that all possible combinations of five variable factors were represented.

The factors were: (1) Presence of readily-decomposable organic matter: (*a*) 3 per cent finely ground *Vetiveria* grass (dominant species on Akuse clay); (*b*) no plant material added. (2) Presence of an inoculum of black Akuse clay: (*a*) 1 ml. of a 1 : 5 soil suspension added; (*b*) no inoculum added. (3) *p*H: (*a*) adjusted to *p*H 5 with 2 *N* hydrochloric acid; (*b*) adjusted to *p*H 8 with 0·25 *N* sodium hydroxide. (4) Presence of excess calcium carbonate: (*a*) 5 per cent calcium carbonate added; (*b*) no calcium carbonate added. (5) Water content: (*a*) substrate kept permanently waterlogged; (*b*) substrate saturated with water and then left to dry out; alternation of anaerobic and aerobic conditions repeated throughout the course of the experiment.

The bottles were kept at room temperature (22–35° C.) and the results recorded after six weeks. No colour changes occurred in the amended kaolin; but in both the red Bunso clay and the mineralized Akuse clay there developed under certain conditions the characteristic grey colour associated with 'grumusols'.

There were four essential conditions for the development of this colour in the mineralized Akuse; namely, the presence of plant material, a soil inoculum, alkaline reaction and waterlogging. The addition of calcium carbonate, however, had no effect.

For the colour to develop in red Bunso clay, alkaline waterlogged conditions and the presence of plant material were again essential. An inoculum of Akuse clay was unnecessary, indicating that the native microflora of the ferruginous clay is able to induce the colour change if the soil conditions are favourable. In the absence of added calcium, the grey zone in Bunso clay was small and ill-defined, indicating that calcium was involved in the production of the colour and that the lack of a response to added calcium carbonate in mineralized Akuse was due to the high calcium status already existing in the soil.

Grumusols develop in warm regions with well-defined wet and dry seasons[1]. Our results indicate that the dark colour of these soils is due to the activity of anaerobic bacteria which develop in the alkaline, poorly drained montmorillonitic clays during the wet season. This confirms the hydrogenic origin of tropical black clays, as suggested by the work of Mohr[8] and del Villar[9].

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Pile Irradiation of Polyethylene Terephthalate ('Terylene')

In view of its bearing on the recent communication from Miss Little[1], some simultaneous and independent work, initiated by Charlesby's claim to have cross-linked polyethylene terephthalate by pile irradiation[2], is perhaps worth recording.

The solution viscosities of two ethylene terephthalate polymers, both before and after varying amounts of irradiation in the BEPO pile at the Atomic Energy Research Establishment, Harwell, were measured in *o*-chlorophenol at 25° C. One polymer ('microdull') contained titanium dioxide as a delustring agent but there was none in the other ('bright'). For both polymers, the limiting viscosity number $[\eta]$ fell and the Huggins's viscosity slope constant[3],

$$k^1_H = \frac{d\left(\frac{\eta - \eta_0}{\eta_0 c}\right)}{dc} \Big/ [\eta]^2,$$

where η and η_0 are the viscosities of solution and solvent respectively and c is the concentration of the solution in gm./ml., rose with increase of radiation dose. It should perhaps be noted that hydrolysis will contribute to the $[\eta]$ drop for the samples of bright polymer irradiated longest in sealed tubes if the temperature in the pile approaches 100° C.

Polymer	Radiation energy (MW. hr. × 10^{2})	$[\eta]$	k^1_H
Microdull	0	76	0·25
,,	0·3 in air	65	0·39
,,	0·5 ,,	62	0·41
,,	1·0 ,,	57	0·43
,,	2·0 ,,	52	0·38
Bright	0	65	0·27
,,	2 *in vacuo*	49	0·43
,,	4 ,,	42	0·58
,,	8 ,,	37	0·52

Although the exact significance of k^1_H is not clear, it is generally agreed that it depends on the interactions between the molecules in high polymer solutions: a rise in k^1_H would correspond to a reduction in the effectiveness of *o*-chlorophenol as a solvent for the polymer. The exponent α, which is thought to be unity for spinning-grade polyethylene terephthalate (W. R. Throssell, unpublished work), in the relation between $[\eta]$ and number average molecular weight $\overline{M}_n$, $[\eta] = K\overline{M}_n^{\alpha}$, would also be expected to fall and cause a reduction in $[\eta]$ uncompensated by the accompanying rise in K. Hence, the observed drop in $[\eta]$ does not necessarily indicate a reduction in $\overline{M}_n$, although the magnitude of the effect suggests that this is probable.

The samples which had been more heavily irradiated *in vacuo* show a small but significant decrease in Vicat softening point of 0·27° C. for unit fall in $[\eta]$. This would be consistent with a modification of the chain structure, for example, by branching. It could be caused by occluded degradation products, but these would probably be removed during the crystallizing pretreatment for one hour at 140° C. before the softening-point test. It cannot be due merely to a reduction in molecular weight, for a fall in softening point is not detected in samples produced by hydrolysis of normal polyethylene terephthalate until $[\eta]$ falls below about 30.

In agreement with the conclusions from X-ray data[1], these results suggest that the effect of pile radiation, at least up to 800 MW. hr., on polyethylene terephthalate is degradative, although possibly accompanied by branching. Furthermore, the relative ease of solution, unchanged by irradiation, of all the samples in *o*-chlorophenol, together with the lowered softening point are inconsistent with the presence of any measure of cross-linking as reported by Charlesby[2].

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[1] Little, K., *Nature*, 173, 680 (1954).

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A Corrected Guldberg Rule

According to the well-known rule of Guldberg[1], the normal boiling point of a liquid is two-thirds of the critical temperature on the absolute scale. The rule is not obeyed by liquids of low boiling point[2], and even for liquids boiling in the range 20–250° C. the ratio T_b/T_c varies from 0·58 to 0·70. Inasmuch as these deviations arise from the different cohesive forces, and the latter are related to the surface tension, we may write

$$T_b\gamma_b^n/T_c = k,$$

where γ_b is the surface tension of the liquid at the boiling point, and n and k are constants. For ordinary organic liquids the relation

$$T_b\gamma_b^{\frac{1}{4}}/T_c = 4/3 \qquad (1)$$

is generally more accurate than the simple Guldberg rule, as may be seen from the following data:

Substance	T_b/T_c	$T_b\gamma_b^{\frac{1}{4}}/T_c$
Carbon disulphide	0·586	1·338
Ethyl bromide	0·618	1·335
Benzene	0·629	1·348
1,1-Dichloroethane	0·633	1·348
Cyclohexane	0·640	1·316
Ethyl ether	0·658	1·305
n-Propyl formate	0·663	1·355
Methyl butyrate	0·677	1·349
*iso*Amyl formate	0·688	1·344
n-Butyl acetate	0·690	1·342
n-Octane	0·700	1·303

A relation between the parachor and the critical volume may be derived from (1). Since the molar volume of a liquid at the boiling point is three-eighths of the critical volume[3], we have

$$\frac{T_b\gamma_b^{\frac{1}{4}}V_b}{T_cV_c} = \frac{1}{2},$$

so that the parachor is given by

$$P = \frac{1}{2}\,\frac{V_cT_c}{T_b}. \qquad (2)$$

A study of the experimental data led Ferguson and Kennedy[4] to propose the empirical formula

$$P = 0{\cdot}324\, V_c^{\frac{7}{8}}T_c^{\frac{1}{4}},$$

but Lennard-Jones and Corner[5] were able to show, on the basis of dimensional considerations, that the parachor is proportional to $V_c^{5/6} T_c^{1/4}$. For non-associated organic compounds, including those in which the molecules are so unsymmetrical as to restrict rotation in the liquid state, they found that the formula

$$P = 0{\cdot}410\, V_c^{5/6} T_c^{1/4}$$

gave slightly better agreement than that of Ferguson and Kennedy. Examination of the available data for liquids of this type reveals that formula (2) is definitely superior to that of Ferguson and Kennedy, and is in general slightly more accurate than that of Lennard-Jones and Corner.

S. T. BOWDEN

University College,
Cardiff. July 29.

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Paramagnetic Resonance, a New Property of Coal-like Materials

PARAMAGNETIC resonance, which has given interesting information on several structures[1], can be used for studying coal-like materials. Using a microwave spectrometer (9,000 Mc./s.) for electronic paramagnetic resonance, we have observed a characteristic line for coals[2]. This sharp line is associated with a Landé factor of 2, which is the free electron value. These results lead us to believe that this paramagnetism is linked with the structure of coal-like materials and cannot be attributed to the minerals always present, such as iron. In the present communication we give further details on the results observed for coals[2] and for several coal-like materials in which paramagnetic resonance has been detected.

The samples of coal studied, coming from mines in northern or eastern France, are of different geological ages. They correspond to the following French designations: anthracite, quart-gras, demi-gras, trois-quart-gras, flambant-gras, flambant-sec. The amplitude of the line decreases from the oldest coal (anthracite) to the youngest one (flambant-sec). Roughly, the amplitude gets smaller as the amount of carbon decreases in the samples and as the amount of volatile substances and oxygen increases. Charring modifies the phenomenon considerably. On heating the coals up to 500° C., the line is seen to decrease gradually with increasing temperature. The line disappears quickly on heating the same samples between 500° and 600° C., when graphitization and electrical conductivity appear. After coking is completed (1,000–1,100° C.) no line can be seen. It must be emphasized that several samples of graphite did not give any line with our apparatus, though a weak line has been reported by Castle[3]. With regard to lignites, the line is absent in a sample from Hostens, present but weak in a sample from Fuveau and in both instances it becomes very strong after heating at 300° C. These results have led us to make some experiments with such materials as charcoals, sugar charcoal and pitches.

Charcoal prepared from pine wood and coconut and also some lightly charred sugars (saccharose, glucose) give a fairly intense paramagnetic resonance line. This line disappears in charcoals activated at 900° C. in presence of combustion gases and steam. No line appears in crude oils; but one is found in pitches which are residues from crude oil distillation. It can be said that paramagnetic resonance appears when carbohydrates are damaged either by Nature, as in coals, or artificially by heating, as in charcoals, sugar charcoal and pitches. The same line appears if the samples (woods, sugars) are irradiated by γ-rays, as was found by two of us[4], which suggests the same sort of damage. This paramagnetic resonance cannot be attributed to a specific defined structure at present; but further experimental and theoretical work is being carried out.

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Electroretinal Photopic Sensitivity Curves

SINCE Adrian[1] first suggested the existence of separate rod- and cone-components in the human electroretinogram, there have been attempts to isolate them so as to demonstrate the degree to which their spectral sensitivity curves adhered to scotopic or photopic patterns.

Thus Riggs, Berry and Wayner[2] determined the function for the *B*-wave. With a 7·5° foveally centred stimulus-flash, the curve closely resembled the scotopic function but was displaced toward the blue. Armington, Johnson and Riggs[3] derived a similar curve for the *A*-wave of the dark-adapted eye. Again excess blue-sensitivity appeared. Boynton[4] has supposed this to be related to the part played by stray light. With small stimulus areas a significant portion of the electrical response is due to light scattered over the peripheral retina, outside the focal area. One contributor is Rayleigh scatter, varying as an inverse function of the fourth power of the wave-length, scattering blue more than red. To support this interpretation, Boynton shows that divergence from scotopic values is less when larger areas are used. Johnson and Armington[5] have confirmed this, demonstrating that with full-retinal stimulation, using an integrating sphere, electrical sensitivity curves for the *B*-wave of the dark-adapted eye coincide with the usual scotopic luminosity curve.

Armington[6] has fitted data for the *X*-wave (Motokawa's designation for Adrian's photopic component) to the CIE photopic luminosity curve. With the photopic receptors we would expect stray light to have less effect. Cones are concentrated near the fovea and are supposed (cf. Stiles–Crawford effect[7]) to be directional. It is disconcerting to find that the *X*-wave curve diverges from the photopic curve just as the small-area *B*-wave curve diverges from the scotopic function. No one has used full-retinal stimulation to elicit the *X*-wave. We cannot say whether such a procedure would bring the *X*-wave

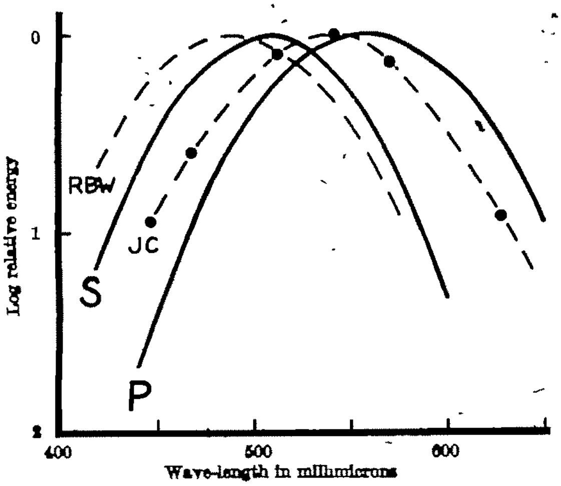

Fig. 1. Log relative energy at each wave-length to achieve standard response. Maxima of curves adjusted to equality. *S*, Scotopic visibility curve; *RBW*, curve for *B*-wave (ref. 2); *P*, photopic luminosity curve; *JC*, curve for *X*-wave obtained by authors using four per sec. flashes in light-adapted eye. Points indicate photopic peaks of narrow-band filters used. Data of three determinations averaged

results into line. Armington speculates that it might not. He has used night-blind subjects and found some alleviation of the disparity. This suggests that the *X*-wave of the normal-seeing person, as elicited by Armington's procedures, is partly of scotopic origin or, alternatively, that the peripheral cones of his night-blind subjects had been affected so that the effect of stray light was diminished even though a 'pure cone' index was being observed.

To throw additional light on the problem we have employed a technique suggested by Dodt[8], in a communication in *Nature* in 1951. He affirms, and we agree, that with a stimulus flickering above a rate of about 20 per sec., scotopic responses appear to fuse, manifesting the equilibrium characteristic of steady illumination. Responses synchronous with 30 per sec. flashes should represent activity of the faster responding photopic system. In the dark-adapted eye there is an initial *B*-wave, following which the 30 per sec. fluctuations appear. These may continue, unaltered, for several minutes. Records taken after different lengths of time in darkness differ only in the size of the initial *B*-wave.

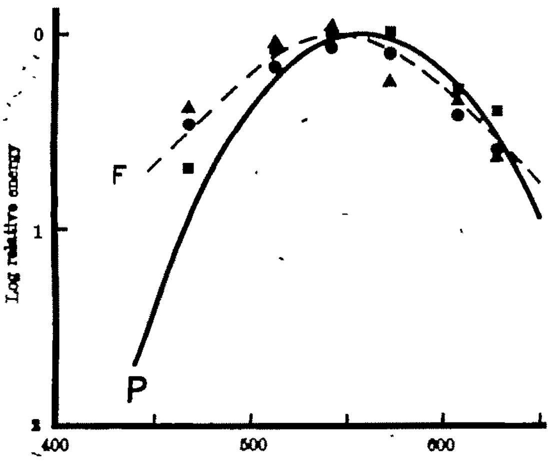

Fig. 2. Log relative energy at each wave-length to achieve standard response. *P*, Photopic luminosity curve; *F*, curve for 30 per sec. flashes. Triangles represent one set of determinations on subject A.T., squares and circles two sets for subject P.J.

Using 4 per sec. flashes (to which the above argument does not apply), and delivering these to the light-adapted eye, we confirmed Armington's findings for the normal eye. Total height of response was measured, from trough of *A* to peak of *X*. Fig. 1 shows the form of the curve obtained using a 20-µV. response criterion. Excess blue-sensitivity is apparent. (Apparatus and treatment of results in this work were similar to those employed in refs. 2–6.)

With 10-m.sec. flashes delivered to the dark-adapted eye at a rate of 30 per sec., and using a 10-µV. trough-to-peak response criterion, the 'sensitivity curve' (Fig. 2) resembles the photopic more than the scotopic function, but is still displaced slightly toward the blue and is less sharply peaked. We must either consider the hypothesis that Rayleigh scatter contributes to the photopic electroretinogram, as it does to the scotopic, or we must admit that neither the employment of night-blind subjects nor the use of flickering stimuli prevents intrusion of a blue-sensitive system, presumably the scotopic, which contributes to the electroretinogram yet fails to show itself during determination of the photopic luminosity curve by the standard procedures.

This work was supported by a contract between the U.S. Office of Naval Research and Brown University, and carried out in the Psychology Laboratories of Brown University.

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A Disease Epidemic in Fish

AN epidemic has occurred in a fish culture of *Tilapia mossambica* in Southern Rhodesia during June 1954. The disease had a mortality of more than 90 per cent of the exposed population. *Barbus* species were also affected. Fungus was seen mostly on the extremity of the dorsal fin but frequently occurred on the caudal peduncle, the tail and on the inter-orbital region. Affected fish were seen lying in shallow water and gasping at the surface. The intestine was filled with a clear gelatinous fluid. No macroscopic gill lesions were noticed. Although cold (below 56° F.) seems a predisposing factor, the etiology is not clear. Helminth cercaria may be implicated as well as fungus. Histologically gill necrosis associated with an invasion of conidia-like bodies, and kidney and liver cloudy swellings are present.

Further details will be published later.

H. AFFLECK

P.B.4, Mazoe,
Southern Rhodesia.
Aug. 30.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Wednesday, September 29

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. A. H. Cutler: "Computing Circuits in Flight Simulators".

Friday, October 1

Hospital Physicists' Association (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. C. A. Coulson, F.R.S.: "Douglas Lea—Physicist into Biologist" (Fourth Douglas Lea Memorial Lecture).*

Saturday, October 2

Royal Photographic Society of Great Britain—Scientific and Technical Group, in conjunction with the University of Durham (in the Lecture Theatre, Stephenson Building, King's College, Newcastle-upon-Tyne), at 10 a.m.—Conference on "Scientific and Technical Applications of Photography".

Association of Clinical Biochemists (joint meeting with the Association of Clinical Pathologists, at the Grand Hotel, Brighton)—Meeting on "Thyroid Function". Morning Session—Papers on "Chemical Pathology"; Afternoon Session—Papers on "Thyroid Function".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Junior Research Fellow (with one or two years postgraduate experience) in Biochemistry, to undertake research in the formation of complexes between metal ions and polypeptides and proteins—The Secretary, The University, Aberdeen (October 1).

Assistant Physicist (with an honours degree in physics and preferably with hospital experience)—House Governor, The London Hospital, Whitechapel, London, E.1 (October 2).

Senior Lecturer or Lecturer (with teaching and research or industrial experience in electronics) in Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (October 4).

Analytical Chemist (with first- or second-class honours degree and preferably with experience in the rubber industry), to supervise analytical work in the chemical division and to carry out research on new methods of physical and chemical analyses in connexion with the natural rubber producing industry; Chemical Engineer (with first- or second-class honours degree and a professional qualification in chemical engineering), to carry out development work to the pilot plant stage, at the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (October 8).

Scientist (with good honours degree in chemistry or physics, preferably with specialization in physical chemistry and experience of surface chemistry), at the Coal Survey Laboratory, Leeds—National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/841 (October 9).

Lecturer, Grade A, in Botany, and a Lecturer, Grade A or B, in General Science, at the Kumasi College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 11)

Keeper (with experience in archives administration) in the Department of Archives—The Director, Museums and Art Gallery, New Walk, Leicester (October 12).

Lecturer (graduate in electrical engineering and preferably with experience in electrical measurements, transmission and distribution of electricity, or high frequency line communication) in Electrical Engineering, at the Auckland University College—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

Lecturer in Machine Tools and Metrology in the Department of Engineering Production, to be responsible for the Metrology and Machine Tool Research Laboratories and for postgraduate teaching and research—The Secretary, The University, Birmingham 15 (October 15).

Research Officer (graduate, preferably with honours degree in veterinary or agricultural science with specialization in animal genetics, and with experience in wool technology and statistical methods and knowledge of the sheep and wool industry) in the Trangie Experiment Station, New South Wales Department of Agriculture, to be responsible to the Director of Veterinary Research for organizing and supervising research projects of the Wool Research Laboratory—The Agent General for New South Wales, 56/57 Strand, London, W.C.2 (October 18).

Senior Lecturer (preferably with good knowledge of classical theoretical physics and quantum theory) in Physics, at the University of New England, Armidale, New South Wales—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 18)

Senior Lecturer in Agricultural Economy; Lecturer in Soil Science; Lecturer in Animal Production at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 22).

Chair of Chemical Engineering—The Registrar, University College, Singleton Park, Swansea (October 25).

Lecturer in Agricultural Economics and Farm Management at University College, Ibadan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

Senior Lecturer in Statistics at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 29).

Assistant Lecturer (with special qualifications in applied mathematics) in Mathematics—The Registrar, The University, Manchester 13 (October 30).

Senior Horticulturist, Senior Scientific Officer grade (with honours degree in botany and with research experience) in the Pomology Section, for work on fruit tree rootstocks—The Secretary, East Malling Research Station, Maidstone, Kent (October 30).

Chair of Applied Mathematics at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Chair of Animal Husbandry at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 6).

Electronic Engineer or Physicist to assist in installation and operation of electronic digital calculator—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

Lecturer (with a degree in mechanical engineering and teaching experience, and preferably with industrial experience) in the Department of Engineering—The Principal, County Technical College, Gainsborough.

Lecturer (with an honours degree and preferably with industrial experience) in Physics—The Principal, Paisley Technical College, Paisley.

Principal or Senior Scientific Officer (with first- or second-class honours degree in civil engineering, or equivalent qualification, with experience in the planning and construction of roads or similar civil engineering work, and preferably with experience of economic problems) at the Road Research Laboratory, Harmondsworth, to study the economics of road construction and maintenance—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E591/54/A.

Research Demonstrator in Physics—The Registrar, University College, Leicester.

Research Engineer (with a university degree and some workshop experience, and preferably with training in research), for experimenta work into the stresses in steam pipe-work with particular referenc to advanced steam conditions—Prof. H. Ford, Mechanical Engineering Department, Imperial College, London, S.W.7.

Rubber Technologists or Science Graduates (interested in th practical applications of science) to undertake technological investigations—The Secretary, Research Association of British Rubbe Manufacturers, Shawbury, Shrewsbury, Salop.

Senior Materials Engineer (with university degree in science and qualified for membership of the Institution of Civil Engineers and with at least 10 years postgraduate experience on road or airport construction including theoretical and practical experience of applied soil mechanics and analysis) in the Public Works Department, Gold Coast Government, to be responsible for the Materials Section, Public Works Department Road and Bridges Branch, including all its field and laboratory activities—Adviser on Recruitment, Gold Coast Office, Melbourne House, Aldwych, London, W.C.2.

Senior Scientific Officer (with first- or second-class honou degree in physics or physical chemistry, or equivalent qualifications and with several years postgraduate research experience) to lead a group investigating the application of engineering technology to th manufacture of explosive weapons, including the study of dust explosion and static hazards—The Senior Recruitment Officer, Atomi Weapons Research Establishment, Aldermaston, Berkshire, quoting 107/WGR/34.

Senior Scientific Officer (Ref. 659) (with first- or second-class honours degree in chemistry, or equivalent qualification, and with a least three years postgraduate experience of inorganic analysis) t take charge of group engaged on research and development work i inorganic analytical chemistry, including the application of moder analytical techniques; Senior Experimental Officers (Ref. 660 (with H.S.C. Science and experience in analytical chemistry) to supervise laboratories engaged on analyses of materials used in atomi energy processes; Assistant Experimental Officers (Ref. 661 (with H.S.C. Science and experience of chemical analysis, preferabl in the organic field) for analytical work on materials used in atomi energy processes, with the United Kingdom Atomic Energy Authority Capenhurst—United Kingdom Atomic Energy Authority, Industria Group Headquarters, P.O. Box 19, Risley, Warrington, quotin appropriate reference.

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THE ADVISORY COUNCIL ON SCIENTIFIC POLICY

THE Advisory Council on Scientific Policy was established in 1947 "to advise the Lord President of the Council in the exercise of his responsibilities for the formulation and execution of Government scientific policy". It is concerned accordingly not with administration but with the strategy of scientific affairs, and in its seventh annual report*, breaking with the practice of the two previous reports, the Advisory Council reviews its activities, including those of the current year, during the whole period since it was established, in the light of post-war developments. The Council was established in the recognition that to-day a country's wealth and power are largely determined by the extent of its scientific knowledge and by its capacity to use that knowledge. It was also realized that the scientific institutions of Britain had grown up piecemeal, and that, although much of their cost fell on the Exchequer, no single body was concerned with the oversight of Government scientific policy in general, with the interaction of new scientific developments—desirable in the national interests—among themselves and with the functions of existing institutions; nor with the responsibility of advising whether the supply of scientific man-power was adequate to meet the needs both of Government and industry.

The first, and major, part of the present report is concerned with the scale of the civil scientific research effort, and discusses the expansion of scientific education and the demand for scientists, including the shortage of science teachers, and next the scale of Government-financed research. The fruition of policy, however, depends on the extent to which industrialists and farmers make use of advances in scientific knowledge, and on the extent to which scientific considerations are taken into account at the highest levels where policy is determined, in industry as well as in Government. The second part of the report, accordingly, reviews briefly the exploitation of the civil scientific effort both by Government Departments themselves and in industry.

The increase in the size of the universities of Britain, and, more particularly, the increase in the numbers of graduates in science and engineering, are, in the opinion of the Advisory Council, among the most noteworthy changes which have occurred in Great Britain during the past ten years. In 1952–53, the universities awarded 5,710 first degrees and diplomas in scientific subjects compared with 3,060 (including higher degrees) in 1938–39; for applied science the corresponding figures are 3,636 and 1,808, respectively; for medicine and dentistry, 2,369 and 1,792; and for agriculture, 803 and 246. Nor was 1952–53 the peak year for all subjects; only in chemistry were more honours degrees awarded in 1952–53 than in 1951–52. For pass-degrees and diplomas in pure science the peak was reached in 1950–51; in applied science it was earlier still—1949–50—and has declined steadily since. Honours degrees in chemical technology have declined from 121 in 1950–51 to 100 in 1952–53, although in engineering sciences as a whole they have remained fairly steady (1,025 in 1950–51, 998 in 1952–53).

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* Seventh Annual Report of the Advisory Council on Scientific Policy, 1953–1954. Pp. iv+23. (Cmd. 9260.) (London: H.M. Stationery Office, 1954.) 1s net.

Discussing these figures in the light of the estimates of the Barlow Committee in 1946, the Advisory Council points out that, while over-cautious about the possibilities of increasing the output of trained scientists, the Barlow Committee was correct in predicting a continuing shortage, and that the position would become serious if the level of new investment in manufacturing industry increased and if the more backward sections of British industry began to employ trained scientists and engineers, not only in laboratories and workshops, but also in boardrooms and sales organizations. There is no indication, however, that the Advisory Council has attempted to estimate the future demand for trained scientists. Apart from discussions initiated by its Committee on Biology and Allied Sciences, the Advisory Council appears to have rested content with the survey made two years ago by its Scientific Man-power Committee, and to have made no further effort to obtain more accurate estimates from the various sub-committees of Lord Hankey's Technical Personnel Committee.

The Council is clearly concerned, however, as to the situation which might arise if investment increased materially, and if the demand for trained scientific man-power reached the proportions which might be regarded as adequate for a progressive industrial nation. There is evidence that the decline in the number of admissions to the universities since 1949–50 has been halted, although university departments in pure and applied science are now doing no more than maintain their student numbers. Numerically, the position of the technical colleges is more encouraging; the awards of National and Higher National Certificates are now about three and six times the pre-war figures, respectively.

Although about twice as many young men and women in each age-group are now going to the universities as compared with pre-war years, the ratio to-day (1 : 31 in each age-group) is still significantly less than in countries like Switzerland or the United States. The Advisory Council has no doubt as to the ability of the universities to cater for larger numbers and for an increased proportion of science students, provided the necessary resources are forthcoming. It assumes that such resources can be provided without detriment to other national interests, and in this survey its chief concern is with the possibility of stimulating more of the able boys and girls of the existing school population to take up science instead of the humanities, or encouraging those who leave school at or before sixteen to stay on until university age. It does not consider that there is much scope for attracting to science more of the present population of the sixth forms of grammar schools, and it is the second measure which offers the best prospect of materially increasing the supply of science undergraduates.

The Advisory Council has recently been told by the Ministry of Education and the Scottish Education Department that the number of boys staying on at school is increasing and that in grant-aided and recognized independent schools the number aged 17–18 rose from 23,000 in early 1950 to 27,500 in early 1953. This trend should bring to the universities more potential scientists as well as more potential first-class scientists; but, even taking into account the effect of the post-war bulge in the birth-rate, which from 1960 could give a 25 per cent increase in university students, the figures would have to increase far more to affect materially the number of trained scientists. Moreover, the Council recognizes that there is a risk that such expansion may be at the expense of the numbers of those at present leaving school before the age of seventeen who continue their scientific and technical education on a part-time basis.

Such recognition, however, is as near as the Advisory Council comes in this report to emphasizing that the expansion of scientific and technological education in Britain must proceed in balance with the expansion of technical education, and that some attempt must be made to see that the demands of industry in respect of technicians are also met. The demands for technicians and for technologists and scientists, moreover, are not entirely independent, as in their supply they are interlocked. Indeed, the Advisory Council might well have directed attention to the importance of industry and Government, as well as the universities and research institutions, making the most effective use of their trained scientists. The demand could be checked at least a little if full care were taken to see that highly qualified men are not employed on work which can be carried out no less efficiently by those less highly trained.

In part, this depends on the availability of adequate numbers of laboratory and other technicians, and estimates of the requirements of industry or Government Departments for scientists or technologists which take no account of requirements for technicians are of little value. This consideration equally affects the supply of science teachers, as was fully recognized by the National Advisory Council on the Training and Supply of Teachers in its report on graduate teachers of mathematics and science; the Advisory Council on Scientific Policy endorses the measures recommended in that report in referring to the shortage of science teachers.

Any attempt to encourage more boys to stay on at school until of university age can be of only limited effect as a contribution to increasing the supply of scientists and technologists until the continuous decline in the numbers and quality of science teachers is checked. Broadly speaking, on the question of the shortage of science teachers, as on the supply of scientists, the Advisory Council's views are similar to those of the committee set up at the conference convened by the Federation of British Industries last January. Serious as is the present position, it will become even more serious in the next five or six years unless action is taken very quickly: by 1960 the deficiency of science teachers in the schools may reach 2,300. The Advisory Council believes that so long as there is a real shortage of scientists, the prevailing salary scales will not attract sufficient numbers to teaching. The poor career prospects in comparison with those in industry or Government service are the basis of the shortage, and this report supports the proposals made by the Federation of British Industries Committee for salary revision which would open up prospects of salaries up to £1,500 for, say, five per cent of science graduates engaged in teaching. It gives no indication, however, of the Council's attitude to the more controversial issue of deferment of National Service, on which the Federation of British Industries Committee suggested a reasonable compromise.

The Advisory Council insists that a solution to this problem of the shortage of science teachers is essential; it does not appear to stress sufficiently that a price must be paid to remove the threat which the shortage offers to the supply of trained scientists and technologists, which conditions so largely the effectiveness of our national economy, even if that price be no more than that involved by the proposals of the Federation of British Industries Committee. That price will only be kept so low, however, if vigorous concerted action is taken to promote the ameliorative measures suggested by the Advisory Council or in the reports by other bodies such as the National Advisory Council on the Training and Supply of Teachers and the Federation of British Industries Committee. For example, the Advisory Council, in pointing out that the need is not for narrow specialists in science, suggests that the universities themselves could, by insisting on a proper standard of general education for all candidates, both check over-specialization in the schools and ease the difficulty of finding specialist science teachers for schools. It also comments that, while the standard of first degrees in scientific subjects should be maintained, the proportion of better students who take up science would rise if the universities made it easier for those who had specialized in the humanities at school to turn to science when they reach the universities.

These are sensible suggestions, and it would seem that the *studium generale* or exploratory year which is under trial at the University College of North Staffordshire may have something to offer in this connexion. The Advisory Council, moreover, reaffirms that it is not deprecating the importance of the humanities in the universities, though it believes that education in science is as likely to provide an intellectual stimulus as an education in the classics or history. The emergence of the competent and open-minded man of judgment depends more on the quality of the individual himself and on the quality of the education he has received than on the curriculum.

The Advisory Council has found no evidence that Britain is losing an undue proportion of our best students to other countries, and it points out that the exchange of scientists and technical men between Britain and other Commonwealth countries is desirable on many grounds. The United Kingdom has probably done more to extend the scale of science education since the War than any other major Power; but we had more leeway to make up and were faced with a sterner challenge in maintaining our standard of living. We have still to plan to meet the need for scientists which is implicit in the view that our economy will grow at a reasonable rate and that there will be a rapid increase in our productivity. The Advisory Council rightly remarks that, in the long run, we need more people studying science because of its general educational value; but meanwhile, if a better balance between the supply and demand for scientists and technologists is to be achieved, the various measures now being taken or considered must be implemented with considerably more drive than appears in this report. It must also be insisted that the price to be paid is one which must be met in full, even if sacrifices have to be made elsewhere.

To assess the magnitude of the national demand for scientists and technologists, however, some regard must be had to the national effort; but when the report comes to consider the scale of Government-financed research, its inadequacy is manifest. Now that the Lord President of the Council has become responsible for the Atomic Energy Authority, the Advisory Council will presumably in future have within its competence the bulk of research in applied nuclear physics. Even so, expenditure on defence research may well be on a scale which makes it difficult to assess independently the balance and distribution of the national research effort. The Government expenditure of £20·7 million on civil research in 1954–55, exclusive of the proportion of the £28 million for the universities which is spent on research, has to be set against expenditure on defence research of £160 million or more, and probably up to £100 million on research and development by industry in its own establishments; the chemical industry alone expends something like £12 million and employs some 3,300 scientists, compared with the 4,423 employed under the research councils, etc., according to this report.

Much of this effort lies, of course, strictly outside the scope of the Advisory Council on Scientific Policy, as civil research lies outside that of the Defence Research Policy Committee. At some level, however, the full extent of Government and industrial and defence commitments in research requires review in relation to resources, nor can the Advisory Council discharge its statutory responsibility to the Lord President without some regard to this over-all picture and the way in which it tends to change, as the report itself explicitly admits. The most interesting feature of the summary of research expenditure appended to the present report is indeed the variation which it reveals in the rate of expansion in different fields. While the grand total of Government expenditure on civil research increased roughly sixfold, from £3,640,000 to £20,720,100, between 1939–40 and 1954–55, that on industry and communications and on medical and health purposes increased more than tenfold, from £983,400 to £9,859,000 and from £223,100 to £2,364,600, respectively; while expenditure on research in agriculture, forestry, fisheries and food increased five times, from £1,243,300 to £6,423,600, and that on overseas research increased only from £750,000 to £1,411,200. As the Advisory

Council points out, the scale of Government-financed research in the civil field has increased over the past decade as much as has university education in general, though expenditure on defence research has trebled between 1950 and 1953. Moreover, the rate of increase in expenditure on Government civil research appears to be appreciably greater than that of industry as a whole on research. A survey carried out for the Federation of British Industries in 1950–51 indicated that some three hundred firms were spending £24 million on research and development, an increase of not more than fourfold on expenditure in 1938, although probably fifty per cent greater than in 1945–46. The Association of British Chemical Manufacturers' estimate of £11·2 million expended by the chemical industry as research and development in 1952 represents an increase of some 32 per cent on expenditure in 1948.

The Advisory Council does not in the present report raise the questions whether this relative trend in expansion of research under Government auspices as compared with research within industry itself is desirable, or whether it represents the distribution of man-power and resources likely to yield the best return from the point of view of productivity and the national economy. It recognizes very clearly, however, the implications of such expansion for its own responsibilities, and the section of this report concerned with the exploitation of the civil scientific effort indicates that the Advisory Council is rightly concerned to see that gaps or weaknesses in the national effort are duly repaired or strengthened. On the evidence of this report, the Council's strategy appears to be sound, even if measures to remedy some of the weaknesses it notes might well have been advocated more forcefully. For example, the Advisory Council recognizes the importance of an efficient library service in the exploitation of the results of research, and that it must accept some responsibility for seeing that the national system is adequate and efficient. Nevertheless, in regard to the proposed Science Centre in London, it merely expresses an earnest wish that the necessary resources will be found shortly, and the hope that steps can be taken to implement the scheme for a national library of science and invention without undue delay. The present report will at least keep before the Government the interlocked proposals for a science centre and a central scientific reference library, and what is said in it may encourage Sir Robert Robinson to make a further effort to secure action on the proposals which he did so much to formulate.

The Advisory Council clearly does not regard the time and money required to implement the proposals as valid reasons for delay in bringing these plans to fruition at an early date, and the way in which these plans are related to the dissemination of the results of research and thus to scientific and technological progress may perhaps induce the Government to regard the matter as urgent and of high priority. At present, scientific library facilities in Britain are markedly inferior to those in the United States and in some European countries. The Advisory Council's Standing Committee has been closely concerned in efforts to overcome the immediate difficulties of the Patent Office Library and the Science Library at South Kensington, and during the past year has reported further to the Advisory Council regarding a national library of science and invention. The main recommendations of the report have been endorsed by the Advisory Council, and those quoted by the Council in its present report set forth concisely the case for early action.

The need for a national science lending library cannot be met either by a national science reference library in London or by the development of any existing library on its present site. In the interests of security, the new library should be outside London, preferably in a place easily accessible to the industrial areas of the North and Midlands, for which it could, to a limited extent, also serve as a scientific reference library. Existing collections in the Science Museum, after providing for the needs of the Kensington museums and of the Imperial College of Science and Technology, could supply much of the material for the new library, responsibility for which would be vested in the Department of Scientific and Industrial Research. The new library is thus visualized as an essential part of the expansion of that Department, and its work would be complementary to that of the Department's Intelligence Division, while it would also be the centre of a regional loans system based on selected municipal libraries which would stock and lend the three hundred or so periodicals most used by scientists and engineers in industry.

The bearing of these schemes on the efficient use of scientific and technical man-power might perhaps have been brought out more emphatically; but the Advisory Council's report at least affords the scientist as well as the industrialist an opportunity of pressing for early action by the Government in a matter vitally affecting the exploitation of the results of research, and one in which the first move must come from the Government. Generally, it would seem that the Advisory Council is satisfied with the arrangements to secure the use of science by Government Departments, though it would welcome an increase in the number of administrators with training and experience in scientific work who could bring an understanding of scientific matters to bear in the determination of policy. It also looks for increasing recruitment into the administrative Civil Service of men with a grounding in the sciences.

On the present record of its activities, it is clear that the establishment seven years ago of the Advisory Council on Scientific Policy has been amply justified; but it could be wished that at times it had raised its voice more emphatically and acted more vigorously, and that its influence had been more decisive. As its comments in regard to oceanographic research in this report illustrate, the Advisory Council is able to bring to bear, in borderline fields of science, an informed and concerted opinion and a co-ordinating influence much more immediately effective in implementing co-operation and closing gaps in our research effort than the delayed comments of the shrewdest and most alert Select Committee on Estimates or Committee of Public Accounts.

THE LIFE AND PHILOSOPHY OF ALMROTH WRIGHT

Almroth Wright: Provocative Doctor and Thinker

By Dr. Leonard Colebrook. Pp. xi+286+10 plates. (London: William Heinemann (Medical Books), Ltd., 1954.) 21s. net.

Alethotropic Logic: a Posthumous Work

By Sir Almroth E. Wright. Presented by Giles J. Romanes. Pp. xvi+346+4 plates. (London: William Heinemann, Ltd., 1953.) 25s. net.

THE task of writing a life of Sir Almroth Wright has been well discharged by Dr. Leonard Colebrook, his pupil and collaborator for many years. Wright was half Irish and half Swedish, and laid the foundations of his remarkable career as scientist, writer and philosopher by reading languages and law as well as medicine, and by an apprenticeship in experimental physiology and pathology before he became a bacteriologist.

Wright's greatest achievement was one of his earliest, the introduction of typhoid vaccine and his campaign for its adoption by the Army. He developed a series of ingenious techniques for studying the activity of leucocytes and the body's response to bacterial infection. An early result of these studies was the discovery of opsonin; another was the formulation of views about the treatment of war wounds in 1914–18 which brought him into violent collision with the President of the Royal College of Surgeons. In this polemic he was deservedly described as a "savage controversialist". Of his advocacy of vaccines in the treatment, as distinct from the prevention, of infection, and of his later views on some aspects of immunity, little has survived in the belief and practice of the present day. Of the extensive vocabulary he coined, only two words, opsonin and prophylaxis, have come into general use. His techniques have been little copied, and the method of experiment in the whole animal has been preferred to those he devised employing only living blood *in vitro*. As Dr. Colebrook frequently points out, Wright's many ideas may yet bear fruit, or might have done so but for the revolution which has taken place in the treatment of bacterial infections. Chemotherapy has removed much of the need for other methods which he was trying to develop.

Wright was an innovator to whom progress in his science perhaps owes most because he was "provocative" of enterprise among both his associates and his opponents. His remarkable personal qualities secured him many friends and much influence outside his profession; Bernard Shaw, for example, although contemptuous of orthodox medicine and disbelieving most of the doctrines on which Wright's work was based, had apparently a profound respect for him. The relations between these two men are well described, as indeed is all the more personal side of his life. This is a thoroughly readable and enjoyable biography, and from the scientific point of view it will be valued as a clear and simple account of a series of investigations which are not easy to follow in the original papers.

Wright's grandson, Dr. G. J. Romanes, his secretary, and four other colleagues and friends have collaborated in editing his last written work. "Alethotropic Logic" is an analysis of some of the workings of the human mind, and as such must be judged by psychologists and logicians. Its theme is the search for truth, and the basis on which truth should be accepted: the main argument can be shortly stated by the proposition that emotions are no basis for belief. Christian dogma is severely castigated in many places, as is the feminine mind, and, in Chapter 19, the orthodox statistical method in medicine. There are entertaining chapters or appendixes on the technique of writing, the defects of dictionaries, pictorial art, the relative degrees of intelligence of dogs and bitches, and some of the author's practical inventions. He employs many new words, mainly, like the adjective in the title, of Greek derivation: these are defined in a glossary. There are frequent quotations from a great variety of sources in five languages, admirably illustrating the argument and often epigrammatic. The book can be browsed in profitably for their sake alone, and it has the merit (itself dependent on the defect that this is a rather miscellaneous compilation) of presenting a more complete picture of the author than any other single work he wrote. One thing remains obscure. His favourite saying was: "God offers to every mind its choice between Truth and Repose". What God did he mean? Neither his own book nor his biographer's answers this question.

L. P. GARROD

ROTATING LIQUID MASSES

The Stability of Rotating Liquid Masses

By Dr. R. A. Lyttleton. Pp. vii+150. (Cambridge: At the University Press, 1953.) 35s. net.

A GIVEN mass of uniform incompressible liquid, acted upon by its own gravitation and no external forces, possesses only one configuration of equilibrium relative to a Newtonian frame of reference, and this configuration is a sphere. If the liquid is rotating relative to such a frame, with given angular momentum H, then, relative to a frame rotating with the liquid, there is a spheroidal configuration of equilibrium, a 'Maclaurin spheroid'. If H exceeds a certain critical value H_0, there is another configuration of relative equilibrium, a 'Jacobi ellipsoid'. If H does not exceed a certain further critical value H_1 ($>H_0$), there is still another equilibrium configuration which, when H_1-H is sufficiently small, is the 'pear-shaped' configuration discovered by Poincaré. When H is not too small, there are also configurations in which the liquid forms two bodies in equilibrium relative to a rotating frame; it used to be thought that, for continuously varying H, the series of pear-shaped figures would be continuous with a series of such binary configurations.

Dr. R. A. Lyttleton's book is an account of the theory of the stability, with respect to arbitrary small disturbances, of the various (single-body) configurations. Two sorts of stability have to be considered, 'ordinary' and 'secular', the latter being relevant if there is any internal friction (viscosity) no matter how small. Although the existence of these two sorts is familiar in ordinary dynamics—for example, in the theory of a spinning top—there are pitfalls into which even the most eminent of previous writers on the present subject have stumbled. Dr. Lyttleton starts with an exceedingly lucid exposition of the theory of stability of a general dynamical system; this should be noted by all applied mathematicians, whether or not they are interested in the present applications.

The classical investigations of the problems treated are those of Poincaré, G. H. Darwin, Jeans, Liapounoff and Cartan. The main part of this book consists of a critical re-presentation of the essential theorems obtained by these writers, with some account of the special mathematical methods required. Here again, note should be taken of the general usefulness of Dr. Lyttleton's admirable summary of ellipsoidal harmonic analysis.

The results are, briefly, that the Maclaurin spheroid is thoroughly stable for $H < H_0$, but the secular stability passes to the Jacobi ellipsoid at $H = H_0$. The ellipsoid is thoroughly stable for $H_0 < H < H_1$ and thoroughly unstable for $H > H_1$. The pear-shaped figure is secularly unstable; it cannot, therefore, arise physically, and questions about its mathematical continuity with other forms have no physical significance.

The evolution of a rotating mass of liquid with constant angular momentum and slowly increasing density is the same as that of a mass with constant density and slowly increasing angular momentum. If, then, a rotating mass of liquid (with non-vanishing viscosity) is contracting slowly from an initial state of sufficient distension, it will evolve through the series of Maclaurin spheroids, until an ellipsoidal configuration is possible, and then through the series of Jacobi ellipsoids, until the last stable ellipsoidal configuration is attained. It will *not* then pass into a pear-shaped configuration and will not undergo fission into two bodies describing periodic orbits about each other. It must almost certainly break up, in some way which is not yet calculable, but the fragments must ultimately acquire orbits leading to infinite separation. These conclusions were first correctly formulated by Dr. Lyttleton himself and are cogently stated in his final chapter on "Cosmogonical Implications". This chapter offers some constructive suggestions about the possible rotational disruption of primitive planets and the formation of satellites in the solar system. But many readers will be more interested in the demonstration that binary stars cannot have been formed by rotational fission. A uniform liquid mass is, of course, an unrealistic representation of an actual star, but certain of Dr. Lyttleton's arguments are not restricted to this case and suffice to establish the result generally. In this connexion, Dr. Lyttleton justifiably criticizes some of Jeans's interpretations of the stability theory: but it should be more widely known that, for reasons other than Lyttleton's, Jeans himself rejected the fission theory of binary stars ("Universe Around Us" (fourth ed., Cambridge, 1944); pp. 227–235).

Dr. Lyttleton's book is clearly going to be the standard work on a subject that must form the basis for future investigations which can be expected to be of great significance.

W. H. McCrea

WRITING FOR ENGINEERS

Engineers as Writers

Growth of a Literature. Edited with Introductions and Critical Comments by Walter J. Miller and Leo E. A. Saidla. Pp. xii + 340. (New York and Toronto: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 32*s*. net.

THE reviewer naturally turns with special interest to the last section of this book, entitled "Suggestions for Review of this Book", only to discover that the word is used with the common American meaning of 'second view'—what the English student would call 'revision'. This little disappointment serves to emphasize the basically American outlook of the compilers of this volume, which is a collection of reports, lectures, papers and extracts from books, all written by engineers. Three of the pieces selected are American translations of Latin authors (Frontinus, Vitruvius and Agricola), four of them are from English engineers of the eighteenth and nineteenth centuries (Smeaton, McAdam, Rankine and Parsons), while the remaining eight selections are by Americans (from Wellington, the railway economist, to Ammann, designer of the George Washington Bridge). Even with the earlier work, there is a striking contrast between the English and American idiom, which becomes progressively more marked.

It is generally acknowledged that every effort should be made to train engineering students in clear self-expression, and this collection has been made as an attempt to assist in attaining this object. As the book is intended for class use in engineering schools, the authors have made comments with each chapter and have added suggestions for study and some introductory remarks. Literary criticism of some of the selections included is disarmed by the fact that the authors themselves adopt the attitude that "any study of engineers as writers would be valueless if we did not consider their weaknesses along with their strengths".

The authors have clearly devoted much labour to the selection of their material, as is evidenced by the acknowledgments to no fewer than fifty individuals who have assisted in the undertaking. The result is an undoubtedly interesting collection of items, which it would be inconvenient (though perhaps a valuable experience) for the student himself to extract from the library shelves, were he merely given instead adequate references to each of them. Unfortunately, library facilities would be overwhelmed if an attempt were made to adopt such a scheme in class.

The most serious doubt which comes to mind, on reading this book, is whether the study of such a heterogeneous collection is, in fact, likely to assist a student to clearer, and hence better, writing of his own. Surely the approach most likely to be successful consists of an exhaustive analysis of the methods available for organizing and presenting material, followed by the most thorough criticism of his own efforts at writing and plenty of practice. But there is no reason why a book such as this might not, with some students, act as a stimulus to better writing.

R. H. Macmillan

SOCIAL INSECTS

The Social Insects

By Dr. O. W. Richards. Pp. 219 + 51 plates. (London: Macdonald and Co. (Publishers), Ltd., 1953.) 15*s*. net.

THE need for an authoritative, up-to-date account of the behaviour of social insects in general has become increasingly apparent in recent years, during which the study of the social insects has attracted much attention.

As Prof. Richards himself points out at the beginning of his book, it is to-day quite impossible for any one worker to have made personal observation on all the species of social insects or to have seen all the varieties of behaviour which have been recorded; but it is doubtful whether there is any entomologist better qualified to write on this subject than Prof. Richards. This book will certainly be welcomed by all who are interested in the subject as it brings together in a most readable form the results of many of the more recent investigations on the biology of ants, bees, wasps and termites by workers in various countries.

After dealing briefly with such matters as instinctive behaviour, learning and orientation, the author goes on to discuss, in the first chapter, the probable way in which insect social behaviour evolved from the solitary behaviour exhibited by most insects, through various sub-social stages such as those shown by the common earwig, some dung beetles, bees and wasps, to the elaborate social behaviour of ants, honeybees, termites and some wasps.

In subsequent chapters many aspects of the behaviour of solitary and social wasps, of solitary and social bees, including humble bees and stingless bees as well as honeybees, and of both ants and termites are described. In a most valuable chapter dealing with social parasites the author expounds theories of the origin of the cuckoo bees and wasps which to-day do not possess any worker castes, and also discusses the development of cuckoo habits in ants, which exhibit all sorts of stages in the development of such behaviour, ending up in workerless, degenerate parasites.

When writing of the termites Prof. Richards stresses the fact that, although they show certain remarkable analogies with other social insects, in reality the differences between the termites and all other social insects are profound and more important than the resemblances. He traces the peculiarities of the termites to two basic facts about their societies. First, that males and females are represented at all stages and in all castes, this being associated with a different method of sex-determination; and, second, that development is gradual, over a series of moults, with no helpless grub-stage. Thus their whole caste system is much more flexible and complicated.

In a most stimulating final chapter the author discusses some of the problems which social animals have had to overcome during the course of their evolution.

This is certainly a book which can be recommended unreservedly to all students of animal behaviour, one's only regret being that it is not longer.

C. G. BUTLER

SOCIAL LIFE AND PHILOSOPHY OF ABORIGINES

The World of Primitive Man

By Paul Radin. (Life of Science Library No. 26.) Pp. xi+370. (New York: Henry Schuman, Inc., 1953.) 5 dollars.

ALTHOUGH this book contains many original, and often profound, observations on the mind and customs of primitive man, it suffers from the lack of an exact definition of the material studied. The author attempts, we are told, "to portray the civilizations of primitive peoples and the world in which they lived". The use of the past tense here is confusing, for most of the examples given are of present-day tribes and the world in which they are living to-day, contaminated as they have been by Western civilization. The words "primitive" and "aboriginal" are used interchangeably (as well as "civilization" and "culture", a synonym with which many would quarrel). The dictionary defines aboriginal as "indigenous, existing in a land at the dawn of history, or before the arrival of colonists", and the author accepts most African tribes as aboriginal only with "many provisos" for this very reason, because they have been transformed by colonists and invaders. Since most of the material is drawn from contemporary sources (largely the New World), this proviso should, strictly speaking, apply to nearly all of it. If it is an attempt to portray the world in which they lived in the past, this is another matter; but in this case, most of the material would be irrelevant.

There is throughout a rather subjective bias towards the "positive achievements" that "aboriginal philosophers and theorists have made to the history of thought"; the "negative" side (by which is implied magic, and the role of fear) is not stressed. These practices and emotions, the author concludes (contrary to most social anthropologists), "interfere little with the orderly processes of life and do not hinder rational and objective thinking". Taboos, for example, are often winked at, or got round, and examples are given to prove the point. But again, the examples are of present-day tribes, who have had contact with Western civilizations: it is the world in which they are living rather than have lived.

Aboriginal philosophy is summarized as "do what you like, but face the consequences", for every individual has the right not only to the irreducible economic minimum, but also to self-expression and the freedom of movement. The "consequences" may be social ostracism, but imprisonment is an uncommon form of punishment. A murderer is seldom sentenced to death, for death meant an economic weakening of the community and, as such, demanded not simply revenge but also replacement for loss with damages. Law, authority and property are never static, but circulate. The authority of an individual (the author contends) is largely fictitious or symbolic; there is seldom despotism, for power resides in the group. Status is never inherited, it is conferred at puberty, and therefore infanticide is not a crime; on the death of an individual, status or authority reverts to the group and has to be conferred again on another individual by the group. Customs only become law in emergencies, and are not obeyed because of a rigid tradition but only from the conviction that they have worked in the case of the elders. Personal property is reduced to a minimum, and anything above this is kept in compulsory movement; its value becomes enhanced as it passes from one person to the next and, although the owner sees no profit, he gains in prestige by these transactions.

One is left with a rosy picture of the happy savage enjoying "an amazing degree of social and political integration" and "the concept of personal security which transcends all governmental forms and all tribal and group interests and conflicts". In spite of the uncomfortable feeling that this picture is particular rather than general, however, one is also left stimulated, and with a better understanding of the minds of men with different cultures from our own.

SONIA COLE

Principles of Numerical Analysis

By Alston S. Householder. (International Series in Pure and Applied Mathematics.) Pp. xi+274. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 48*s*.

THIS book is not a manual on numerical computation but gives an account of the mathematical principles upon which numerical techniques covering a wide field may be based. It has been written on the assumption that the reader has access to a high-speed digital computor; but techniques for use on hand machines are also treated.

After an introductory chapter, mostly on the estimation of error, methods are described for solving systems of linear equations. The necessary matrix and determinant theory is developed *ab initio*, and is readable by the student who has gone only as far as the calculus in his mathematical training. Next, processes are described for solving non-linear equations. A thorough treatment of iterative methods is included. There is an important chapter on methods for calculating the latent roots and vectors of matrices, and for the inversion of matrices. Some new methods are described and compared with older techniques. The next two chapters deal with interpolation, and with more general methods of approximation. Then there is a chapter on numerical integration and differentiation, and finally a brief chapter—too brief, perhaps—on the Monte Carlo method.

There are some pleasing features about this book. Bibliographical notes appear at the end of each chapter, and the literature is well covered by the extensive bibliography at the end of the book. It is very easy for the reader to find a reference to more detail on any particular item of interest. The material is up to date (1952), and some recent developments have not been noted by the reviewer in any other book. Altogether, the author has been careful in the selection of material and in the method of presentation.

L. S. Goddard

Physical Chemistry of Metals

By Dr. Lawrence S. Darken and Dr. Robert W. Gurry, with a Collection of Problems by Dr. Michael B. Bever. (Metallurgy and Metallurgical Engineering Series.) Pp. ix+535. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 61*s*.

METALLOGRAPHY has been defined as the physical chemistry of the metallic state. In Britain, however, during the past fifteen years or so, attention has, in the main, been directed rather to the somewhat speculative physical aspects of the subject, though an outstanding exception is to be found in the work of Hume-Rothery and his pupils, of which generous acknowledgment is made in this book. In America, however, and by Masing in Germany, the physico-chemical aspects have remained a subject of continued study.

It is probably true that physical chemistry may be studied just as profitably in the melting furnace or heat-treatment plant as in laboratory glassware. Reaction kinetics and the theory of diffusion are examples of this. As metallurgy is being transformed from a craft to a science, although the craft is most emphatically still there, the physico-chemical bases of metallurgical processes, no less than those of metallography itself, are assuming greater and greater importance. It is therefore not without significance that both the authors of this book are connected with the United States Steel Corporation, and the volume which they have produced is one of quite outstanding interest. It should, however, be made clear from the very start that this is no 'technical' treatise. It provides a thoroughly sound treatment of general physical chemistry on classical lines, but in which the various aspects of that science are studied and exemplified from metallurgical and metallographic examples. Although it is primarily intended for the more advanced student of metallurgy, this book might be used with advantage in the teaching in university schools of chemistry. It would, at any rate, introduce a sense of realism in its own branch of that subject which at times is somewhat lacking. The success or otherwise of such an experiment would be a matter of no little interest in the teaching of pure science.

As examples of the sort of treatment adopted, the nucleation of gas bubbles may be cited, which is exemplified by the frothing of the slag in the open-hearth furnace, or that of solid diffusion, where the processes of gas-carburization and welding are similarly employed. The iron–nitrogen and the iron–carbon systems are both considered in detail as examples of particular binary systems; but one of the most interesting chapters in the whole book is that on the liquid state, which might be read with as much profit by the chemist or the physicist. This is metallurgy as a legitimate branch of science in its own right.

F. C. Thompson

Plant Life in Malaya

By Prof. R. E. Holttum. Pp. viii+254. (London: Longmans, Green and Co., Ltd., 1954.) 18*s*. net.

PROF. R. E. HOLTTUM, with some thirty-odd years of personal observations in one of the world's richest and most interesting floristic regions, has placed botanists, both in Malaya and elsewhere, in his debt by the production of this modest but fascinating volume. Into two hundred and fifty pages he has compressed an introductory account of a very complex and diverse subject—plant life in Malaya.

The aim of the book was to select judiciously from a vast amount of material, so that residents, teachers and first-year university students may be introduced on easy terms to some of the more common plants and their structure and mode of life, to species which illustrate growth-forms, the relationships of plants to their environment, floral structure, the biology of fruits and seeds, and so on. These are illustrated by line-drawings and by a wealth of what is evidently the author's personal observation. For the reviewer, at least, an attractive and interesting feature of the book is the author's demonstration of how well such common tropical plants as rubber, coconut, ginger, bamboo and yams, to mention only a few, can be used in teaching some of the elementary lessons in botany.

The curiosities of plant life, in which the region abounds—including saprophytes, parasites, aquatic plants, ant-plants, nest-ferns, climbing ferns, etc.—are also described and illustrated. In the final chapter, the author seizes on a theme that seldom fails to touch the imagination, namely, the tropical forest in all its extravagance and diversity, as a community of interdependent organisms. The effects of destroying extensive forest areas in the interests of agriculture are also expounded and discussed. This compact volume might well be used as part of the general reading of students of botany in British universities.

C. W. Wardlaw

DEVELOPMENT OF LOGICAL AND MATHEMATICAL CONCEPTS: PIAGET'S RECENT PSYCHOLOGICAL STUDIES

By DR. W. MAYS
Department of Philosophy, University of Manchester

JEAN PIAGET'S reputation as a psychologist in Great Britain is largely based upon a series of books written during 1925–32 dealing with the development of thought, language and moral judgment in the child. But, as he himself points out, this work was merely a prolegomena to his later investigations extending from 1937 to the present day, and reported on in sixteen books and numerous articles. But though these researches are both theoretically and experimentally an advance upon his earlier work, they have, however, had little effect on English psychological thought. (Prof. L. S. Hearnshaw, in his presidential address to Section J of the British Association, 1954, directs attention to the comparative neglect of Piaget's more recent investigations by British and American psychologists.) This is probably due to Piaget's introduction of a new and complex terminology, his use of symbolic logic, and the fact that his most important work remains untranslated. Further, these studies deal with a field which in the past has been the natural preserve of the philosopher and methodologist of science.

A. Piaget's Early Work on Child Thought and Logic[1]

Piaget (now professor of psychology in the Universities of Paris and Geneva) largely concerns himself in this work with investigating the various kinds of thought activity entering into the intellectual behaviour of the child. He criticizes the method of intelligence testing as a tool for investigating child thought, since (*a*) the test-questions and test-conditions under which the test is given are stereotyped in character, and (*b*) the use of a fixed questionnaire neglects the spontaneous answers of the child. Piaget's method in some ways resembles that of the clinical psychologist, since he attempts to make the child talk freely, varying the questions according to the situation.

Piaget distinguishes between ego-centric thought, and communicable thought depending on demonstration. In the former, in which the child uses thought largely as a means for satisfying his desires rather than convincing others, little value is attached to proof. Thought on this level is largely intuitive and operates through subjective schemata. Up to about the age of 7–8, children's concepts have a certain fluidity about them and vary imperceptibly throughout a reasoning process. The child tends to argue from particular to particular and has difficulty in coping with syllogistic and analytic reasoning. Piaget further demonstrates that the conceptual apparatus by which the child orders the world around him is of a much more naïve variety than had previously been suspected.

B. Experiments on the Development of Logical and Mathematical Concepts[2]

Starting from these earlier studies, Piaget set out to make a more detailed experimental study of the way logical and mathematical concepts develop in the child. What is really important about Piaget's approach is that it gives us for the first time a method of testing experimentally many of the concepts and principles which philosophers have discussed in the past on a purely *a priori* level.

Piaget's subjects were children aged 4–12, observed individually. The experimenter performs in front of them experiments on familiar objects (beads, counters, modelling clay, dolls, etc.) and they are asked to predict their outcome. Further questions are put to them to find out how they interpret these experiments.

(1) *The development of the concepts of quantity, weight and volume*[3]. The concept of quantity has for Piaget essentially a logical character. An example of the type of experiment used by him to study its development is given below.

Two identical vessels, A_1 and A_2, are filled to the same level with a coloured liquid. Half of the contents of A_2 are then poured into a vessel B_1 and the other half into a vessel B_2 (both the same size as A_2). The child is then asked if the quantity of liquid in A_1, and that in B_1 and B_2, remain the same. Young children of about 4–6 assert that the quantities are now unequal; some note that the levels of B_1 and B_2 are lower than that of A_1, while others, who note that the liquid is now contained in two vessels, believe that B_1 and B_2 contain together more than A_1.

The child only arrives at the concept of conservation of quantity when he knows how to restore the original state of the liquid by pouring the contents of B_1 and B_2 back into A_2. He is now able to grasp that the diminution in the height of the level of the liquid is compensated by an increase in the number of containers. For Piaget, 'reversibility', namely, the ability to produce in thought for any set of activities a corresponding reverse procedure, is essential for any form of mental experimentation as well as logical inference.

Other experiments of this series use different types of material, such as balls of clay moulded into different shapes and collections of beads. Piaget also demonstrates that the related concepts of weight and volume which appear at about 9–11 and 11–12 on the average are only acquired after the concept of quantity has been formed at about 7–8.

(2) *The development of the concept of number*[4]. In these experiments the child is required to establish a term-to-term correspondence between different collections of objects (for example, flowers to vases, glasses to bottles, counters or beads to one another, etc.).

When, for example, a child aged 4–5 is asked to spread out on a table as many red counters as there are in a row of blue counters, he begins by making a row of the same length, using only perceptual criteria. However, if the counters forming one of the two rows are spaced out or closed up a little, he will now believe that the longer row contains more. Number and space are as yet undifferentiated for him, they form a perceptual whole.

But once the concept of the conservation of number has been formed at about 7 years of age, if the intervals of the row are now changed, the child will assert that there has been no change in number. He becomes aware (at least intuitively) that the increase of the length of the row is proportional to the increase of the intervals between the counters, and that re-establishing the original intervals re-establishes the original length of the row. He will be able to match counter to counter and thus demonstrate that the rows are equal.

Piaget believes that his experiments have some relevance to the dispute among mathematicians as to whether number is a primitive intuition or a purely logical notion. He finds that it is difficult to speak of the intuition of an integer before the child's logical concepts of invariance have developed at about 7. Further, the transition to number occurs in the child just when the classifying and ordering activities he uses about objects become related into logical systems. There is thus some resemblance between the way number comes to be constructed in child thought, and the attempt, on a purely normative plane by Russell and others, to define number in logical terms.

(3) *The development of the concepts of time, movement and speed*[5]. The concept of time, far from being an object of *a priori* intuition as the Kantians assumed, also arises at a relatively late stage, since time at first remains confused with space. Piaget demonstrates this by a further series of experiments.

For example, equal quantities of water are allowed to run into two differently shaped vessels (one pear-shaped and the other spherical). Now, despite the fact that the child has observed that the vessels have started and completed filling at the same time, he will assert that, since the level of the water in the pear-shaped vessel appears higher than the other, it has taken longer to fill. Time in this case will only be estimated objectively when the child no longer judges it simply by the increase in the level of the water, but by its increase in relation to the dimensions of the vessel.

Our everyday notion of time is also constructed on similar lines. At first the child confuses the notion of age with that of height or other visible signs of ageing. Age differences are not thought of as constants. A child born at a later date than another may outpace him if he outgrows the latter. Objective time, since it involves the ability to reverse the course of events in thought, also assumes the concept of reversibility.

As time has a complex character, Piaget, acting on a suggestion of Einstein, proceeds to study the more concrete notions of movement and speed, since psychologically they are prior to the notions of time and space. He finds that these concepts, too, are not given as primitive intuitions, but only gradually disengage themselves from perceptual experience. The speed of an object, for example, remains at first confused with the distance run through.

(4) *The development of metric, projective and topological space*[6]. Historically, geometry has developed in several stages. First there arose three-dimensional Euclidean geometry, later projective geometry and finally topology. The development of the concept of space is, Piaget claims, made in the child in precisely the reverse order. The child starts with purely topological notions, continues with projective notions and finally arrives at those dealing with the size and shape of the object. At the age of three the child can, for example, distinguish between open and closed figures. He can do this before he can draw a rectangle and express its Euclidean characteristics (number of sides, angles, etc.). Only at about 7 does the concept of perspective appear, and at about the same time the system of horizontal and vertical axes, the development of which leads to the metric representation of space. Thus the psychological order of development would seem to come much closer to modern geometry's logical order of axiomatic construction than it does to the historical order of discovery.

C. Related Studies

In discussing the concept of chance[7], Piaget makes the point that the child is oblivious to this concept as long as he remains incapable of reversible logical operations, that is, until about 7–8. There would thus appear to be a close correlation between the construction of the notion of probability and the development of logical operations. This was already noted by Boole in a somewhat different context when he linked probability with the algebra of logic.

So far as perception is concerned, there is a radical difference between Piaget's views and that of the Gestalt psychologist. For the latter the perceptual constancies of shape and size belong directly to the perceived object and are independent of age and ability. For Piaget, on the other hand, our perception of figures is built up as a result of a series of random eye and other muscular movements which are gradually corrected. Starting from the observable facts of child behaviour, Piaget's work would seem to reinforce some of the conclusions of the cybernetician, since he believes that the logical systems which emerge in child behaviour arise as a result of the child's trial and error activities attaining an *equilibrium*. Piaget is also interested in the neuro-physiological aspects of thought activity. He believes that, with the aid of logical techniques, it may be possible to translate the child's activities of classifying, ordering, setting up correspondences, etc., into neuro-physiological terms.

The most interesting conclusion which emerges from this important series of experimental researches[8] is that mathematical concepts in their psychological development are ultimately based upon simple logical notions. Indeed, it might be said, without undue exaggeration, that Piaget's psychological studies are the genetic counterpart of Russell and Whitehead's attempt in "Principia Mathematica" to put mathematics on to a logical basis.

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[1] "The Language and Thought of the Child" (1924). "Judgment and Reasoning in the Child" (1924). "The Child's Conception of the World" (1926). "The Child's Conception of Causality" (1927). "The Moral Judgment of the Child" (1932). (All published by Routledge.)

[2] Summaries of Piaget's more recent work may be found in "Introduction à l'Épistémologie Génétique" (Presses Universitaires de France, 1949–50, 3 vols.); and "Logic and Psychology" (Manchester University Press, 1953).

[3] "Le développement des quantités chez l'enfant" (Delachaux et Niestlé, 1941).

[4] "La genèse du nombre chez l'enfant" (Delachaux et Niestlé, 1941. English translation, Routledge, 1952).

[5] "Le développement de la notion du temps chez l'enfant" (1946); "Les notions de mouvement et de vitesse chez l'enfant" (1946). (Both published by Presses Universitaires de France.)

[6] "La représentation de l'espace chez l'enfant" (1948). "La géométrie spontanée chez l'enfant" (1948). (Both published by Presses Universitaires de France.)

[7] "La genèse de l'idée de hasard chez l'enfant" (Presses Universitaires de France, 1951).

[8] Other recent works of Piaget are: "La naissance de l'intelligence chez l'enfant" (1937; Eng. trans. 1952); "La construction du réel chez l'enfant" (1937); "La formation du symbole chez l'enfant" (1945; Eng. trans. 1951); "La Psychologie de l'Intelligence" (1947; Eng. trans. 1950). The logical aspects of his work are treated in "Classes, Relations et Nombres" (1942); "Traité de Logique" (1949); "Essai sur les transformations des opérations logiques" (1952). For Piaget's recent articles see *Archives de Psychologie*.

GERMANIUM AND GALLIUM AND THEIR APPLICATIONS

On September 7, three papers on germanium and gallium were read before Section B (Chemistry) of the British Association. Mr. A. R. Powell gave an account of the occurrence of germanium and gallium in British minerals and their extraction from flue dust, Mr. A. A. Smales discussed problems in the analysis of the raw materials and finished products, and Dr. E. G. James described the scientific and industrial applications of germanium.

Germanium occurs in Britain in the zinc ores of North Wales, the pure zinc blende often containing up to 0·03 per cent of the element; but the quantity of ore mined is insufficient to justify special treatment for the recovery of its germanium content. Germanium and gallium are trace constituents of most coals mined in Britain, except those of Kent and the South Wales anthracites. The amount present varies considerably from a few up to 30 p.p.m., with an average of about 7 p.p.m. This means that more than 1,000 tons of each element are present in the coal mined every year in Britain. But only a very small proportion of this output can be recovered economically. When the coal is burned in domestic grates and industrial furnaces, the soot or flue-dust produced contains only insignificant concentrations of germanium, most remaining with the ash. In the smelting of iron ores the germanium in the fuel passes mostly into the pig iron and then is lost in the slag or fume produced in the open-hearth or Bessemer refining processes. In the coking of coal practically all the germanium and gallium remain with the coke; but here again they are lost when the coke is used for domestic or industrial heating. However, when the coke is converted into producer gas, the sulphur present is sufficient to convert both the rare elements into their volatile lower sulphides, which pass off with the producer gas; on cooling this gas the soot deposited may contain up to 0·5 per cent of each rare element as well as up to 50 per cent of carbon and a large number of other elements. This gas is, however, usually burned while still hot, and then the rare elements are converted into their non-volatile higher oxides which collect in the flue system. In the gasworks much of the producer gas made is used for heating the coking retorts, and the heat of the waste gases from this operation is utilized in waste-heat boilers before the gases pass to the stack. The dusts, which collect in the flues between the boilers and the stack, are at present the principal sources of germanium and gallium in Britain. The amount of the rare elements in the dust varies from almost nothing up to as much as 2·7 per cent, according to the conditions under which the producer is operated and the gases are utilized; the average content of gasworks flue dust is, however, 0·5–0·7 per cent of each of the rare elements. If the coke is used for making water gas, the conditions in the producer are so strongly reducing, owing to the high hydrogen content of the gas, that the volatile compounds of the rare elements are converted into metal which alloys with the common metals, chiefly iron, present in the reduced ash of the coke; consequently, no germanium or gallium is found in the flue dust from burning water gas.

The high affinity of germanium for iron and of gallium for copper is made the basis of the first step in the extraction process. Dust from many gasworks is mixed and analysed, and a charge is made up of dust, fluxes, coke and copper-bearing materials such that, on smelting, a neutral silicate slag is obtained together with a metallic regulus consisting of iron, copper, sulphur and arsenic with which most of the germanium and gallium are alloyed. A small proportion of the rare elements passes into the zinc fume which is evolved during smelting and is recovered from the zinc oxide flue dust which collects in the baghouse. The metallic regulus is broken up and placed on a perforated plate in a large glass tower filled with dilute ferric chloride solution through which a current of chlorine is passed. The resulting exothermic reaction heats the solution to boiling and maintains it in this state until all the regulus is dissolved, loss of volatile constituents being prevented by a reflux condenser at the top of the tower. The concentrated chloride liquor from the towers is transferred to glass stills, treated with sulphuric acid to liberate 6 N hydrochloric acid, and distilled to remove arsenic trichloride and germanium tetrachloride with the hydrochloric acid vapours. The condensate separates into two layers, the upper consisting of 6 N hydrochloric acid containing most of the arsenic chloride and the lower of germanium tetrachloride with 10–15 per cent of arsenic trichloride.

The lower layer is separated and fractionated in an adiabatic column similar to that used in the separation of hydrocarbons in the oil industry. This yields an overhead of germanium tetrachloride containing about 10 p.p.m. of arsenic and a residue of arsenic trichloride almost free from germanium. The distillate is refluxed over copper turnings for some hours and again distilled to yield a distillate with less than 0·05 p.p.m. of arsenic based on its germanium content, the arsenic trichloride present in the fractionated chloride having been converted by the copper into non-volatile copper arsenide and cuprous chloride. The pure germanium tetrachloride is stirred for some hours with sufficient water to hydrolyse it and leave a 6 N hydrochloric acid solution in which the solubility of germanium dioxide is a minimum.

The resulting oxide is collected, washed free from acid, dried at 150° C., and reduced to germanium powder by heating in a rapid current of hydrogen at 650° C.; the powder is then melted in nitrogen or inert gas to obtain an ingot of germanium containing no chemically detectable impurity other than about 0·05 p.p.m. of arsenic. This product is, however, not sufficiently pure for the physicist who, therefore, further refines it by zone melting. In this process a series of molten zones is caused to travel along the ingot so as to collect the impurities and sweep them along to one end. In this way practically all the impurity collects at one end of the ingot, the remainder of which is left in a highly pure form.

Gallium is recovered from the liquid remaining in the stills from which the crude germanium chloride was distilled, by first reducing the ferric salt to ferrous and precipitating the copper, arsenic, antimony and heavy metals by stirring with scrap aluminium. The acidity of the reduced solution is then adjusted to 6 N by adding hydrochloric acid, and the gallium chloride removed by continuously distilling isopropyl ether into the bottom of the vessel containing the stirred solution and allowing the ether to overflow from the top of the vessel back into the ether distillation flask. In this way gallium chloride accumulates in the aqueous layer below the ether in the latter flask. This layer is freed from ether and treated with hydrogen sulphide to remove traces of heavy metals. The purified solution is then made alkaline with sodium hydroxide, filtered, and electrolysed to recover the gallium, which is finally purified by shaking with nitric acid.

So far, little commercial use has been made of gallium; but it has some interesting properties which may in the future find industrial applications. It melts at about 30° C. and boils at above 2,000° C.; but unfortunately the liquid metal attacks at high temperatures all metallic materials of construction now known and reacts with most refractory materials unless completely protected from oxidation; it can, however, be handled in silica ware up to above 1,000° C. in absence of oxygen.

The chief analytical problems associated with germanium and gallium are their determination in ores and coals and the determination of impurities in the purified elements. Traces of gallium can be completely extracted as the oxinate from solutions of pH 2–3 by chloroform and afterwards determined by measuring the fluorescence of the morin compound. Traces of germanium are best recovered by distillation of the chloride or extracting it with carbon tetrachloride; the element can then be determined colorimetrically in the spectrophotometer as the phenylfluorone complex. For the determination of arsenic in germanium oxide or metal chemically, a complex of germanium with oxalic acid must first be prepared; the arsenic can then be extracted by addition of diethylamine diethyldithiocarbamate and shaking with chloroform. The extracted arsenic can be determined spectrophotometrically as the reduced arsenomolybdate complex, or by a modification of the Gutzeit test in which electrolytic hydrogen from a zinc-coated platinum cathode is generated in the solution and then passed over thin cotton string impregnated with mercuric chloride to collect the arsine; the stain is developed by immersion in silver nitrate solution and its length is measured and compared with that of similar stains produced from known amounts of arsenic. The success of both of these methods depends on the absolute freedom of the reagents from arsenic, but of course blanks must be used to correct for traces of arsenic in the reagents. The radioactivation method developed recently at Harwell is designed to overcome this disadvantage; in this method the substance is placed in the pile to convert the inactive arsenic-75 into active arsenic-76, a known amount of inactive arsenic (say 50 mgm.) is added and, after ensuring thorough mixing, the arsenic in the mixture is extracted and determined by any suitable chemical method. The amount of radioactive arsenic is then determined by counting and, since the proportion of the arsenic recovered to arsenic added is known, a simple calculation gives the arsenic in the original material; in this way as little as 10^{-10} parts of arsenic may be estimated with accuracy compared with 2×10^{-8} by chemical methods using a much larger sample.

Very pure germanium is of great importance to the physicist, since it enables him to investigate fundamental processes such as electrical conduction and wave-motion in solids; but the importance of germanium to the electronic engineer depends on the presence of very minute quantities of certain impurities. Germanium free from all impurities would have the relatively high resistivity of 70 ohm-cm. at room temperature, since most of its valence electrons are tightly bound in interatomic bonds leaving very few to conduct current. On replacement of a few germanium atoms in a crystal by arsenic, four of the valence electrons of arsenic form bonds with neighbouring germanium atoms and the fifth becomes free to increase the conductivity of the crystal; such germanium is known as 'n-type' since the current is carried by negative electrons.

On replacing some of the germanium atoms in a crystal by tervalent atoms such as indium, gallium or boron, only three of the four interatomic bonds are filled, and the fourth has a missing electron; the resulting hole behaves as a localized positive charge. The impurity atoms will take an electron from a neighbouring bond in the lattice and the hole is set free to contribute to the conductivity; germanium in which the principal mode of conduction is by holes is known as 'p-type'. Rectifying devices have been made from both p- and n-type germanium and from a combination of both. Generally, the impurity concentration required is very small (10^{-7} to 10^{-9}) and has to be controlled within fine limits if devices with reproducible characteristics are to be produced.

Since germanium is very prone to twin, and twinned crystals are undesirable in rectifying devices, the zone-purified ingot must be converted into a single-crystal ingot. For this purpose the germanium is melted in a crucible and a small seed of single crystal is immersed in the top of the molten germanium, which is then made to solidify on to the seed while the growing crystal is withdrawn very slowly from the melt. The required impurity content is added to the melt before growing the single crystal. The resulting single crystal is cut up into thin slices, which for point-contact devices are cut into sections 1 mm. square and ½ mm. thick. This is attached to a backing, and a fine tungsten wire is arranged to make contact with the face of the germanium under slight pressure. With such a device the current increases rapidly when the whisker is positive with respect to the germanium, but the current is very small when the whisker is negative, up to the turnover voltage, usually well above 100 volts.

The next device to be developed was the point-contact triode, which was the first semi-conductor amplifier. This device consists of a small wafer of n-type germanium, one face of which is soldered to a metal support, while at the other face two fine metal wires make point contacts at a distance apart of less than 0·005 in. If one whisker is biased negatively and the other positively with respect to the base, the device behaves as an amplifier with characteristics similar to those of a thermionic triode. These devices have important applications in computors and oscillators, since the rate of change of collector current with emitter current is about 3. Triodes capable of oscillation at frequencies approaching 100 Mc./sec. have now been developed.

More recently, p–n junction diodes and triodes have been prepared by diffusing indium and antimony or arsenic into the germanium in such a way that one portion of the crystal is p-type and the other n-type, or a central thin portion of p- or n-type separates two outer portions of n- or p-type respectively. Various methods of producing such crystals were described and some of their characteristics illustrated by graphs. Among the important features of these devices are small size, ruggedness, low voltage operation, low power consumption and long life. They suffer, however, from the disadvantages that they are not suitable for operation above about

60° C., and the maximum frequency of operation of triodes is at present limited to 1–2 Mc./sec. Experimental types have, however, been prepared capable of operating up to about 20 Mc./sec. as amplifiers and up to 100 Mc./sec. as oscillators. The first application of these devices to reach commercial production is as a hearing-aid amplifier; but some of the most important applications are likely to be in the telecommunications field, domestic radio and electronic computors. At present the biggest problem with computors is dissipation of the heat generated by the large number of thermionic valves employed. Crystal valves not only remove this handicap but also one triode can be made to do the work of two thermionic valves, thereby simplifying the circuit.

A. R. POWELL

THE RELIEF OF PAIN

IN his presidential address to Section I (Physiology) of the British Association meeting at Oxford, which opened a morning's discussion, Prof. A. D. Macdonald, University of Manchester, stressed the importance of the relief of pain even though chemotherapy now deals so efficiently with the causal organisms of many diseases. When the Section last devoted a day to the problems of pain—in 1939—relief was largely limited to the use of opiates and the rather heroic destruction of pain pathways by surgery or alcohol injections. Since then new synthetic analgesics have been developed along various lines. These drugs have their advantages and disadvantages, and the establishment of their analgesic value in the laboratory is only a first step in the assessment of their clinical possibilities.

Analgesics can be defined as drugs which reduce or relieve the sensation of pain without producing loss of consciousness or parallel depression of other senses. Thus general anæsthetics, while used at times, as in labour in sub-anæsthetic doses, for escape from pain, are not true analgesics nor are they desirable in the everyday treatment of pain. Local anæsthetics are of established value in the treatment of certain localized pains, such as fibrositis, and can give remarkable and sustained relief in suitable cases. The use of this group intravenously for analgesic purposes, though supported by some, is difficult to justify pharmacologically, for most local anæsthetics are rapidly cleared from the blood-stream and their use is not free from the danger of depression of the respiratory centre.

Adrian, while doubting whether pain is as much appreciated at the level of the thalamus as Head maintains, agreed that the basal ganglion and the cortex share in its experience. True analgesics should therefore act at both levels. Tracer technique has not so far indicated marked selective action in these areas. Local application of analgesics to the mid-brain is effective with very small doses; but the precise mechanism of analgesic action is still unknown and does not appear to be due to changes in oxygen consumption.

Prof. Macdonald dealt with methods for the comparative assessment of analgesic drugs in both experimental animals and in man, stressing the large psychological element and the substantial individual variation in such experiments. The need in new analgesics is not so much for substances more potent than opium and its alkaloids or the modifications thereof in therapeutic use, for these are powerful enough. What is wanted is a drug with all the advantages of morphine and none of its disadvantages, and work to this end has followed on various lines, of which the following have been most promising:

(1) Drugs closely related to morphine, of which levorphan is one of the best, while dextromethorphan is interesting because it allays cough in small doses though not analgesic and apparently not a drug of addiction.

(2) Pethidine and related compounds, now widely and successfully used to reduce pain during labour, together with inhalations of nitrous oxide or trichloroethylene.

(3) Methadone and related compounds, which are in the morphine class as analgesics though less effective as narcotics and in the relief of anxiety.

(4) The dithienylbutenylamines, intermediate in activity between pethidine and methadone, but still in the experimental stage.

All these, like morphine, are potential drugs of addiction; this limits their usefulness in chronic non-fatal illness. The potentialities of a new drug as a drug of addiction are often obscure; but there are various methods by which it can be assessed, and these methods were discussed.

The coal tar antipyretic-analgesic group (Fourneau's antalgics) has aroused new interest from the use of phenyl-butazone in the treatment of rheumatic symptoms. This drug has much in common with the now despised or rejected amidopyrine, while some new compounds promise to be more powerful yet safer.

Such drugs as the barbiturates have failed to live up to their original pretension to analgesic activity except in anæsthetic doses; for this purpose the short-acting barbiturates such as sodium thiopentone are increasingly used.

Cannabis, its active constituents and their synthetic substitutes have limited analgesic activity, and therapeutic interest in this group is now largely limited to the treatment of cannabis addiction. To restore morale and maintain confidence, methyl pentynol and chlorpromazine might be more effective. The search for the ideal drug continues, and with so many attacks on the problem a solution will surely be found.

A paper on "Some General Views on Drug Addiction" was read by Dr. P. O. Wolff, of Geneva, chief of the Section of Drugs Liable to Produce Addiction of the World Health Organization. Dr. Wolff said that by accepted definition addiction is a disease, not a crime, and that even when it leads to certain illegal acts these may be symptoms of the disease. The drug peddler, however, should be treated as a potential murderer. Again by definition, addiction differs from habit in that it produces a state of periodic or chronic intoxication detrimental both to the individual and to society. Thus barbiturates, like morphine, cocaine and cannabis resin, are potential drugs of addiction, whereas tobacco is a habit. The symptoms of addiction are the overpowering desire or need to continue the taking and obtaining of the drug by any means, the tendency to increase the dose because of the development of tolerance, and the development of psychological and sometimes physical dependence on its effects.

Addiction is distinctly a human phenomenon. While animal tests of the addictive capacity of a drug might be misleading, Seevers has confidence in his ability to make accurate predictions by his studies on monkeys of the risks of analgesics to induce tolerance and physical dependence in man. Many attempts have been made to account for tolerance. The most satisfactory available hypothesis is still the 'dual action' developed by Tatum, Seevers and Collins, according to which the drug combines with receptors both on the surface and within the nerve cell, which acquires resistance to narcotic effects. Physical dependence denotes the presence of an acquired abnormal state wherein the regular administration of adequate amounts of a drug has, through previous prolonged use, become requisite to physiological equilibrium. The degree of physical dependence often runs parallel with the development of acquired tolerance. Dr. Wolff agreed with Prof. Macdonald that there are good prospects of the discovery of analgesics which will be free from the undesirable properties of morphine while retaining its valuable actions.

Dealing with the work of the World Health Organization on drugs of addiction, Dr. Wolff stressed the importance of an early decision on the convertibility of innocuous compounds into drugs of addiction. A drug is regarded as 'convertible' when the ease of the conversion and the yield constitute a risk to public health, or where there is still uncertainty about that risk. Up to the present, all synthetic analgesics have proved to be addiction-producing. The fact that a drug can be used for a time on many psychologically normal patients under hospital conditions without addiction arising is no guarantee of its safety—a better test is to see whether or not in addicts it could adequately replace their usual drug.

There is a widespread misconception about the prognosis in the addict. Relapse is common because former addicts often remain emotionally disturbed. Yet the high incidence of relapse does not justify a refusal to treat the sufferers any more than in other chronic diseases. There is now a combined approach from the chemical, pharmacological, clinical, mental health, sociological and legal angles, reinforced by well-established international co-operation.

Mr. J. B. Pennybacker, neurological surgeon to the Radcliffe Infirmary, Oxford, read a paper on the contribution of surgery to the relief of pain. Drugs, he maintained, are best used for pains which are not expected to last long, such as that attendant on surgical operations or manipulations. Drugs are also important in painful incurable diseases, some of which being non-fatal cause untold misery over years.

Surgery has been most successful in relieving pain due to mechanical disorders and inflammatory processes. The hope that with expanding knowledge of the anatomy and physiology of the central nervous system many of the intractable pains such as headache, backache, facial neuralgia, post-herpetic neuralgia, painful amputation stumps or phantom limbs and causalgia following peripheral nerve injuries might be relieved by the neurological surgeon has been fulfilled only in part. Increasing knowledge of the pain pathway has increased the possibility of successful relief by dividing that path, and this has been done at various levels.

Section of peripheral nerves has a limited application because most nerves have motor fibres, because of the extensive overlap in innervation, because trophic changes follow complete denervation, and because divided nerves might regenerate and the pain return. Section of posterior nerve roots avoids motor paralysis but the other drawbacks of nerve section remain. Its greatest success is in trigemial neuralgia, probably the most severe of all pains, by section of the root behind the Gasserian ganglion.

The operation of cordotomy (division of the spinothalamic tract) has been practised since 1911, and though still used has not proved the hoped-for panacea, for relief often lasts for only a few months. In other countries small focal lesions have been produced in the optic thalamus, the great sensory nucleus in the base of the brain, using stereo-tactic methods. Excision of the relevant cortical area, which subserves the highest level of sensory perception, unfortunately sacrifices a good deal of ordinary sensation as well as pain, and the pain might persist or recur. Frontal leucotomy sometimes relieves a patient's misery, and he bothers no longer about his pain—or about anything else. Smaller lesions appear justifiable in some cases, to ease the pain of the last few months of a patient's life, not only for the patient's sake but also for the relatives who have to watch and suffer as well.

Mr. Pennybacker referred to the challenge of an ageing population in which the problem of finding relief from pain is increased. He doubts whether the development of 'pain clinics' is the answer, because interest there would be focused on a symptom instead of the disease. He found the greatest encouragement for the neurological surgeon in the discovery, twenty-two years ago, of how sciatica is often due to compression of a nerve root by a rupture of the intervertebral disk. This affords a satisfactory explanation for the pain and a certain method of curing it.

In the subsequent discussion the speakers were asked about the relief of the pain of 'nervous tension' and the value of hypnotism in anaesthesia, in relieving pain and in the treatment of drug addiction. Dr. Wolff and Prof. R. R. MacIntosh expressed doubt about the efficiency of hypnotism unsupported by other measures.

THE VEHICLE AND ROAD SAFETY

THE increasing interest in the scientific attack on problems of road safety was shown by the fact that the whole of one of the opening sessions on September 2 of Section G (Engineering) at the British Association at Oxford was devoted to two papers on the safety of vehicles. The first paper was by Mr. G. Grime, of the Traffic and Safety Division of the Road Research Laboratory, and the second by Mr. D. Bastow, chief engineer, Jowett Cars, Ltd.

Mr. Grime set out to show where improvements are required in the design of vehicles, to demonstrate the urgent need for better maintenance of lights and brakes, and to consider how these improvements might be brought about.

To be able to see well is obviously of the greatest importance to a driver, and, in this connexion, startling figures were given to show the poor state of aim and maintenance of vehicle headlamps. Only about one-half of the headlamps examined in a survey carried out in 1952 were aimed within three degrees of correct aim, while one-sixth had deteriorated so badly that their light intensities were less than one-tenth of what they once were when new. All this leads to the inequalities of illumination which are the most potent factor in causing dazzle and poor seeing.

A similar situation, though not quite so disturbing, exists in regard to the brakes of vehicles in use on the roads of Britain. A survey, made in 1948–50, revealed that about 7 per cent of vehicles require twice as great a distance to stop as that given in the Highway Code for brakes in good condition.

Mr. Grime gave reasons for concluding that the most effective way of making the necessary improvements in the maintenance of the vehicle to overcome present shortcomings in headlights, brakes, etc., is compulsory vehicle inspection. Evidence from the United States suggests that compulsory vehicle inspection and associated safety measures have resulted on the average in a 12 per cent reduction in deaths in the States where it is in force.

Comparatively small changes in the design of vehicles to improve visibility might perhaps lead to substantial reductions in accidents. The right-turning manœuvre is a dangerous one for almost all vehicles, and the fitting of properly designed and placed rear-view mirrors as standard on all vehicles including bicycles was advocated.

In emergency braking, especially on wet roads, steering control may be completely lost if both wheels on either front or rear axle lock. An efficient brake, arranged never to lock any wheel, whatever the friction between tyre and road, would therefore represent an important advance in the design of the vehicle, and would be particularly beneficial to motorcyclists.

American research on the injuries suffered in car accidents shows that much could be done, by redesigning the interior of the car, to minimize the severity of these injuries. The most important requirements are the elimination of sharp edges and points, the fitting of resilient pads at appropriate positions, and the provision of safety belts or other means of holding the occupants in place during the accident. Mr. Grime suggested that the vulnerability of motor-cyclists to injury (about thirty times that of drivers of four-wheeled vehicles) might be reduced by enclosing their vehicles in saloon bodies and perhaps tying the riders into their vehicles with safety belts. There is already a tendency in the direction of making enclosed motorcycles for reasons of weather protection.

Mr. Donald Bastow introduced his paper entitled "Vehicle Design for Safety" by referring to the great possibilities of reducing accidents which were afforded by improvements to the road system of Britain. An experiment by Mr. G. T. Bennett in the County of Oxford showed that, by relatively slight alterations to rural road junctions, a reduction of about one-third in the accident-rate at those junctions had resulted. There was little evidence from insurance premiums that vehicles of particular makes were more liable than others to be involved in accidents, and he considered that accidents were generally the result of human frailties rather than vehicle imperfections.

Like the previous speaker, Mr. Bastow considered that the first and most important safety requirement is all-round visibility, and proceeded to describe the methods employed in measuring and plotting the obstructions to the driver's vision. He considered that curved safety glass had done more than anything else to improve visibility, by enabling windscreen pillars to be placed farther back, and by making possible really large rear windows. Important accessories which are now coming into use on modern cars to improve visibility are windscreen-washers, powerful fresh air heating systems, and electrically heated rear-windows.

For driving in fog, Mr. Bastow advocated the use of headlamps by day to give warning of approach and by night the use of two fog lamps to give a wide spread of light.

Next in importance to visibility comes the controllability of the vehicle, and here the speaker discussed, in simplified form, modern theories of steering, stressing the all-important role of the tyre. For ease of control, particularly by inexpert drivers, an 'understeering', that is, a stable rather than an 'oversteering' or unstable characteristic, is desirable. Springing also influences controllability, and the softer front springing which has become possible with independent front springing has helped in this respect by reducing variations of load on the front wheels.

Two practical problems in maintaining efficient braking are those of adjustment and of overheating with consequent fading of brake efficiency. A new development which may overcome both is the disk brake, with which a greater mechanical advantage may be employed.

Further considerations in favour of a non-locking brake were mentioned. Such a brake is already available for aeroplanes and may eventually become a commercial possibility for road vehicles.

In the discussion which followed the two papers, Mr. L. Bainbridge-Bell mentioned a very simple and cheap brake-testing device made in the form of a rectangular box, of such a size that when placed on a flat horizontal surface in the car, it fell over when a certain deceleration was exceeded.

In reply to a question by Sir Richard Southwell, Mr. Grime gave the results of a series of tests by the Road Research Laboratory comparing yellow with white light for headlamps. Two cars and twenty drivers were employed in the tests, which took place on a track, about half a mile in length, along which unlighted obstacles were placed. The cars were fitted with both white and yellow headlamps of the same design and giving the same beam distribution. They started simultaneously from opposite ends of the track using in turn either the white or the yellow headlights. Drivers were asked to record their preferences both when the opposing car was too far away to produce dazzle and when it was near. Tests were conducted with the track both dry and wet, and with correctly and incorrectly aimed beams. In tests of a different kind, the distances at which test objects could be seen were measured, this time with six observers.

The results may be summarized in the statement that all the differences found were small. The distances at which the target could be distinguished were on the average slightly greater (about 5 per cent) with yellow than with white light, but this increase is not a significant one. In the opinion tests with twenty observers, when there was no opposing glare, there was a significant preference for the white beam. When the cars approached near one another, although more observers considered the yellow beam less glaring than the white, there was a small majority in favour of the all-white system. It may therefore be stated with confidence that changing over to yellow light will not solve the headlight problem.

Dr. E. A. Watson directed attention to Fig. 13 of the first paper, which indicates that there is more glare from the modern British dipped headlamp than from headlamps on American roads. Since modern British and American dipped beams are very similar in characteristics, the difference suggests that British headlights are not properly aimed when they leave the manufacturer or agent.

Dr. Watson deprecated the unsafe practice of driving with sidelights in badly lighted streets.

Mr. B. G. Robbins brought up the question of improved windscreen wipers with blades travelling horizontally across the glass, and Mr. Bastow said that this is quite feasible though expensive. A wiper of this type was on the market some years ago but has been abandoned.

OBITUARIES

Prof. William S. Boulton

The death on September 14 of Prof. William S. Boulton, emeritus professor of geology in the University of Birmingham, in his eighty-eighth year, has removed the last of the Victorian geologists. He was first an assistant of Lapworth's at Mason College, Birmingham, and later studied under Judd at the Royal College of Science, London, heading the examination list in geology. He stayed on for a fourth year as one of two assistants to Lockyer in his work on stellar photography, the other being Richard Gregory, later editor of *Nature*. The Victorians built on broad foundations! In 1890 Boulton returned to Mason College as demonstrator and assistant lecturer under Lapworth, and in 1897 went to University College, Cardiff, as lecturer in geology and geography, becoming professor there on the creation of the University of Wales in 1904.

Under Lapworth, engineering and mining students were taught the principles of geology, with some emphasis on their application to their particular professions, and with field-work as an essential part of the course—a novelty in those days. Boulton carried these ideas to South Wales and did a good deal of proselytizing through the medium of university extension lectures, to which he attracted large audiences, chiefly in the mining towns of the coalfield. He also was a contributor to and editor of a six-volume "Text-book of Practical Coal Mining".

At Cardiff he built up a reputation as a teacher of geology and geography, and as a consulting geologist in coal mining and water supply; and on Lapworth's retirement from Birmingham in 1913 he was appointed as his successor. The First World War interrupted all university work; but after it Boulton brought the whole of the Geology Department under one roof—it had previously been partly in the new buildings at Edgbaston and partly at Mason College—and under his guidance it expanded greatly while retaining the ideals of Lapworth with respect to pure research and the application of academic geology to engineering, mining and later to the oil industry. Boulton became acknowledged as one of the most outstanding authorities on the geological side of water supply, and he practised as a consultant for many years after his retirement from the University on reaching the age limit in 1932.

Boulton rendered public service on the Geological Survey Board, the Safety in Mines Research Board, the Government Inland Water Survey and the Council of the Geological Society; he was president of Section C (Geology) of the British Association in 1916, of the South Staffordshire and Warwickshire Institute of Mining Engineers (1922–23), vice-president of the Geological Society (1934–35) and dean of the Faculty of Science both at Cardiff and Birmingham.

Apart from his investigations in connexion with coal and ironstone mining and water supply, most of which naturally remains unpublished, Boulton's early interests were petrographical. Later he made valuable contributions to our knowledge of the red rocks between the Coal Measures and the Trias in the Midlands; but it is particularly as a teacher, administrator and consultant that Boulton will long be remembered by colleagues and by a host of students now scattered all over the world.

L. J. Wills

Prof. Antonio Minto

Prof. Antonio Minto, whose death is reported at the age of seventy-four, was for long years one of the best known and most influential figures in Italian, especially Etruscan, archæology. As professor in Florence, as 'soprintendente' for northern Etruria, and as president of the Istituto di Studi Etruschi, he came to occupy a commanding position in this field.

Born at Pieve di Sacco near Vicenza in 1880, the first part of his archæological life was spent in Greece, where he worked with Halbherr and Pernier. Then came the First World War. Afterwards he worked in Campania (1922–24), until, in 1924, he was appointed 'soprintendente' in Florence. There he remained until the end of his working career (he retired in 1951), and it is with Florence and northern Etruria that his name will always be particularly associated.

Under his direction the reorganization of the Museo Archeologico in Florence, begun in the reign of Milani, was largely completed. The original home of the Museum, the Palazzo della Crocetta, was enlarged by the addition (1930–40) of the long series of galleries that now house the greater part of the Museo Topografico, and was itself largely rearranged so that a great quantity of material was made readily available to students. The vision that had been Milani's, of Florence as the centre for Etruscan, and indeed Italic, studies, was shared by Minto, although he could never realize it fully. He had to endure the existence of another 'soprintendenza' for southern Etruria and the sight of the rich results of the new excavations at Vulci and Cervetri going to the Villa Giulia in Rome. He was, however, able to bring to birth the Istituto di Studi Etruschi with its home in Florence, and its annual, *Studi Etruschi*, published there (1927 onwards). Moreover, the extraordinarily rich collections of the Florentine museum, logically arranged and fully exhibited, together with the attitude of its directorate that makes study in the museum easy, have enabled it to maintain its position as the best single place in which to study Etruscan civilization.

Minto was not a great original scholar, not an intellect with the imagination to open up vast new vistas: his great service was in making material available and encouraging study. His work in the Museum was one result of this guiding principle. His writings, which were numerous, were nearly all publications of material that came into his control. New finds in his province were usually made known comparatively quickly and comparatively fully. His only two major publications were, characteristically, excavation reports: one of the remarkable early necropolis at Marsiliana d'Albegna excavated by the Prince Don Tommaso Corsini (published in 1921); the other of his own most important excavations, at Populonia (published in 1943). Besides these excavations, he undertook many less exciting investigations, notably at Heba, Saturnia and Sestino, of which notices appeared in the *Notizie degli Scavi*.

W. L. Brown

NEWS and VIEWS

W. C. Gorgas (1854–1920)

One of the world's greatest sanitarians, William Crawford Gorgas, was born a century ago, on October 3, 1854, near Mobile in Alabama. After graduating M.D. at Bellevue Hospital Medical School, New York, in 1879, he joined the Medical Department of the United States Army. An attack of yellow fever at Fort Brown, Texas, rendered him immune from this disease, and as a result he was frequently sent to camps where outbreaks had occurred. In 1898 he was appointed chief sanitary officer in Havana. When the Reed Commission had proved the mode of transmission of yellow fever by *Aedes aegypti*, he began to attack the mosquito's breeding places and in less than eight months succeeded in eradicating the disease from a region where it had existed continuously for one and a half centuries. But for Gorgas, the construction of the Panama Canal could never have been accomplished. Made chief sanitary officer of the Canal Zone in 1904, he converted this 'white man's grave' into a healthy and inhabitable region. His reputation was now world-wide. In 1913 he visited the Transvaal to advise on the control of pneumonia among the native miners of the Rand and afterwards investigated endemic foci of yellow fever in South America for the Rockefeller Foundation's International Health Board. During 1916–18 he served as surgeon-general of the United States Army. On his way to West Africa, he died in London on July 3, 1920, after a cerebral hæmorrhage, and was given a military funeral in St. Paul's Cathedral. During his last illness he was visited by King George V, who conferred an honorary K.C.M.G. upon him.

Second International Conference of Teachers of Geography

In 1951 the British Geographical Association initiated an international conference with a meeting at Sheffield, and in August 1954 Holland acted as host for the second conference, which was attended by 160 delegates from about twenty countries. Wisely the formal work is limited to the thorough discussion of two or three topics, each introduced by a paper and then debated in groups before the group-leaders put questions to the lecturer. In every discipline there is the constant problem : How soon and at what stage should academic advances in the subject—with results which may only be tentative—be introduced into the teaching in schools and colleges ? The Conference agreed that the concept of under-developed lands contains an element of subjective judgment highly dangerous if introduced without the utmost care to children of school age. The idea of different stages in cultural and economic development is better introduced incidentally in the teaching of regions. The separation of physical and human or social geography which exists in Dutch universities was admitted as specially applicable to conditions in a country where vital work in land reclamation and soils is so much to the fore, but generally was regarded as unsuitable elsewhere. The discussion on 'field-work' revealed no exact word or phrase in the languages of Western Europe to cover the outdoor activities of school geography classes now so well known in Britain and voted as desirable elsewhere. The other half of the work of the Conference is for the host country to show in the field as much as possible of modern developments. This the Dutch, under the presidency of Dr. W. J. Jong and with Prof. A. C. de Vooys as organizing secretary, did extremely well—with special emphasis on the problems of the new polders of the erstwhile Zuyder Zee.

Vacation Course in Synoptic Meteorology

For the fifth year in succession, the Royal Meteorological Society, in conjunction with the Council for the Promotion of Field Studies, held a vacation course in elementary synoptic meteorology at the Council's field-centre at Malham Tarn. The course was held this year during August 25–September 1 and was attended by some thirty-five students. The majority of students attending were undergraduates, reading for degrees in mathematics, physics and geography, nearly half the universities in the United Kingdom being represented. The instructors were again Mr. James Paton, Scottish secretary of the Royal Meteorological Society and senior lecturer in meteorological physics in the University of Edinburgh, and Mr. C. D. Ovey, a vice-president of the Royal Meteorological Society and lecturer in geography in the University of Cambridge. Visiting lecturers included Prof. G. Manley, who described the Helm Wind at Crossfell ; Mr. W. V. Lewis, of the Geography Department, University of Cambridge, who gave a talk on the movement of glaciers and process of glacial erosion ; Dr. S. R. Eyre, of the Geography Department, University of Leeds, who gave a lecture on microclimatology of the New South Wales coastal lowland ; Dr. W. A. Fairbairn, of the Department of Forestry, University of Edinburgh, who spoke on climate and forestry ; and Mr. E. G. W. Spence, who explained the construction and use of meteorological instruments. Towards the end of the course a visit was arranged to the Meteorological Office Station at Squires Gate, near Blackpool. An important part of the course consisted of observation work and the plotting of synoptic meteorological data. As in previous years, various education authorities and the Education Department of the R.A.F. made it possible for some of the students to attend the course, which is approved for grants in suitable cases. It is planned to hold a similar course in mid-August 1955 ; in view of the increasing number of applications received, a parallel course in 1955 for sixth-form students, to be held at the Juniper Hall Field Centre of the Council, is at present under consideration.

Archæology in Greece during 1952–53

The annual report for the session 1952–53 of the managing committee of the British School of Archæology at Athens, by J. M. Cook and J. Boardman, entitled "Archæology in Greece, 1952–1953", is reprinted from the *Journal of Hellenic Studies* (Vol. 74, pp. 64+4 plates. London : British School of Archæology at Athens), and summarizes the varied work of the year ending September 1953. The Greeks continue restoring ancient and medieval buildings up and down their country, and the Americans in the Agora at Athens are rebuilding the Stoa of Attalos—a colonnaded block of shops built in the second century B.C.—to serve as their museum and are also preparing to landscape other ruins. This sort of work offends purists ; but ancient sites do not belong only to specialists. Excavators have been busy in Athens, Eleusis, Corinth, Mycenæ, Lerna, Argos, Olympia, Pylos, Crete, Chios, Thasos, Samothrace, and elsewhere ; the most useful results are likely to be for the Bronze Age. More entertaining discoveries are the dedication of the famous prostitute Rhodopis, the helmet of Miltiades (presumably the victor of Marathon), and what—it seems—the Athenians of the fifth century B.C., after archæological examination, wrongly identified as the graves of the Seven against Thebes.

Torquay Natural History Society

The impact of the Second World War of necessity curtailed the activities of the Torquay Natural History Society, and the centenary year of 1944 passed almost unmarked with the exception of a short historical article in the April issue of the *Museums Journal* in that year. Prior to this the Society had published papers from time to time in its *Transactions* on one aspect or another of its development and activities; but the main historical record remains that of Mr. Harford J. Lowe, published in four parts over the years 1909–13, on the growth and history of the Society. This is now more than forty years ago, and A. G. Madan, curator of the Museum, has prepared an account not only to bring the history up to date but also to report on the collections and present-day activities of the Society (*Trans. and Proc. Torquay Nat. Hist. Soc.*, 11, No. 3). Much of the history is concerned with the excavations at Kents Cavern during which considerable evidence was unearthed which threw fresh light on the antiquity of man.

Oil Palm Research

The first annual report of the West African Institute for Oil Palm Research, just published (pp. 1–135. Benin City, Nigeria; and Crown Agents, 4 Millbank, London, S.W.1. 2*s.* 6*d.*), gives an account of the Institute's organization, research and field work for the period 1952–53. The first issue of the Institute's research journal, which contains detailed reports, has already appeared and has been noted in these columns (*Nature*, 173, 19; 1954): and other publications are in preparation. While the scientific staff list still shows a considerable number of vacancies, the research policy, which is here defined in some detail, is being actively carried out in all its many aspects. The present report gives a comprehensive account of field studies, agronomy, chemistry, plant breeding, general botanical studies, pathology and statistics.

Canadian Biological Publications

With the support of the Research Council of Ontario, J. Murray Speirs, Ruth Kingsmill and George W. North, of the Ontario Fisheries Research Laboratory of the University of Toronto, have prepared a bibliography of Canadian Biological Publications for 1949. The bibliography, a most thorough and comprehensive survey, was assembled by searching biological journals in local libraries, and by following leads suggested by correspondents. Medical and commercial papers have been omitted unless the biological content predominated. The bibliography is arranged by subjects, and within the subject by author, publication, date and page. To anyone wishing to know of recent biological events in Canada this survey will be most valuable; its value would be considerably enhanced if its publication coincided more closely with that of the papers mentioned in it. The bibliography is published jointly by the Quebec Biological Bureau and the University of Toronto.

Annals of Library Science

The first number of a new quarterly periodical (1, No. 1; March 1954; published by the Times of India Press, Delhi; Rs. 10; 3 dollars; 20*s.*), edited by Dr. S. R. Ranganathan, contains two articles by Dr. Ranganathan on Depth Classification which include some criticism of the Decimal Classification and describe the emergence of the Colon Classification. The Universal Decimal Classification is also criticized in an article by Faqir Chand. These, like K. A. Isaac's article on dialectics of the Universal Decimal Classification, are continuations from the journal *Abgila*. The issue also contains a glossary of cataloguing firms by K. D. Puranik, a further article by Dr. Ranganathan on a library development plan for Delhi State, and one by G. Otterick and S. Mochlenbrook on training for library service in Sweden.

Callendar's "Radio-Balance" for determining the Thermal Energy of Radiation

In 1910 H. L. Callendar described a thermal-balance device which he called a "radio-balance" and which consisted of a calorimeter for the measurement of radiation in which the quantity of heat to be measured was balanced against the cooling from a Peltier couple. With this device he made measurements of the solar radiation and also of the energy emitted in unit time from a sealed source of radon which had been lent to him by Lord Rutherford. Since then the only other use of a radio-balance appears to be that of F. E. Hoare some twenty years later, who utilized the device to determine the Stefan–Boltzmann radiation constant. However, the radio-balance as an instrument for the measurement of energy dissipation has much to commend it, and the operation of the device has been extensively investigated recently by W. B. Mann (*J. Res. U.S. Nat. Bur. Standards*, 52, 177; April 1954; Research Paper 2486) with the view of its use for the accurate determination of the energy emission from radioactive sources. Several radio-balances were constructed, and the final version consists of two copper cups 13/16 in. long and having internal and external diameters of 0·099 and 0·130 in., respectively. Each cup is mounted on a six-junction constantan-chromel thermopile, and the lower junctions of each thermopile are dipped into silicone oil contained in two small cavities in the lower copper block that constitutes the container of the radio-balance. A constantan-chromel Peltier couple is soldered to the base of each cup. Each cup may be used singly, and the cups may be used together in opposition. In the series of experiments described by W. B. Mann, measurements were confined to radium preparations contained in platinum–iridium needles of 0·5 mm. wall thickness. For an absorption equivalent to 0·126 cm. of lead, a heat emission of 128·9 cal. gm.$^{-1}$ hr.$^{-1}$ was found for radium in equilibrium with its products down to radium D. The estimated accuracy is ± 0·7 per cent. It is stated that it is proposed to apply the radio-balance described to the measurement of the average energy of beta-ray emitters, and a new radio-balance is being constructed for the comparison of the United States and Canadian national radium standards.

Dreyer's Catalogue of Nebulæ and Clusters of Stars

J. L. E. Dreyer's "New General Catalogue of Nebulæ and Clusters of Stars", giving descriptions and positions of all the nebulæ known at the end of 1887, was published in 1888 (*Mem. Roy. Astro. Soc.*, 49, Part 1; 1888), and this was later supplemented by his "Index Catalogue of Nebulæ found in the Years 1888 to 1894, with Notes and Corrections to the New General Catalogue" (*Mem.* 51; 1895) and by the "Second General Catalogue" (*Mem.* 59; 1908), which provided similar data up to the end of 1894. The Royal Astronomical Society decided to reproduce the three sections by photographic means and to include them in one volume under the title "Memoirs of the Royal Astronomical Society. New General Catalogue of Nebulæ and Clusters of Stars (1888). Index Catalogue (1895). Second Index Catalogue (1908)" (from the Society, Burlington House, London, W.1; 1953; £3 10*s.* post free, or £2 10*s.* to Fellows). This is very much more convenient for observers than the three separate volumes and, except for the alteration in the pagination of the two Index Catalogues to follow on from that of the "New General Catalogue", the catalogue has remained unaltered. In its present form this volume should prove very acceptable to observers of nebulæ and clusters.

Design and Accuracy of Volumetric Glassware

THE sixth in the series of "Notes on Applied Science" prepared by the National Physical Laboratory, Teddington, is entitled "Volumetric Glassware: Scientific Aspects of Design and Accuracy" (pp. 22. London: H.M.S.O., 1954; 1*s.* 6*d.* net). It presents the basic scientific information which must be taken into account in the preparation of standards for volumetric glassware and sets out the main features of standardization which are of general applicability in rationalization or verification. The information given is supplementary to that of any test pamphlets issued by the National Physical Laboratory and also to the British Standards issued by the British Standards Institution. The booklet does not discuss techniques of manufacture or the uses to which the glassware is put. It consists of three main sections dealing with the basis of graduation, the construction and verification of apparatus, and the dependence of volume delivered on delivery procedure. The first section contains a clear explanation of the three units of volume in use—the litre, imperial gallon and cubic foot—and the relationship between them; a discussion of the effect of temperature on the capacity of a glass vessel; and the definition of capacity involving either a volume of water or mercury and, in the case of a graduated glass vessel, the precise setting of the liquid meniscus to a horizontal line. Various details of procedure to be adhered to in the cleaning and in the determination of the capacity of a glass vessel are included in the second section. It is emphasized that all traces of detergents, which are now being increasingly used for cleaning glassware, must be carefully removed from volumetric glassware before calibration, otherwise the surface tension of the water used in the calibration, and consequently the shape of the meniscus, will be considerably affected. Also, all determinations of a glass vessel are based ultimately on the gravimetric method, so that when water is used for calibration and high accuracy is required, both the temperature and pressure of the air at the time of weighing should be recorded. The final section contains a detailed discussion of delivery times and drainage times of burettes and pipettes and is illustrated by several graphs and tables. The booklet concludes with a list of references and of British Standards relating to volumetric glassware.

Institution of Gas Engineers: Annual Report

THE ninety-first annual report and accounts of the Council of the Institution of Gas Engineers (Pub. No. 440; pp. 42; from the Institution, London; 1954), presented at the annual general meeting of the Institution in Bournemouth during May 31–June 2, includes a list of communications during the year, and the regulations for the award of the Charles Hunt Memorial Medals in gas engineering are appended. Five supplements to the fourteenth report of the Chairman's Technical Committee were issued during the year by the Gas Works Safety Rules Committee. These were concerned with a model specification for platforms, ladders and stairways to provide means of access to plant, a code of practice for the safe operation of tower purifiers, a note on the operation of electro-detarrers with carburetted water-gas plant, safety recommendations for electrical equipment in gas manufacture, purification and distribution, and additional references to the bibliography of literature relating to accident prevention. A booklet on "Unusual Incidents at Gasworks" was due to be published, and a supplement dealing with the internal protection of gas pipes has been issued by the Pipes Committee.

Museum of Comparative Zoology at Harvard College: Annual Report for 1952–53

THE annual report for 1952–53 of the Museum of Comparative Zoology at Harvard College (pp. 24; from the Museum, Cambridge, Mass., 1953) details the work of an institution which, though burdened with an antiquated name, executes an extremely important task. It is in effect mainly a research institution in which function is deemed of more importance than taxonomy, though studies in the latter are still undertaken. In addition, important additions have been made to the Museum collections, and several expeditions, including a survey of molluscs at the site of the Jim Woodruff Dam at Chattahoochee, Florida, have been undertaken. An impressive list of ninety-five papers published by the staff is some indication of the continued activity of this well-known Museum.

Reactor School at Harwell

As a step towards encouraging industry to play a greater part in the development of atomic power, the United Kingdom Atomic Energy Authority has opened a reactor school at Harwell. The new school will provide, for a fee of £250, a three-months course of training for staff from industrial concerns to learn the techniques by which heat from atomic piles can be converted into useful power. Priority will be given at first to staff of firms already acting as contractors to the Atomic Energy Authority. Some new graduate members of the Authority's own staff will also be trained in the school. Three courses will be held each year, the next in January 1955. The syllabus includes lectures and individual instruction in nuclear physics, reactor physics, metallurgy and reactor engineering, as well as experimental work. Lectures are given by experts drawn from various divisions at Harwell, and by the full-time school staff. Applications for places in the school should be made to the Manager, Reactor School, A.E.R.E., Harwell, Berkshire, and should give sufficient information for the Management Board to assess whether the student has the required academic standard for entry to the School. It is expected that all students will be physics or engineering graduates or else have had considerable theoretical and practical experience in at least one branch of science or engineering. Mathematics up to subsidiary degree standard is necessary, particularly for the reactor physics lectures. The fee of £250 for the course does not include hotel accommodation; but the school is prepared to book hostel, hotel or guest-house places for students as available.

Fourteenth International Horticultural Congress, Scheveningen

The Fourteenth International Horticultural Congress will be held in The Netherlands at Scheveningen during August 29–September 6, 1955. Prior to the Congress, during August 25–27, excursions will be made to scientific institutions and to horticultural districts in The Netherlands. The Congress will consider vegetables and seeds; fruits; flowers and flower bulbs; trees, shrubs and perennials; and tropical and subtropical horticulture and plantation crops. Within each of these sections the following will be discussed: plant breeding and propagation; soils, fertilizers and water supply; plant diseases and pests; environment; and horticultural engineering, technology and technical marketing problems. Twenty minutes will be allowed for reading each paper, with ten minutes for discussion. The language may be English, French or German. The fee for membership of the Congress is 60 guilders (which includes a copy of the proceedings) or 25 guilders for an associate member. Application for membership should be sent to the Secretary of the Congress, Dr. G. de Bakker, Ministry of Agriculture, 30 Bezuidenhout, The Hague, from whom further information can be obtained.

Announcements

The Committee of Privy Council for Medical Research, after consultation with the Medical Research Council and with the president of the Royal Society, has appointed Prof. A. Bradford Hill, professor of medical statistics in the University of London, Prof. G. F. Marrian, professor of chemistry in relation to medicine in the University of Edinburgh, and Prof. G. W. Pickering, professor of medicine in the University of London, to be members of the Medical Research Council; it has also appointed the Honourable Richard Frederick Wood, M.P., to be a member.

The André Dreyfus Foundation has awarded the Dreyfus Prize for 1954 to Dr. Hans Kalmus, of the Galton Laboratory, University College, London. Dr. Kalmus intends to use his prize spending a semester (April–September 1955) in Brazil, working on problems of human genetics.

The Perkin Medal of the Society of Dyers and Colourists has been awarded to Dr. Arthur Zitscher for his work leading to the discovery of the new class of azoic dyes based on the arylamides of *o*-hydroxycarboxylic acids. The presentation will be made at a meeting of the Society to be held in the University of Manchester on October 15, when Dr. Zitscher will deliver a lecture on his work.

The Textile Institute Medal has been awarded to Sir Ernest Goodale, president of the Institute during 1939–40 and chairman of the Institute's London Section during 1950–52; the Medal was inaugurated in 1921 to mark distinguished services to the industry in general and to the Textile Institute in particular. The Warner Memorial Medal, awarded in recognition of outstanding work in textile science and technology, has been awarded to Mr. R. Meredith, of the College of Technology, Manchester.

The Scientific Instrument Manufacturers' Association is arranging an exhibition of electronic aids to production, design and research, under the title "Electronics at Work", to be held in the Chamber of Commerce Hall, Birmingham, during November 23–25. Admission is by ticket obtainable free on request from the Association at 20 Queen Anne Street, London, W.1, or from the Birmingham Chamber of Commerce, the Birmingham Exchange and Engineering Centre, or the Information Department, Birmingham.

The Spectroscopic Panel of the Hydrocarbon Branch of the Institute of Petroleum is arranging a conference on "Molecular Spectroscopy", to be held in the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, during October 28–29. Further information can be obtained from G. N. Ross, Anglo-Iranian Oil Co., Ltd., Chertsey Road, Sunbury-on-Thames, Middlesex.

A second edition of the "Departmental Handbook" of the New Zealand Department of Scientific and Industrial Research (pp. 68. Wellington: Government Printer, 1954) has been necessitated by departmental reorganization, staff changes and the heavy demand for the first edition. The bulk of the Handbook is given to brief descriptions of the various Divisions, Laboratories, Sections, etc., of the Department, with lists of staff and also the incorporated research associations. These are supplemented by notes on the general organization and administration of the Department, its activities and responsibilities and development, with details of committees and an index. The Handbook is illustrated and is well produced.

The twenty-first annual Christmas symposium of the Division of Industrial and Engineering Chemistry of the American Chemical Society will be held during January 7–8, 1955, the subject being "Pulsatory and Vibrational Phenomena". The symposium will be broad in scope, with papers on the following subjects: shock phenomena; pulse extraction and other vibration devices in chemical engineering process operations; generation and effects, both physical and chemical, of ultrasonic vibrations; vibration problems in combustion; vibration effects on structures and structural materials; and high-frequency heating. Those intending to participate should write to the programme chairman, DeWitt O. Myatt, Atlantic Research Corporation, 901 N. Columbus Street, Alexandria, Virginia.

Erratum. Mr. R. Persson states that in his communication entitled "Measurements on the Neutron Multiplication in a System of Uranium Rods and Ordinary Water", published in *Nature* of August 7, p. 265, the results obtained from formula (4) should be corrected for the diffusion of slow neutrons from the reflector to the core. This correction is important, especially for the most compact lattices, and the experimental points are then in much better agreement with the theoretical curve.

RECRUITMENT IN THE ENGINEERING INDUSTRY IN BRITAIN

A JOINT discussion between Section G (Engineering) and Section L (Education) at the British Association meeting at Oxford on September 7 was opened by Dr. Willis Jackson, director of research and education, Metropolitan-Vickers Electrical Co., Ltd., who emphasized the great gap between the numbers and quality of recruits needed by the engineering industry and the boys actually coming from the schools. He stressed the importance of continued education, general as well as technical, and of systematic practical training. He believes, however, that there is a fundamental change in attitude on this question based on the recognition of its national importance and arising from the increasing number of men in high executive positions who themselves have had a sound engineering education. The engineering industry, Dr. Willis Jackson said, needs recruits at three levels—professional engineers, technicians, and craftsmen. These sometimes overlap; but each has an essential place in the industry, and he believes that it is the facilities for training technicians which are the least satisfactory, partly because the need for training them systematically has not been clearly appreciated. More deliberately organized courses of practical training and technical study are needed here; but Dr. Jackson stressed the need for more flexibility in training all types of recruits, and also the importance of corporate life during industrial training and the value of the activities of apprentice associations.

Dr. Jackson was particularly concerned with the recruitment of professional engineers. The number of corporate members admitted to the Institutions of Civil, Mechanical and Electrical Engineers has increased from 2,741 in 1951 to 3,310 in 1953, of whom 1,444 possessed a university degree, as compared with 1,215 in 1951. Nevertheless, while the facilities for engineering students at the universities have increased, they are not being used: three hundred first-year places in university engineering schools were unfilled this year and two hundred more will be available in the next three years. More disturbing still, in one university thirty per cent of those accepted failed to pass their first-year examination. Dr. Jackson wondered whether we are trying to draw into the university engineering schools boys who would be better served by entering industry as student apprentices. He also thought that there is a need for better means of informing boys and parents as to the nature and prospects of engineering as a career.

Mr. Donald Lindsay, headmaster of Malvern College, who followed, flatly challenged the assumption that it is the business of the grammar school to produce engineers or any other particularly qualified group. The percentage of able boys is limited to about ten per cent of the school population, and this proportion has to supply all the professions with their best men. In his opinion, the school should be neutral, and should not attempt to influence recruitment for any particular profession. Nevertheless, Mr. Lindsay believes that the engineering profession could do more to attract not the outstandingly able boy, who usually knows his own mind, but the less-able boy, who, like his parents, often has the vaguest ideas of what it means to become an engineer. He suggested that the engineering industries could follow the example of the Armed Services in preparing a single-page document explaining clearly methods of entry and age and educational requirements for their various branches. Mr. Lindsay is also concerned at the possible effect on the prospects of the less-able boys of the new certificate examinations at ordinary level, and still more at the consequences for such boys of the shortage of science teachers and especially the decline in quality of science teachers.

Mr. H. A. Warren, principal of East London Technical College, outlining the contribution of the technical colleges to recruitment and training for the engineering industries, pointed out that grammar schools provided 45 per cent of the technical college students who obtained their Higher National Certificate in 1953. He said that the quality of the work of the technical colleges reaches as high a standard as the grade of student entry permits. The standard of teaching is good, the scale of equipment excellent and also the co-operation from industry, and so far as the student is characterized by a narrowness of outlook, it should be corrected by the philosophy and outlook of this age. Technology, he urged, should be restored to the service of the liberal ends of human life and character; and, referring to the proposals for a new national award in technology, Mr. Warren said that not only has any new award to prove its worth, but also it is essential for it to encourage breadth of outlook and height of aspiration, thus bearing witness to those social, cultural and philosophical qualities which were the original characteristics of a university degree.

ATTITUDES TO WORK

IN an address to the Industrial Section of the British Psychological Society*, Prof. L. S. Hearnshaw stated that as soon as psychologists have become convinced that values have a place in the world of fact and not only in the heads of philosophers, and that they are capable of being investigated by empirical means, the main resistances to their study will have been overcome, and one of the chief regulators of human behaviour brought within the framework of psychological study.

The growing number of attitude surveys that have been carried out among industrial workers since the War is a recognition that this area of psychology is industrially important. For the study of attitudes merges necessarily into the study of values. The difficulties confronting the psychologist in these studies are formidable and even discouraging.

The most suggestive observations on attitudes to work have come not from industrial psychologists—with the exception possibly of Mace, who is a man of many parts—but from an economist, like Zweig, a historian, like Carr, a philosopher, like Salmon, or from the mainly amateur members of productivity teams.

On the whole, the studies carried out by industrial psychologists themselves in the field of industrial attitudes have been restricted in their frames of reference. They have been concerned, broadly speaking, with three main topics. First, there have been studies of attitudes to specific features of the industrial environment, to wages and wage systems, security, status, supervision, working conditions, unions, industrial relations policies, types of job, and so on. Secondly, there have been comparative studies of the sort carried out by Marriott in Britain and by various groups in the United States, in which different factories have been compared with regard to attitudes, and an attempt made to link differences in attitude to features of the industrial situation. Thirdly, there have been studies of changes in attitudes resulting from changes in the industrial situation, both planned and unplanned.

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* *Occupational Psychology*, 28, No. 3 (July 1954)

Attitude studies along these lines have a twofold value. They provide a knowledge of the features within the industrial situation that influence and modify attitudes, and they provide local knowledge of attitudes to various situations which is of diagnostic value in troubled industrial conditions and a pointer to management.

In modern technical civilizations work has increasingly become a demarcated area of life. There is for more and more people a recognizable meaning in phrases such as 'on the job', 'working hours', 'retirement', in a sense quite unlike anything that obtains, or has obtained, in a simpler peasant or craft economy. A characteristic feature of work is that it is an activity performed under obligation. The individual undertakes to carry out certain duties (this word in itself is significant) in a certain manner, and usually, though not always, to be in certain places at certain times.

There are other attributes of work such as the fact that it usually implies activity continued over a period of time, perhaps a lifetime, and pursued with some regularity—odd jobs are the vanishing point of work—and also the fact that it is commonly integrated into the economic system.

If work is a demarcated area of life, this area can be evaluated in importance in relation to other areas. An individual's attitude to work will partly depend upon this evaluation. Secondly, if work implies obligations, an individual's attitude to work depends partly on his grasp and his acceptance of these obligations, and the qualitative standards of performance which serve as his norms or models.

Certain broad conclusions seem clearly to emerge from cross-cultural studies of this kind and to confirm qualitative studies which have been made. First, attitudes to work are cultural acquisitions bound up with many features of social organization, economics and ideology, and linked to personality structure; secondly, the roots of these attitudes go deep into the historical past; thirdly, though extremely persistent, such attitudes are not unchangeable.

There is a good deal of clinical and psychoanalytical evidence suggesting that personality structure and attitude to work are closely related, that work is one of several ways of securing reassurance against neurotic anxiety—a way agreeable to some, to others profoundly disagreeable. Attitudes to work cannot be understood except against the whole background of a culture and the predominant personality structure that goes with it.

Attitudes, however, though often persistent and stretching back into history, are not unchanging or unchangeable. Strong attitudes may slowly and imperceptibly erode and decay. New attitudes may emerge in response to the challenges of man or Nature. Although there are difficulties in interpreting this evidence, it all points in the same direction and to suggest that attitudes to work have eroded more in Great Britain than elsewhere. Not much can be done about this until more is known.

Into the problem of attitude to work three lines of research suggest themselves: the comparative, the genetic, and the psychometric.

Less is known about the character structure of the good workman, technician or professional man than the character structure of the young delinquent; the underworld has had more than its share of psychological attention. Attitudes to work are acquired in the process of growing up. What in fact are the formative influences upon which such attitudes primarily depend? What part do family influences play? To what extent in our culture are attitudes to work acquired at school? What is the effect of different types of education, or vocational placement, of the way a young person is introduced to work, of methods of industrial training, of blind-alley jobs? Again, what permanent influence do breaks in continuity of work have—military service, for example, or periods of unemployment? These and numerous other questions can be asked, but scarcely answered.

Work, not in the sense of physical effort, but work as a mastery of technique, as control, attention and service is the lynch-pin of modern society; and work in this sense depends even more than does physical labour on the attitude of those who perform it. Attitude to work is fundamental to the very continuance, still more to the progress, of society. There is no more important question for the industrial psychologist to turn his attention to than the way attitudes to work arise, grow and are transmitted.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION, AUSTRALIA

ANNUAL REPORT FOR 1952–53

FOLLOWING the practice adopted in the previous report, in the fifth annual report of the Commonwealth Scientific and Industrial Research Organization, Australia, covering the year ended June 30, 1953[*][†], material is arranged according to its subject and not the Division or Section concerned. Expenditure for the year totalled £4,526,270, including £1,044,392 from sources other than the Commonwealth Treasury, notably £327,283 from the Wool Industry Fund and £455,273 from the Wool Research Trust Fund. Continued progress is reported in the erection of new buildings, and the new laboratory for the Division of Tribophysics was practically complete.

Detailed surveys carried out by the Division of Soils covered about seventy thousand acres and broad-scale surveys about fifty thousand square miles, the field-work for about half the Melbourne sheet of a revised soil map of Australia being completed during the year. In soil chemistry, work on manganese-deficient soils continued and that on the ion exchange–pH relations in cation-dominant soils is almost complete. Work is in progress on a modification of the rapid Passon method for determining free carbonates in soils, and factors affecting the growth of strains of *Rhizobium trifolii* in the rhizosphere of subterranean clover have been investigated. Attempts to fractionate humic acid into its colloidal constituents failed.

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[*] Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Fifth Annual Report for the Year ending 30th June, 1953 (1952–1953). Pp. vi+200. (East Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) n.p.

[†] Commonwealth of Australia. Fifth Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1953 Pp. 191 (Canberra. Government Printer, 1953) 11s.

In the Division of Plant Industry increased emphasis was given to fundamental studies, and work on plant chemistry, biochemistry, physiology, microbiology, genetics and cytology is to be extended. Although no officers were collecting overseas, plant exploration dominated the work of the plant introduction unit. Some of the varieties of tall fescue continued to be outstanding in pasture introduction trials at Armidale, New South Wales, and strains of chick pea from Spain and Eritrea appear to be useful, drought-resistant, quick-growing forage plants. Nearly seven hundred new introductions were established in the quarantine nursery at Strathpine, Queensland, chiefly large collections of pasture and crop plants from Africa. Potato varieties infected with virus X have been successfully reconstituted by treatment with the dye malachite green, and comparative *in vitro* tests have shown that streptomycin and aureomycin are more effective than bacitracin, chloromycetin, terramycin and penicillin in inhibiting growth of *Corynebacterium michiganense*, *Xanthomonas vesicatorium*, *X. phaseoli*, *X. campestris*, *Pseudomonas medicaginis* and *P. syringae*. A start has been made on the determination, from each important group of soil microflora, of the numbers which can normally be expected to be present in known fertile soils at different seasons. It has been shown that the reduction of ferric compounds by bacteria results from reducing conditions caused by dehydrogenase systems, and this type of reduction may be important in supplying plant nutrients from iron and manganese oxides.

Preliminary trials on Golden Delicious, Delicious, Granny Smith and Sturmer apples indicate that storage in low concentrations of oxygen in absence of carbon dioxide gives very promising results, scald and breakdown being reduced and texture greatly improved. Investigations on the effect of nitrogen and plant spacing on leaf quality and also on the effect of temperature on the resistance of tobacco plants carrying the necrotic type of resistance to tobacco mosaic were continued. The prevalence of trashy leaf causes considerable losses to the Australian tobacco industry, and the qualitative and quantitative changes in composition of glasshouse plants submitted to treatments conducive to trashiness are being studied. Trials with potassium, copper, zinc, molybdenum, manganese, iron, magnesium and boron on soils in the Southern Tablelands of New South Wales were maintained, and a programme of work has been initiated which should provide detailed information for the solution of subsidiary nutritional problems in the Ninety-Mile Plain area, particularly relating to zinc and copper requirements and the function of these elements in the general physiology of plants. An attempt is being made to determine whether varieties of oats differ in the efficiency with which they utilize copper within the plant. Studies of the distribution of treeless grasslands in south-eastern Australia in relation to soil, climate and fire are in progress; and a detailed study has been commenced of the rate and nature of the improvement of fertility by subterranean clover in New South Wales. Ecological surveys of pastures continued in the New England region of New South Wales, in south-western Queensland and at Deniliquin, where studies with a range of irrigated pastures on several soil types also continued. Studies at Perth of the factors affecting zinc responses in subterranean clover indicate that high levels of soil moisture increase the zinc requirements and that a high level of available nitrogen hinders the utilization of zinc in the soil. Studies on the black soils of the Darling Downs now completed indicate that nitrogen and sulphur are the primary limiting plant nutrients. The large-scale grazing experiments at Lawes with the grass *Paspalum scrobiculatum* and lucerne indicate that the two plants are complementary in terms of production and in providing an overall balanced diet for stock. The range of concentrations of zinc and copper in subterranean clover and lucerne on soils of the Coonalpyn Downs has been investigated as an aid to the diagnosis of incipient deficiency of zinc and copper, and preliminary studies indicate that 3-(*p*-chlorophenyl)-1 : 1-dimethylurea is a powerful herbicide, acting chiefly through the root system.

The Irrigation Research Station at Merbein, Victoria, where a programme of research on breeding tomatoes resistant to nematode and other pests and diseases has proceeded for some years, is broadening its interest in nematology, while much of the work of the Irrigation Research Station at Griffith, New South Wales, has been concerned with the principles and methods of applying water, and the removal of surplus water by drainage. Only slow progress is reported with the establishment of the Sheep Biology Laboratory at Prospect Hill, Parramatta, Sydney, where basic physiological and biological studies of the sheep are to be concentrated. At the National Cattle Breeding Station, Belmont, Rockhampton, methods so far adopted to control infestation by tick (*Boophilus microplus*) appear to be of limited value. The investigation of breeding systems at the Poultry Research Centre, Warribee, Victoria, indicates that the most effective way of improving characters of a quantitative nature with low heritability in a pure-bred population is by selection of genetically superior parents, which are discovered by progeny or sib-testing, or both, and by mating to avoid close in-breeding. Experiments on nutrition and wool production have been extended to provide further knowledge of the metabolism and utilization of methionine, which is convertible *in vivo* to cystine, the main amino-acid in wool keratin. Studies of the physiology of the wool follicles have also been initiated to extend existing knowledge of the process of keratinization. The effects of insulin on sheep and lambs have been studied further, and studies of the relations between vitamin B$_{12}$ and cobalt ingestion in the sheep have shown that the syndrome of cobalt deficiency is due to vitamin B$_{12}$ deficiency.

The Animal Genetics Section has undertaken a survey which is designed to indicate the total variation between sheep throughout Australia in quantity and quality of wool production and the fraction of variation which can be apportioned to genetic and other causes. Further observations have been made on the relation of particle size of phenothiazine to its anthelmintic efficiency, the mode of action of phenothiazine and related compounds, the techniques of drenching sheep and resistance to nematode parasites. With proper dipping technique, at the concentration generally recommended, benzene hexachloride promises to eradicate *Linognathus ovillus* on sheep. Further work on pleuro-pneumonia of cattle is reported, on mastitis in dairy cattle, on brucellosis in cattle and on infectious bovine ophthalmia. Further work has shown that loss of efficiency of benzene hexachloride dipping fluids is related to a selective depletion of the toxic gamma isomer.

In the Division of Entomology the Biological Control Section has intensified its work on the green vegetable bug and is endeavouring to establish parasites of the oriental fruit fly which will give some control of the Queensland fruit fly. Promising methods of controlling cattle tick and lucerne flea have been evolved, and a new virus attacking a pasture caterpillar has been discovered. Periodical surveys of the main infestation areas of St. John's wort (*Hypericum perforatum*) continued, and long-term field studies on insect populations were commenced. Field experiments with DDT indicate that very satisfactory control of the earth mite can be achieved by proper application, and a large-scale eradication campaign against the Argentine ant is to be carried out in an area of 1·5 square miles near Sydney. Some progress is reported towards the development of an insect-proof packing material.

The Wild Life Survey Section shifted its interest in myxomatosis from extensive survey to more intensive studies of special aspects of this problem. Joint investigations with the Tasmanian Fauna Board on the economic biology of the mutton bird (*Puffinus tenuirostris*) were continued in the Furneaux Group and extended to Trefoil Island. An investigation of the role of the straw-necked ibis (*Threskiornis spinicollis*) and the white ibis (*T. molucca*) in the natural control of locusts and to define measures for the preservation of their breeding haunts is under consideration, and the Section is to undertake the establishment of a national bird-ringing scheme. The Land Research and Regional Survey Section has since 1946 completed surveys of 223,000 square miles of under-developed regions in northern Australia, and a second unit is about to commence a survey of the Buna region of Papua. These broad-scale ecological studies determine both the distribution of the native vegetation and the possibilities of growth and establishment of fresh crop and pasture species. They include the assessment of land-use potential, research into problems of agricultural and pastoral development of the zones, climatological studies and a general topographical survey.

In fisheries research more time is being devoted to observations in south-eastern waters on water and plankton conditions, and studies are being made of gummy shark (*Emissola antarctica*) and the fishes of the continental shelf. Progress is reported in the recording of underwater shoals of pelagic fish by echo-sounding. Much useful information on the transport of small fish fry, particularly *Mugil cephalus*, from the small creeks and estuaries around Moreton Bay, was obtained before the lagoon was rendered useless for experimental purposes by the destruction of the sand barrier. Another fish farm for the culture of mullet fry in Moreton Bay is under construction, and the fish culture experiment at Maianbar is proceeding. A detailed investigation of the 'white crayfish' occurrence in coastal areas was made in December 1952, and preliminary biological surveys of prawns were made in north-west waters of Western Australia. Sufficient data have been collected to interpret and predict changes in the scallop fishery. A spectrophotometric method was devised for the determination of phytoplankton densities.

Special reference is made in the report to the co-operation of the Biochemistry Department of the University of Sydney with the physical chemistry group of the Division of Food Preservation and Transport. During the year, the Division commenced a survey of the nature and extent of wastage in cooked prawns for the Chief Secretary's Department of New South Wales and a survey of the Victorian Fishermen's Co-operative cold stores and their operation for the Victorian Department of Fisheries and Game. The study of the chemical composition of apricots and peaches continued. Experiments to increase the biological efficiency of the freeze-drying process for cultures have commenced, and the sudden rise in respiration about the time of ripening has been investigated in apples and pears. Use of the maturometer has made long-term prediction of pea-crop maturity a practical possibility, but the instrument requires modification for use with green beans. Trials of the removal of 'bloom' from the surface of grapes by immersion in warm ethylene dichloride have been extended to the currant and sultana, and the hot sulphite dip for sultanas has been applied by growers at Woorinen with very satisfactory results. Butter-milk, as well as skim-milk, has now been utilized satisfactorily as an addition to bread. Work on the physiological mechanism by which *Lepidium* spp. causes a high content of indole and skatol in milk and cream has stopped. A stock of efficient single-strain cheese-starter cultures has been established.

The Division of Forest Products has investigated the characteristics of tension in wood by microchemical and X-ray diffraction methods and has constructed a rheometer for measuring ~~stress–strain–time~~ relations on paper strips which will be used to study the relation of physical properties to the structure of paper and also manufacturing problems. The essential changes induced in cellulose fibres by beating, and the relation between the moisture intersection point obtained from strength studies and that determined from shrinkage studies are being investigated, and the increase in apparent density of wood substance with external swelling due to the displacement liquid has been confirmed. A study of the effect in laminated beams of using external laminæ of relatively strong species over a core of lighter and weaker material was completed, the high-pressure pilot plant was in almost continuous operation for the experimental treatment of rail-sleepers for co-operative tests, and a series of tests on the resistance to leaching of nineteen water-borne preservatives has given a valuable picture of the relative permanence of different preservatives. An investigation on the manufacture of plywood from veneers immunized against termite attack was commenced, and a spectrophotometric method developed for determining amino groups.

In the Division of Building Research greater emphasis was given to the work on lightweight aggregates and the use of plaster of paris as a structural material, the long-term study of the mechanism of failure of concrete under load and investigations on foamed concrete continued, and the survey of clay resources and the heavy clay industry in New South Wales and Victoria was completed. In the Wool Textile Research Laboratory at Sydney the study of the physical properties of single fibres is being extended to fibre assemblies and the physical properties underlying textile processes. Other work on wool textiles has included X-ray studies of the transformation of α-keratin to β-keratin, the application of resins to wool, the construction of a Hepp-type of osmometer to determine the mean molecular weight of wool dispersions prepared by extraction with urea-bisulphite solutions and the study of protein structure, while good yields of alcohols have been obtained in small-scale hydrogenation of wool-wax acids at 300° C./4,000 lb. per sq. in. in the presence of copper chromite catalysts. Work on the pilot-plant scale on the aerated retting technique for treating flax was completed, and possibilities of improving flax-scutching machinery were being explored.

The Division of Industrial Chemistry continued its fundamental work on the carbides and iodides of thorium in relation to the thermal deposition of the metal, on the fluorides of cerium and their use as fluorinating agents and on the preparation and properties of titanium nitride, and is to conduct research on a large pilot-plant scale on a new method of treating copper concentrates, sponsored by Mount Lyell and Mount Morgan mining companies. The study of portland cement and pozzolanic cements and the survey of Australian resources of ceramic clays continued. A systematic study of the theoretical and experimental aspects of the chemical effects of high pressure was initiated and the work on the purification of antibiotics by fractional adsorption processes was concluded. A study of the physical and chemical properties of spread monomolecular layers has shown that the monolayer techniques can be used advantageously for determining the general architecture of molecules of between twelve and forty carbon atoms and the position of chemically reactive groups within the molecule. Techniques have been established for obtaining reproducible evaporated films and for measuring their thickness by multiple-beam interferometry, and a novel approach to the spectrochemical estimation of elements, invoking atomic absorption rather than emission, is being developed. In organic chemistry, apart from the chemistry and utilization of wool wax and sugar-cane wax, the research programme is concerned chiefly with the examination of Australian plants for alkaloids of pharmaceutical value and substances toxic to livestock, the kinetics of the phenol–formaldehyde reaction, the general chemistry of long-chain aliphatic compounds and the examination of seed oils from Australian plants.

Some work was done on the application of gravity and magnetic methods of concentration for the recovery of wolfram and scheelite from a fine-grained ore from New South Wales, and an intensive investigation commenced on the flotation of cassiterite. Fuel research included a pilot-scale investigation of the carbonizing properties of Australian coals and of the gasification of Victorian brown coal. Detailed investigations of titanium–tin and titanium–silver alloys were completed, and an X-ray diffraction study of the lower oxides of titanium has assisted the interpretation of the structure of oxide scale layers formed in the oxidation of titanium. The Division of Tribophysics has extended its work to include fundamental studies in metal physics and work on reaction kinetics, and reports major advances in the understanding of distortions produced in metals by plastic deformation. A study of the oxidation of propylene suggests that higher aldehydes are formed as a result of the decomposition of peroxides produced by a similar mechanism to that in the simpler liquid-phase reactions. Work on the thermal conductivities of organic vapours continued.

The Division of Metrology was again mainly occupied with statutory and industrial requirements relating to national standards, but also produced and measured three end-standards and platen for an international intercomparison arranged by the International Bureau of Weights and Measures. In low-temperature physics the Division of Physics began an examination of the thermal conductivity of various metals, and a study of the condensation of vapour on a solid surface has shown that, at very low supersaturations, condensation is due to imperfections of the surface. Research on the theory of optical instruments continued, and considerable progress was made in the construction of equipment for solar research. In electrotechnology work continued on the relation between the chemical and physical structure of organic compounds and their dielectric properties. The Division of Radiophysics continued its fundamental work in rain physics and radio-astronomy and also investigations on electronic computing and radio aids to navigation. Much information has been obtained about ionospheric winds, and the Organization has now embarked on intensive studies of the physics of the atmosphere. The work of the Meteorological Physics Section is directed to a more fundamental understanding of the weather and the physical processes which control it. With its new radio-spectroscope, the Division of Radiophysics has discovered a new phenomenon—the production of 'harmonics' of bursts of radio-emission from the sun.

Much of the work of the Nuclear Physics Section was concerned with angular correlations between particles participating in nuclear reactions, with nuclear energy-level determinations, and with scattering investigations. The cosmic-ray spectrometer determination of the variation of the specific ionization of cosmic-ray mesons as a function of their momentum was completed at Melbourne, and directional measurements of cosmic-ray intensity at Hobart continued. In mathematics the analysis of rainfall records and statistical studies of sheep-breeding continued, and effort was concentrated on the final development and use of the electronic computor, while work is almost complete on the development and application of beam-deflexion valves for digital computing.

A CHAINOMATIC PYCNOMETER FOR THE DETERMINATION OF CHLORINE IN SEA WATER

By D. J. ROCHFORD

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IN the early part of the present century, Nansen[1] used hydrometers for the determination of the salinity of sea water, and this method has been used to a limited extent since that date. However, Nansen was quick to realize the limitations of a hydrometer with an emergent stem, and tried to improve the pycnometric method by using totally immersed floats and holding them in equipoise with added weights. Pettersson[2] greatly improved the original idea of Nansen by using a gold chain as the source of weight, and other mechanical improvements. Petters-

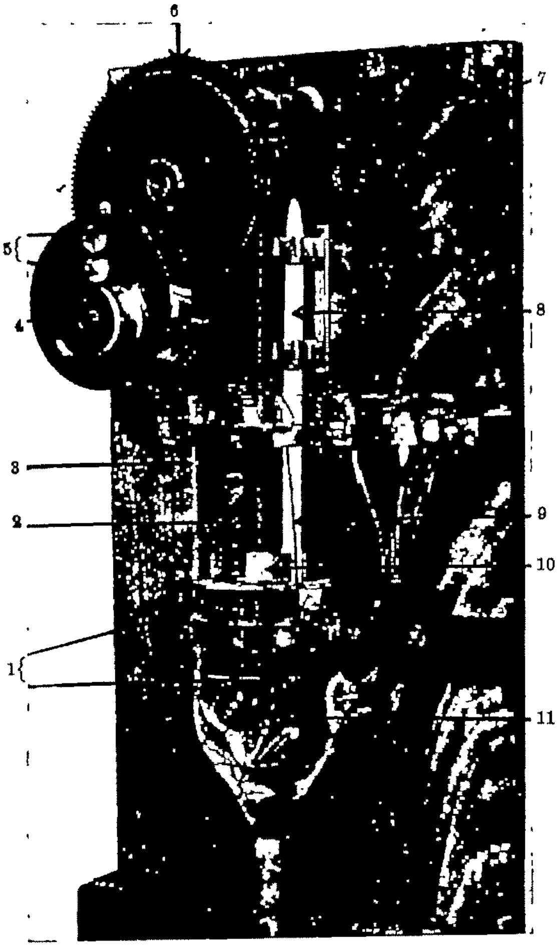

Fig. 1. Front panel of a chainomatic pycnometer. (1) Calibrating lines; (2) gold chain; (3) float chamber; (4) chain-adjusting knob; (5) chain-setting dials; (6) chain drum; (7) tension clutch; (8) thermometer; (9) float lifter; (10) chain guide; (11) float

son described two pycnometers, one with the gold chain as a tail on the float and operated in a tall cylinder in some 500 ml. of sea water, and the other utilizing the chainomatic principle in which gold chain was added link by link from a drum to the top of the float. This second pycnometer was essentially a laboratory instrument, and according to Pettersson, if the temperature was controlled it was capable of high accuracy of density determination.

The Division of Fisheries of the Commonwealth Scientific and Industrial Research Organization has been making extensive investigations of the coastal and estuarine environments of Australia, and a rapid accurate method of determination of chlorine capable of use by field-staff under rather primitive conditions seemed highly desirable. The pycnometric method of salinity estimation was finally chosen because it is a direct physical method, which without the range of equipment needed for a chemical determination or the skill required to construct and maintain electronic equipment is in our experience capable of high accuracy in the hands of semi-skilled operators. Moreover, it is capable of linear operation over the whole range of salinity from sea water down to fresh water.

The chainomatic pycnometer of Pettersson was adapted to our needs and the model now in use possesses the following improvements on his design. (*a*) It is portable, folding as a unit into a carrying case, 15 in. × 7½ in. × 3½ in. (*b*) The glass parts are extremely rugged. (*c*) Certain mechanical features, particularly the tension clutch in Fig. 1 (7) and the 'Perspex' chain guide (10), ensure perfect reproducibility of chain setting and lead to high accuracy of initial determination by users of the instrument. (*d*) The calibration is in $\mathrm{Cl}^{\circ}/_{00}$ units, and calibration graphs enable rapid conversion of instrument data into $\mathrm{Cl}^{\circ}/_{00}$.

The chainomatic pycnometer used by the Division was exhibited at the 8th Pacific Science Congress at Manila in November 1953 and attracted much interest from the oceanographers present. A sample unit has been sent to Canada for use in coastal oceanographical studies. It is hoped that this instrument will be in commercial production by an American firm at an early date. A technical description of the instrument and its use is being submitted for publication.

[July 23.

[1] Nansen, F., *Norske Videnskabs Selskabets Skrifter*, 1, No. 3 (1905).

[2] Pettersson, H., and Pettersson, O., *Svenska Hydrografisk Biologiska Kommissionens Skrifter*, N.S., Hydrographie III (1929).

INTERDEPENDENCE OF TEMPORAL AND AUDITORY JUDGMENTS

By Prof. JOHN COHEN, C. E. M. HANSEL and J. D. SYLVESTER

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We have previously presented evidence that judgments of the spatial and temporal components of space-time events are interrelated[1,2]. We have used the term '*kappa*-effect' to denote the influence of the spatial component on judgments of duration to distinguish it from the *tau*-effect[3], which denotes the influence of the temporal component on spatial judgments. In our earlier report we referred briefly to the effects of order of presentation of the display and of visual angle. These effects and the relation between the *kappa* phenomenon and the perception of movement have been more fully described in a paper awaiting publication elsewhere.

In the experiments now to be described we consider the question, raised in the first report, whether the spatial element as such is an essential feature of this type of temporal phenomenon, and whether a delimitation of the time intervals by non-spatial stimuli such as auditory pitch might not produce similar effects.

One effect may be studied by presenting a cycle of three different tones. The flashes of light (as in the previous experiment) are now replaced by brief tones to delimit the temporal intervals, and distance is replaced by tonal interval. A second effect may be studied by means of a temporal interval which is not delimited by two tones but is itself indicated by a continuous single tone. In the first case we are concerned with the influence of tonal intervals on temporal judgment, and in the second case with the influence of continuous tones as such on the temporal judgment.

Effects with Tonal Intervals

(*i*) *Auditory tau.* The subject heard through headphones a repeated succession of three different tones of brief and equal duration and was required to adjust the pitch of the second tone until it seemed

Table 1. AUDITORY *tau* EFFECT FOR TONAL INTERVALS
Mean frequency (and standard deviations) of middle tone from adjustments by subjects ($n = 8$). $T(t_1 + t_2) = 1 \cdot 47$*

$\frac{t_2}{t_1}$	Frequency (c./s.) of first tone (upper figure) and third tone (lower figure)			
	1,000 3,000	2,000 4,000	4,000 2,000	3,000 1,000
0·5	1,676 (230)	2,628 (260)	2,837 (261)	1,921 (292)
1·0	1,874 (211)	2,693 (483)	2,808 (246)	1,838 (274)
2·0	2,068 (276)	2,786 (295)	2,674 (297)	1,725 (245)

* The duration of the complete cycle was 1·5 sec., of which 0·03 sec. was taken up by the onset and fading of the tones necessary to remove clicks.

intermediate in pitch between the first and the third tones. Each cycle of three tones was repeated after an interval of 5/3 of the total cycle. The two successive time intervals (t_1 and t_2) delimited by the three tones could be varied by the experimenter by adjusting the position of the middle tone in the cycle. The three ratios of t_2/t_1 employed were 0·5, 1·0 and 2·0, the total interval remaining constant at 1·5 sec. The frequencies of the first and third tones were set by the experimenter to provide tonal intervals of different magnitude and ascending and descending order. The frequencies used are shown in the column headings of Table 1.

The tones were generated by three audio-oscillators which fed into a mixer embodying a mechanism whereby each tone could build up and fade out in a short period of time so as to remove click disturbances. The sequence of the brief tones was controlled by a continuously rotating switch making contact with three positions, the centre position being variable.

The values in Table 1 are the means for eight subjects, each subject giving two judgments under each of the twelve conditions. It appears from these figures that when the observer is adjusting the second tone so that it seems to him intermediate in pitch between the first and third tones, he makes the tones which are presented closer together in time farther apart in frequency, regardless of the ascending or descending order of the tones. He does this because as, for example, t_2/t_1 is reduced to 0·5 after his adjustments when $t_2/t_1 = 1$, the tones delimiting the shorter time interval (t_2) seem too close together in pitch. In order to make the middle tone appear intermediate in pitch between the first and third, he reduces its frequency, thus increasing the frequency difference between it and the third tone. For example, when $t_2/t_1 = 0 \cdot 5$ and the first and third tones are 1,000 and 3,000 respectively, the mean frequency for the second tone is 1,676 c./s. as compared with 1,874 c./s. when $t_2/t_1 = 1$.

When $t_2/t_1 = 0 \cdot 5$, an interval of 1 sec. is followed by an interval of 0·5 sec. When $t_2/t_1 = 2 \cdot 0$, the reverse is the case. If we combine the figures in Table 2 so as to eliminate the effects of order of presentation of time intervals and ascending and descending order of frequency, there is a mean deviation of 8 per cent when the first and third tones are 1,000 and 3,000 c./s. and about 3 per cent when they are 2,000 and 4,000. Both these deviations are significantly larger than zero at the 0·05 level. Thus the *tau* effect is present under both conditions and is larger when the difference between the outer tones is greater. With the difference between the two tones smaller (2,500, 2,973 c./s.), no significant effect was observed under the above experimental conditions.

Table 2. PERCENTAGE DEVIATION OF JUDGMENTS FOR UNEQUAL TEMPORAL INTERVALS WHEN COMPARED WITH EQUAL TEMPORAL INTERVALS

$\frac{t_2}{t_1}$	Frequency (c./s.) of first tone (upper figure) and third tone (lower figure)			
	1,000 3,000	2,000 4,000	4,000 2,000	3,000 1,000
0·5	− 10·6	− 2·4	1·0	4·6
2·0	10·4	3 5	− 4 8	− 6·1

(*ii*) *Auditory kappa.* The procedure was the same as for the auditory *tau* except that the observer was required to adjust the timing of the middle tone so that t_1 seemed to equal t_2. The frequency of the middle tone was set by the experimenter so as to make three different ratios of tonal intervals.

The results obtained possibly suggest a very slight tendency for comparative judgments of two successive time intervals delimited by successive tonal intervals to be influenced by the relative magnitudes of the two intervals. The results, however, are not statistically significant.

Effect with Continuous Tones

The apparatus was modified so that each temporal interval was indicated by a continuous tone, the second immediately following the first. The tones were set by the experimenter and the subject was required to make an adjustment so that the two tones seemed of equal duration.

Table 3. AUDITORY *kappa* EFFECT FOR CONTINUOUS TONES
Mean for eight subjects when $T(t_1 + t_2) = 1 \cdot 47$ sec.*

(i)		(ii)	(iii)	(iv)	(v)	(vi)
First tone f_1 (c./s.)	Second tone f_2	$\frac{t_2}{t_1}$	t_1 (sec.)	σt_1 (sec.)	t_1' (sec.)	$\frac{t_1'-t_2'}{t_1'} \times 100$ (percentage)
3,000	1,000	1 06	0·715	0·062	0·682	− 15 5
4,000	2,000	0·91	0 771	0·059	0·735	0·0
2,973	2,500	0 95	0·755	0·042	0 720	− 4·2
2,500	2,973	0·83	0 803	0·081	0·765	7·8
2,000	4,000	0·85	0·794	0·072	0·756	5·6
1,000	3,000	0·85	0·793	0·070	0·756	5·6

* See footnote to Table 1.

In col. i of Table 3, we show the pairs of successive tones presented by the experimenter, and col. vi shows the corresponding percentage effect. In col. v a correction has been applied to eliminate time error by multiplying the values in col. iii by a constant derived from the mean of all the readings.

It appears from col. vi that there is a tendency for the time allotted to the higher tone to be less than that allotted to the lower tone. As in the case of auditory *tau* for tonal intervals, the effect appears most marked with the greatest difference in frequency between the two tones.

We have shown that auditory and temporal judgments are interdependent, the *tau* effect appearing most markedly with three brief tones and the *kappa* effect most markedly with two continuous tones. There is a reduced *kappa* effect with three tones, as compared with the corresponding *tau* effect. This is possibly due to the fact that, whereas in the *tau* experiment the subject has to attend to the pitch of the three tones in order to make his adjustment, in the *kappa* experiment he can make his adjustment by disregarding the pitch of the tones as such and attending to them as delimiting temporal intervals.

The subjects' verbal reports support this explanation. In the case of *kappa* with two continuous tones, the subject is compelled to attend to the tones throughout the entire cycle in order to discriminate between them and make his adjustment.

Having demonstrated the interrelation between (i) temporal and spatial and (ii) temporal and auditory judgments, we can now say that the spatial component as such is not an essential feature in these phenomena of interdependence. It may be asked whether the temporal element as such is essential, and whether spatial and auditory judgments are interconnected in the same manner when the temporal component is absent. Preliminary experiments have thus far failed to show an effect comparable to *tau* or *kappa* when the temporal element is absent, though other forms of interrelation between spatial and auditory judgments have been demonstrated in our own laboratory and elsewhere.

These experiments indicate the pervasive character of the temporal component in perception and the need for further study of its effects. [June 22.

[1] Cohen, John, Hansel, C. E. M., and Sylvester, J. D., *Nature*, 172, 901 (1953).

[2] Price-Williams, D. R., *Nature*, 173, 363 (1954).

[3] Helson, H., and King, S. M., *J. Exp. Psychol.*, 14, 202 (1931).

SHIELDING EFFICIENCY OF CATIONS

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It is quite generally accepted that the 8-electron shell is able to shield the nuclear charge of an atom more efficiently than the 18-electron shell. The main object of this communication is to suggest a quantity which may be used for comparing the shielding efficiency (S_{eff}) of all cations; but before doing so, the sense in which shielding efficiency will be used here will be illustrated by two examples.

Consider first the 8- and 18-electron cations, Na$^+$ and Cu$^+$. They both carry unit charge and have the same radius[1,2] (0·95 A.); yet, whereas only 5·1 V. is required to remove an electron from an atom of sodium in sodium vapour, 7·7 V. is required to ionize copper to Cu$^+$. Evidently the $4s$ electron in copper is more tightly held than the $3s$ electron in sodium, and the principal, though not the only, cause may be considered to be due to comparatively poor shielding by the 18-electron shell.

In the above example, singly charged cations were considered; but for more highly charged cations, the equivalent ionization potential will be used—the second for doubly charged cations, the third for trebly charged cations, and so on: thus, comparisons are always made of the energy required to remove one electron—the last one—to give the particular ionic state in question.

As a second example, we may take the pair Zr^{4+} and Hf^{4+}, each with a charge of four and a radius of about 0·79 A.; their fourth ionization potentials are 34 V. and 31 V., respectively. Hence, as it requires more energy to remove the first $4d$ electron from outside the 36-electron krypton core than to remove the first $5d$ electron from outside the 68-electron hafnium core, giving in each case a cation of equal charge and radius, shielding in Zr^{4+} is apparently less efficient than in Hf^{4+}. It will become evident later that, although the ionization potential difference is 3 V. in this pair as compared with 2½ V. for the pair Na$^+$ and Cu$^+$, the shielding efficiency difference between Zr^{4+} and Hf^{4+} is much smaller than in the pair Na$^+$ and Cu$^+$.

In the above examples, radius and charge are the same for the constituents of each pair and nothing can be concluded about how the shielding efficiency in Na$^+$ compares with that in Zr^{4+}, where both radius and charge differ. Consider first the relationship between r and I when charge is kept constant. Attention has been directed[3] to the fact that the relationship

$$I \propto 1/\sqrt{r} \quad (\text{or } I^2 \propto 1/r) \tag{1}$$

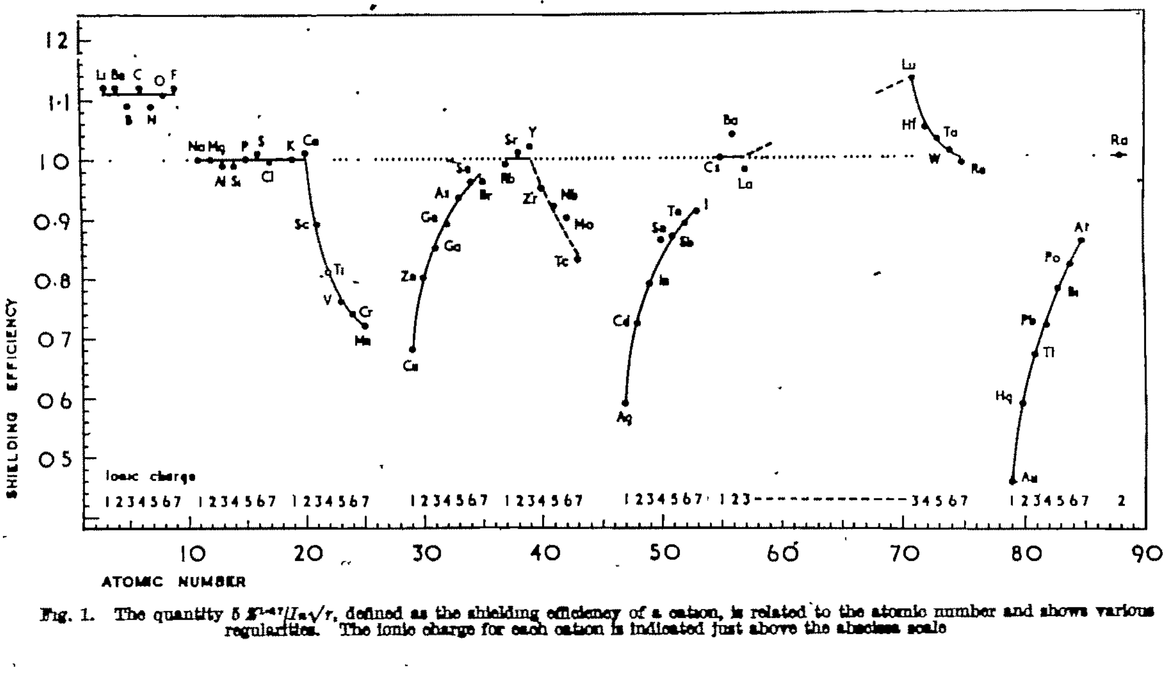

Fig. 1. The quantity $5\,Z^{1\cdot47}/I_z\sqrt{r}$, defined as the shielding efficiency of a cation, is related to the atomic number and shows various regularities. The ionic charge for each cation is indicated just above the abscissa scale

is quite closely followed by the 8-electron groups, Na^+, K^+, Rb^+, Cs^+, and Mg^{2+}, Ca^{2+}, Sr^{2+} and Ba^{2+}. Neither the 2-electron cations, Li^+ and Be^{2+}, nor the 18-electron cations Cu^+, Ag^+, Au^+ and Zn^{2+}, Cd^{2+} and Hg^{2+}, fit the above general relationship. Attention has also been directed[2] to the smooth inverse regularities which exist between r and I_n in such sequences as $Li^+ \rightarrow F^{7+}$; $Na^+ \rightarrow Cl^{7+}$; $K^+ \rightarrow Mn^{7+}$; $Cu^+ \rightarrow Br^{7+}$; $Ag^+ \rightarrow I^{7+}$, etc. Combination of such a regularity for the sequence $Na^+ \rightarrow Cl^{7+}$ with the above inverse-square relationship yields

$$\sqrt{r} \propto Z^{1\cdot27}/I$$
$$\text{or } \sqrt{rI} = K\,Z^{1\cdot27}, \qquad (2)$$

where Z is the ionic charge. With I in volts and r in A., K is found to be $5\cdot00 \pm 0\cdot01$. The extent to which this relationship is obeyed by non-transitional type 8-electron cations may be observed from Table 1.

It is suggested that the quantity $5\,Z^{1\cdot27}/\sqrt{rI}$ be used as a measure of the shielding efficiency of cations, and those cations which obey equation (2) and therefore have $S_{\text{eff}} = 1\cdot00$ (Table 1) will be defined as having normal shielding efficiency.

Table 2 gives values of S_{eff} for cations arranged according to the Periodic Table, whereas Fig. 1 relates S_{eff} to atomic number in consecutive sequences.

The plotted points of highly charged cations in Fig. 1 do not correspond exactly with those of Table 2, as they had been calculated on the basis of a value of 1·26 for the charge exponent and not 1·27. As the differences are insignificant with regard to the various regularities of Fig. 1, it has not been redrawn.

S_{eff} either remains uniform ($Li^+ \rightarrow F^{7+}$, and $Na^+ \rightarrow Cl^{7+}$) or varies regularly toward or away from a value of unity. Entry of $3d$ electrons in particular, and $4d$ and $5d$ to a lesser extent, causes a lowering in the shielding efficiency as defined: the effect increases with charge. The reverse developments take place after completion of the 18-electron shells; and in the sequences $Cu^+ \rightarrow Br^{7+}$, $Ag^+ \rightarrow I^{7+}$ and $Au^+ \rightarrow At^{7+}$, S_{eff} increases with charge and tends to approach unity in each case. The effect of entry of $4f$ electrons is apparently unique, and thus the third ionization potentials of lanthanum and lutetium are almost identical (19 V.); the radius decreases from 1·15 A. to 0·85 A. and hence S_{eff} increases from about unity to 1·14, a maximum value which is apparently very similar in magnitude to that of the 2-electron cations. (The third ionization potentials of Ce^{3+} . Yb^{3+} are not known.) S_{eff} reaches its minimum (0·46) in Au^+.

Table 1. CALCULATED VALUES OF K and S_{eff} (for definition see text)

	$Z^{1\cdot27}$	r (A)	I_n* (V.)	K	S_{eff}
Na^+	1	0·95	5·12	4·99	1·00
Mg^{2+}	2·41	0·65	15·0	5·01	1·00
Al^{3+}	4·03	0·51	28·5	5·05	0·99
Si^{4+}	5·82	0·42	45·2	5·05	0·99
P^{5+}	7·72	0·35	65·0	4·98	1·00
S^{6+}	9·73	0·30	88·1	4·97	1·005
Cl^{7+}	11·83	0·27	114·3	5·00	1·00
K^+	1	1·33	4·34	5·01	1·00
Ca^{2+}	2·41	1·01†	11·9	4·96	1·01
Rb^+	1	1·46	4·17	5·03	0·99
Sr^{2+}	2·41	1·18†	11·0	4·95	1·01
Cs^+	1	1·66	3·89	5·01	1·00
Ba^{2+}	2·41	1·34	10·0	(4·80)‡	(1·04)
Ra^{2+}	2·41	1·43	10·1	4·98	1·00
			Av.	5·00	1·00

* All ionization potentials from Landolt-Bornstein, 6 Auflage, 1 Band, 1 Teil (Atome-Ionen) (Springer, 1950).

† These radii are slightly greater than those given by Pauling (ref. 1) and Ahrens (ref. 2), in accordance with fairly definite evidence from internuclear distance measurements in alkaline earth fluorides and oxides.

‡ Omitted from calculation of the average.

Table 2. SHIELDING EFFICIENCY OF CATIONS

Li^+ 1·12	Be^{2+} 1·12	B^{3+} 1·10		C^{4+} 1·13	N^{5+} 1·10	O^{6+} 1·12	F^{7+} 1·13
Na^+ 1·00	Mg^{2+} 1·00	Al^{3+} 0·99		Si^{4+} 0·99	P^{5+} 1·00	S^{6+} 1·005	Cl^{7+} 1·00
K^+ 1·00	Ca^{2+} 1·01	Sc^{3+} 0·90		Ti^{4+} 0·82	V^{5+} 0·77	Cr^{6+} 0·74	Mn^{7+} 0·71
Cu^+ 0·68	Zn^{2+} 0·80	Ga^{3+} 0·86		Ge^{4+} 0·90	As^{5+} 0·96	Se^{6+} 0·97	Br^{7+} 0·98
Rb^+ 0·99	Sr^{2+} 1·01	Y^{3+} 1·03		Zr^{4+} 0·96	Nb^{5+} 0·93	Mo^{6+} 0·92	Tc^{7+} 0·85
Ag^+ 0·59	Cd^{2+} 0·725	In^{3+} 0·80		Sn^{4+} 0·86	Sb^{5+} 0·88	Te^{6+} 0·91	I^{7+} 0·93
Cs^+ 1·00	Ba^{2+} 1·04	La^{3+} 0·99	Lu^{3+} 1·14	Hf^{4+} 1·06	Ta^{5+} 1·04	W^{6+} 1·02	Re^{7+} 1·00
Au^+ 0·46	Hg^{2+} 0·61	Tl^{3+} 0·70		Pb^{4+} 0·75	Bi^{5+} 0·81	Po^{6+} (0·86)	At^{7+} (0·90)
	Ra^{2+} 1·00			Th^{4+} 0·98			

Some ionization potentials are not accurately known (for example, the sixth of tungsten, the seventh of rhenium, astatine, manganese as well as a few others), but their magnitudes are apparently reliable and serve satisfactorily to reveal the main regularities of Fig. 1.

It should be recalled that the radii of Li^+, Na^+, K^+, Rb^+, Cs^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Y^{3+}, and La^{3+}, are virtually identical with those which may be obtained from internuclear distance measurements in dominantly ionic crystals, and that the others may be derived from them either by calculation[1] or from smooth extrapolations[2]. Thus, although the absolute magnitudes of the radii considered here may not have significance other than for investigations on ionic crystals, it is believed that their relative radii are usually accurately known, and this fact may well be of physical significance. A systematic increase of, say, 50 per cent in all the radii would in no way affect the general regularities which have been noted here (Fig. 1).

Discussion in this communication has been restricted to a suggested definition and measure of shielding efficiency; but its possible significance for determining a variety of physical and chemical properties of elements and their compounds will be discussed elsewhere, together with a detailed account of periodic variations between r, I and Z. The significance of ionization potentials in some of these respects has been noted[2-4]. Some examples of properties which might be determined at least in part by shielding efficiency and which will be considered are: atomic volume, metallic properties of manganese as compared with chlorine and bromine as gases, refractive indices and melting points of ionic compounds, structures of metal – non-metal compounds which have low co-ordination, ability of cations to form complexes in solution and the stability of such complexes, stability of bonds in general, heats of hydration, behaviour of cations in fractionated silicate melts, etc. [May 20.

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LETTERS TO THE EDITORS

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Longitudinal Distribution of Organic Components of Bone

Previous workers[1] have published results on the variation of nitrogen, collagen and phenolic material along long bones. The variation has now been determined of nitrogen, hydroxyproline, tyrosine, hexose and glycogen.

The femur of a freshly killed eighteen months old male goat was sawn into sections as indicated in Fig. 1 and the epiphyseal plates dissected out. The trabecular sections were sampled well away from the periphery of the bone, freed from blood by washing in a high-pressure water jet and from fat by 48 hr. ether extraction. The shaft sections were well scraped inside and out after the marrow had been scooped out. Ether extraction was unnecessary as the shaft bone contained an insignificant amount of ether-extractable material. The sections were crushed to finer than 100-mesh in a steel hammer mill. All results are in mgm./gm. dry weight, moisture being determined by heating to 105° for 16 hr. and weighing after cooling in a desiccator.

Hexose was determined by a modification of Morris's anthrone method[2]. Bone powder containing 50–100 μgm. equivalent of galactose was weighed and transferred to a 24 mm. × 150 mm. test-tube. 2 ml. of water and 4 ml. freshly prepared anthrone reagent were added, the latter from a broad-tipped pipette. The tube was shaken and stood in a 95° water-bath for 15 min. After cooling and centrifuging, the supernatant was read against a standard galactose solution at 620 mμ. Duplicates agreed to within 2 per cent and recovery of added glucose, galactose or mannose was 98–101 per cent. Glucuronelactone, glucosamine and an artificial gelatin hydrolysate even in concentrations much higher than those occurring in bone neither gave any colour nor did they affect the colour given by hexose. Tryptophan gives a colour with anthrone[3] but is only present in collagen in negligible amount[4]. 100 μgm. galactose or mannose gave a colour density equal to that given by 55 μgm. glucose. In view of the isolation of a galactose–mannose containing polysaccharide from bone[5], results are given as galactose equivalents.

For determination of glycogen, 0·1–0·5 gm. bone was shaken with 5 ml. 30 per cent potassium hydroxide in a 95° water-bath for 1½ hr., making up to volume occasionally with water. The freed glycogen was precipitated and determined essentially as described by Ellis *et al.*[6]. Recovery of glycogen added to bone powder was 85 per cent. Results have been corrected to allow for this.

Hydroxyproline, tyrosine and nitrogen were determined on 6 *N* hydrochloric acid hydrolysates (48 hr., 105°), the acid being removed by repeated evaporation to dryness in a vacuum desiccator. Hydroxyproline was determined by the method of Neumann and Logan[7], tyrosine by that of Udenfriend and Cooper[8] and nitrogen by a micro-Nessler method[9].

The general level of organic components is low in the shaft, rising toward the epiphyses. Collagen and total nitrogen were found to have this type of distribution by previous workers[1]. The galactose curve suggests that non-chondroitin-like polysaccharide material is present, the amount of which is markedly high in the epiphyseal plate. Glycogen varies in a similar manner but at a far lower level. No chemically determined figures for bone glycogen have come to my notice except those of Leynse[10] on rabbit, rat and cat long bones. His results are higher than these, but were obtained on very young animals. Glock[11], using a histological method, finds the glycogen content of rat long bones to decrease sharply with age after the tenth day, becoming about 0·5 mgm./gm. after the fortieth day.

The hydroxyproline curve gives a measure of collagen content probably more significant than previous results based on autoclave soluble-nitrogen determination. The epiphyseal plates do not have a markedly different hydroxyproline content from the other epiphyseal and metaphyseal sections. The nitrogen/hydroxyproline curve suggests the presence of relatively high amounts of non-collagen protein in the epiphyseal plates and proximal metaphyseal trabeculæ. It must be borne in mind that material similar to the alkali-soluble collagen precursor

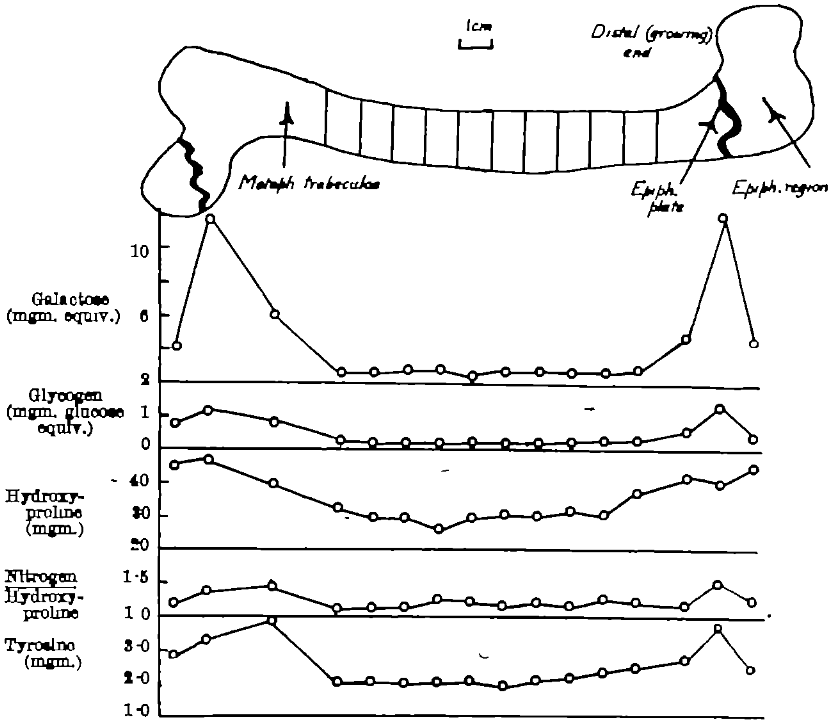

Fig. 1. Longitudinal distribution of organic components in goat femur. Values are in mgm./gm. dry bone powder. Galactose equivalent values do not include glycogen

extractable from skin is very possibly present in relatively high amounts in the metabolically active epiphyseal and metaphyseal areas. As this has a rather higher hydroxyproline and rather lower tyrosine content than collagen as a whole[12], its presence would tend to obscure the contribution of non-collagenous protein, high in tyrosine and without significant hydroxyproline to those areas.

Determination of phenolic material by the Folin–Ciocalteau method[10], on the above and other bones, gave tyrosine equivalents up to 30 per cent higher than those obtained using the more specific method for tyrosine of Udenfriend and Cooper. Thus the presence of small amounts of non-tyrosine phenolic material is indicated.

The results are in general agreement with a previous less-detailed series of determinations carried out on an eighteen months goat ulna.

I thank Dr. J. Eastoe, Dr. H. J. Rogers and Dr. T. F. Dixon for discussing this work with me, and the latter also for suggesting its subject. I also thank Mrs. N. Mendlesohn for the nitrogen determinations.

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Maternal Effect on Birth Weight in South Devon × Dexter Cattle Crosses

In reciprocal crosses between the Shire horse and Shetland pony, representing respectively extremes in large and small breeds, Walton and Hammond[1] demonstrated that the size of the offspring at birth and the placental weight are directly proportional to the size of the dam, and not simply intermediate between the sizes of the parent breeds. Hammond[2] postulated that the limitation of size in the cross-bred fœtus carried in the small mother is possibly brought about by a higher rate of metabolism of maternal tissues, as compared with a lower rate in the large breed. Otherwise, it was argued, special growth substances of maternal origin may be involved.

This approach to the study of factors controlling birth-weight has been followed up with various other types of mammals[3-5]; but the conclusive results obtained from the equine crosses were not achieved. It seems, therefore, that certain factors are responsible for the manifestation of a decided maternal influence, of which the length of gestation and the extent of the differences between the two parent breeds are perhaps the most important. In multiparous animals, furthermore, the maternal influence may be obscured by variations in litter size.

Though in cattle it is not possible to obtain breed differences as great as those available in the horse, we possess an animal with a long gestation period which should promote expression of a maternal effect, if present at all. Observations made during cross-breeding experiments between Holstein-Friesian and Jersey cattle at Beltsville, United States[6], however, revealed no significant differences between either of the reciprocal cross-bred offspring, or the mean of the birth-weight averages for the parent breeds. On the other hand, results of experiments in progress in South Africa[7], where Afrikaner (cows averaging 1,002 lb.) and N'guni (cows averaging 740 lb.) cattle are reciprocally crossed, provide at least some evidence of such an influence.

To gain further information on this subject in the bovine, three South Devon heifers were inseminated with deep-frozen Dexter semen, and three Dexter females similarly with semen from a South Devon bull. The difference in size between these two breeds can be judged from the illustrations, reproduced to scale, shown in Fig. 1 (*a*). Following conception, the animals received routine farm treatment, but were brought under shelter a few days prior to calving to make possible close observation. As soon as the calves were sufficiently dry after birth, weights and body measurements were recorded, while photographs were taken within twenty-four hours post-partum. The results obtained are summarized in the accompanying table; differences in size between the reciprocal crossbred calves at birth are illustrated by the scale photographs shown in Fig. 1 (*b*).

	Calves out of: South Devon dams	Dexter dams	Difference
No of observations	3	3	—
Age of dams at calving (months)	35·7	42·0	6·3
Gestation period (days)	290·3	278·0	12·3
Weight of dams, pre-partum (lb.)	1158·7	614·0	544·7
Weight of dams, post-partum (lb.)	1031·7	535·3	496·4
Weight lost (lb.)	127·0	78·7	48·3
Weight of calves at birth (lb.)	72·0	57·5	14·5
Weight of placenta (lb.)*	10·6	3·2	7·4

* Two observations only for each group

The South Devons, all three maiden heifers, consisted of a fairly homogeneous group regarding both size and breeding, and calved at much the same age. Though also closely related, only two of the Dexter females were first calvers, the third being an older cow with two previous pregnancies. Differences in age within the latter group also accounted for a larger variation in weight. The mothers were all weighed within a day or two before calving, as soon as signs of parturition became apparent. The post-partum weight was recorded within forty-eight hours following calving. This latter figure, in particular, serves as an indication of differences in size between the two parent breeds, namely, the larger breed was nearly twice the size of the smaller.

The mean birth-weight for the calves out of South Devon mothers truly reflects the range encountered. Considering 94·5 lb. as a reliable birth-weight for pure-bred South Devon calves (out of first-calf mothers[8]), it is clear that the size of the cross-

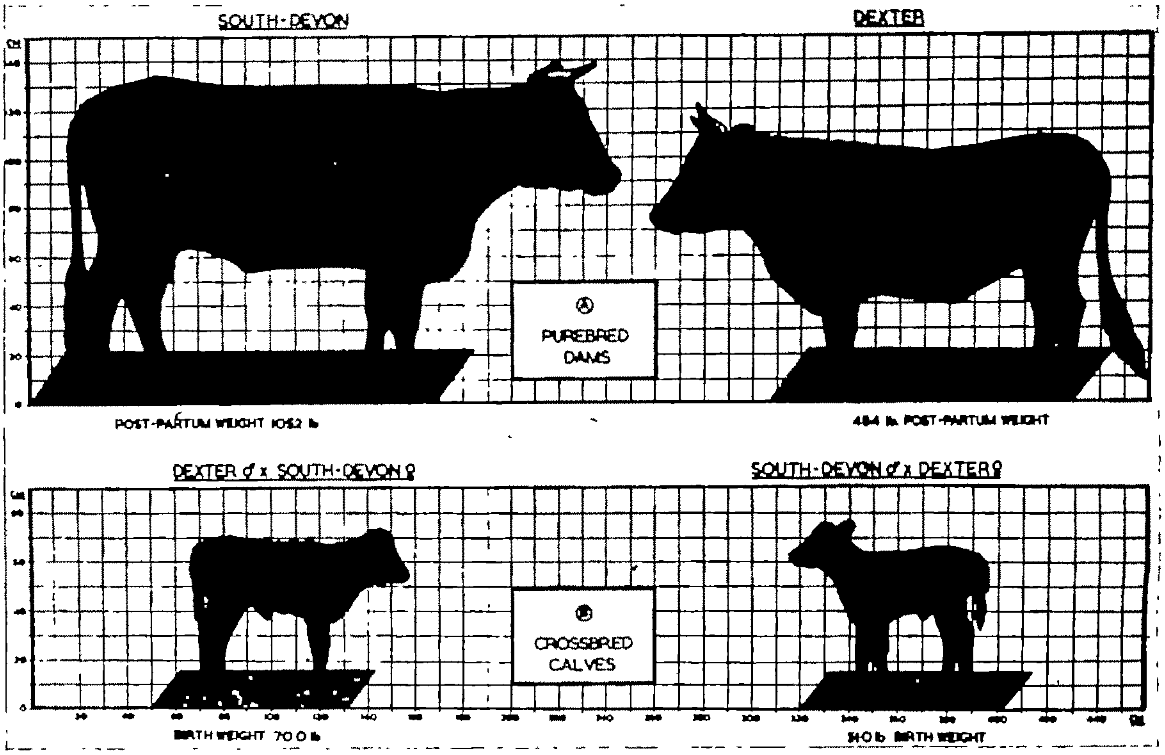

Fig 1

bred offspring, though failing to attain the pure-bred weight, was favourably influenced by the larger uterine environment. The rather prolonged gestation, compared with that of their reciprocal crosses, also indicates that there was a decided effort to reach maximum size at birth, especially in view of the fact that parturition normally occurs at a time when the fœtus approaches a size characteristic of the species and is still able to pass through the genital passage.

The cross-bred calves out of Dexter mothers were larger (57·5 lb.) on an average than the Dexter breed mean of 52·3 lb.; but the effect of restricted uterine space nevertheless is apparent. The average value, though probably a true reflexion, is, however, composed of a rather wide variation ranging from 40·5 to 81·0 lb. The smaller calf was produced by a small (352 lb.) two-year-old heifer, in fact too small to deliver a calf even of that size. Though the small dam severely limited overall size of the fœtus, the early maturing fœtal head had much the same proportions as that of a calf 12–15 lb. larger, which made a normal parturition impossible. The large birth-weight of the latter individual may be explained by the more advanced age (6 yr.) and greater size (770 lb.) of the mother. Furthermore, the mother had the advantage of abundant early summer grazing during late pregnancy which was not available to any of the other cows included in the study.

Expressing the birth-weight of the calf as a percentage of the weight lost during parturition, striking differences are revealed. Calves out of South Devon dams constituted 56·7 per cent of the total loss, compared with 73·1 per cent for calves out of Dexter dams. Hence, in the event of a restricted uterine environment, the fœtus receives preference over development of accessory tissues and fluids, rather similar to the effect of a low nutritional plane[9]. This fact was substantiated by the placental weights. Not only is the placenta smaller in absolute measure in the case of the small calf, but it is also relatively smaller. The placenta expressed as a percentage of the birth-weight equals 14·5 and 7·1 per cent respectively for the large and small reciprocal crosses.

When mating a large bull to a small cow, provided the mother is normally developed for her age, the results indicate that the smaller maternal environment should restrict fœtal size sufficiently for parturition to be possible. On the other hand, in the case of an inter-breed crossing in which the mother is the larger parent, she will exercise a beneficial influence on the offspring, at least so far as size at birth is concerned. It is hoped that the investigation may be continued to study post-natal growth to determine whether this advantage is still manifested during later life.

Our thanks are due to Mr. L. E. Rowson, Agricultural Research Council Unit of Reproduction, for performing the inseminations and for veterinary attention, and also to Mr. G. Pluck and staff members of the Animal Research Station, Cambridge, for assistance with the experimental animals.

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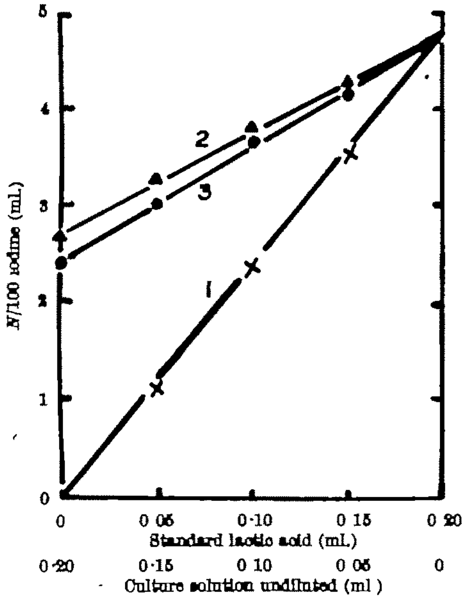
Determination of Lactic Acid in Cultures of Lactobacilli

THE technique of Barker and Summerson[1] for the determination of lactic acid in blood has been successfully applied to the determination of this acid in silage[2,3] and in milk[4]. During the course of work which is being carried out jointly in these laboratories and in those of the Department of Bacteriology, Edinburgh and East of Scotland College of Agriculture, on the formation of lactic acid and volatile fatty acids in cultures of lactobacilli, it became clear that the results obtained by the above technique were unsatisfactory. For example, extremely high 'blanks' were given by the culture medium itself, and it was found impossible to obtain replicate results with samples of the same cultures. Various dilutions of the uninoculated medium were tried and it was found that even at high dilution substantial development of colour occurred. This was originally thought to be due to the high glucose content of the medium (5 per cent w/v); but, again at high dilution, this seemed unlikely. The possible answer may lie in factors involved in the yeast extract incorporated to the extent of 0·5 per cent w/v in the medium.

Recourse was made to the method of Long[5], which has been found to be wholly satisfactory for the present purpose. The method as used here is as described in the original paper, except that 0·1–0·2 ml. of culture fluid is introduced into the thistle funnel of the apparatus and is washed into the distillation tube with 4 ml. of water. Where very large amounts of lactic acid are present, it is advisable to dilute an aliquot of the culture by 10 and to use 0·2 ml. of the diluted fraction. From recovery experiments (Fig. 1) it would appear that material containing considerably larger quantities of lactic acid than those suggested by Long may be successfully handled. The general run of all experiments has indicated a recovery of lactic acid varying between the limits of 95·5 and 103 per cent.



1 ml. N/100 iodine = 0·45 mgm. lactic acid

Fig. 1. Recovery of lactic acid: (1) from 0–0 20 ml. of standard (1·20 gm. of acidified lithium lactate/100 ml.); (2) from mixtures of lactate standard and added amounts of culture of lactobacillus (homofermentative strain at 30° for 12 hr.); (3) as in (2), using a heterofermentative strain grown at 45° for 72 hr

A full account of the results obtained in the study of acid formation in cultures of lactobacilli will be published elsewhere.

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Interference and Cell Protection by Poliomyelitis Virus in Tissue Culture

RECIPROCAL interference between strains of the three recognized types of poliomyelitis virus has been reported by Ledinko[1], using roller-tube cultures of monkey testicular tissue. In her experiments, both the 'interfering' and the 'excluded' virus were fully cytopathogenic, and there was no suggestion of any mutual inhibition of their degenerative effects on the cells. Prevention of growth of the second virus, as shown by titration in the presence of type-specific antiserum against the first, was apparently the result of pre-emptive infection and subsequent destruction of susceptible cells by the first virus. The purpose of this communication is to describe a further example of interference among poliomyelitis viruses, in which a more direct recognition of the effect was made possible by the peculiar cytopathogenic behaviour of the interfering virus.

Roller-tube cultures of rhesus monkey kidney were used. Pieces of minced tissue, about 1 mm. in diameter, were stuck to the glass with a thin plasma clot and grown in 2 ml. of a medium consisting of the synthetic mixture 199 [2] with 5 per cent of heated horse serum and 1 per cent of chick embryo extract. After eight days, most of the explants had produced an epithelial-cell outgrowth of about 5 mm. radius. At this time the medium was replaced by 2 ml. of mixture 199 and the cultures were ready for infection.

During the second and third passage in such cultures of the newborn mouse-'adapted' MEF_1 strain of Type 2 poliomyelitis virus[3], a characteristic picture was seen by the fifth day after inoculation: most of the affected cells were already in advanced decay and coming off the glass; yet around each explant there remained an island—1–2 mm. in radius—of healthy looking cells. The edge of these islands was quite sharply defined and picked out by a 'tide-mark' of degenerating cells and cell debris, as shown in the accompanying photograph. Slowly, the more outlying cells became increasingly granular, and degeneration progressed towards the explant. Finally, between two and three weeks after infection of the culture, the explant disintegrated and its dependent sheet broke up into individual cells, which before long were destroyed.

Cultures infected five days earlier with approximately a hundred cytopathogenic doses (TCD_{50}) of third-kidney-passage MEF_1 virus were re-inoculated, after renewal of the medium, with 100 TCD_{50} of either Mahoney (Type 1), *Y-SK*, *MIN* (both Type 2) or Saukett (Type 3) strains of poliomyelitis virus, all producing rapid and complete degeneration of outgrowth and explant in cultures of monkey kidney. A cytopathogenic strain of Coxsackie virus was also

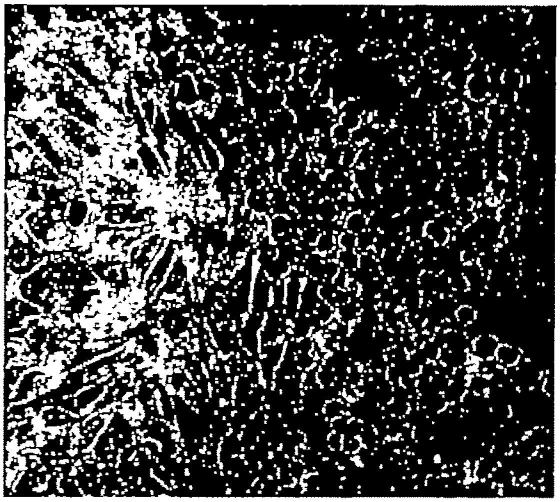

Fig. 1. Culture of monkey kidney five days after infection with MEF_1 virus. (The ocular was × 10, the objective × 5.) The explant is out of the picture to the left. Photograph taken by Mr. W. Clifford

tested. Similar cultures, but uninfected with MEF_1 virus, were inoculated as controls.

Within the first two days after superinfection, no obvious change was noted in the cell-islands, whereas the control cultures had by then almost completely degenerated. Thereafter, marginal degeneration of the islands began again and proceeded as in the MEF_1 controls, or more rapidly. It was clear, however, that those cells which had weathered the initial MEF_1 attack had been temporarily spared from the destructive action of the other four strains of poliomyelitis virus and the strain of Coxsackie virus.

Sabin, Winsser and Hennessen[4] reported that large doses of MEF_1 virus of the 134th baby-mouse passage produced no degeneration in cultures of cynomolgus monkey kidney, but that several blind passages yielded cytopathogenic virus. Lines of low or absent, and of high, cytopathogenicity have since been separated (Sabin, personal communication) and it has been found possible to titrate the first virus thanks to its blocking of the degeneration produced by the second.

In previously reported examples of interference between animal viruses in tissue culture, the demonstration of an interfering effect has depended on subtitrations of the second virus either in animals or in further tissue cultures. The observations of Sabin and his colleagues and those now reported are concerned with the direct, microscopic detection of virus interference, as seen in the exposed cells. To these cells the first virus, having forestalled the second, has given a definite, if transient, protection by virtue of its presence and activity at the surface or in the interior of the cell, or by some other means unknown.

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Biogenesis of Hyoscyamine

THE biogenetic origin of the tropane bases has recently been the subject of some discussion[1,2], Mortimer[1] suggesting that the tropane skeleton may be derived from the breakdown products of tryptophan metabolism. This novel idea is contrary to the accepted hypothesis that a base such as tropine is produced *in vivo* by reactions analogous to the *in vitro* synthesis[3] of tropinone from succindialdehyde, methylamine and acetone. The succindialdehyde is considered to be a metabolite of ornithine, and James[4] showed that significant increases in the amount of hyoscyamine in *Atropa belladonna* occurred following the feeding of arginine or ornithine.

We have tested this hypothesis by feeding radioactive ornithine to mature *Datura stramonium* plants which produce hyoscyamine and hyoscine. [α-^{14}C]-Ornithine hydrochloride with an activity of $4 \cdot 8 \times 10^{7}$ disintegrations/min./m*M* was administered to the plants by addition to the aerated nutrient solution in which the roots were growing. After a week, almost all the activity had disappeared from the nutrient solution and was translocated throughout the plant. The crude alkaloids were obtained from the dried plants by standard methods[5]. Paper chromatography of the alkaloids showed radioactivity to be present in the spot corresponding to hyoscyamine, but little or none to be present in that corresponding to hyoscine. The alkaloids were separated on a 'Celite' column[6] yielding pure hyoscyamine aurichloride with a specific activity of $1 \cdot 08 \times 10^{6}$ disintegrations/min./m*M*. The hyoscine obtained from the column was inactive. The radioactive hyoscyamine was degraded to locate the positions of activity. Alkaline hydrolysis gave active tropine and inactive tropic acid. Oxidation of the tropine with a mixture of chromic and sulphuric acid[7,8] gave N-methyl-succinimide, which had the same specific activity as the hyoscyamine. Reaction of the imide with phenyl magnesium bromide according to the procedure of Lukeš and Prelog[9] gave 1-methyl-2,5-diphenylpyrrole, which was oxidized with aqueous potassium permanganate to give a mixture of inactive oxalic acid (from the β-carbons of the pyrrole) and benzoic acid which had a specific activity half that of the hyoscyamine. This indicated that all the activity in the hyoscyamine was present in the bridge-head carbons (1 and 5) of the tropine. It thus follows that ornithine is indeed the precursor of the pyrrolidine ring of tropine and renders very improbable the speculations of Mortimer[1].

Previous work in these laboratories[5] has shown that [1,4-^{14}C]-putrescine when fed to *D. stramonium* at a stage of growth corresponding to that in the present experiments did not give rise to radioactive hyoscyamine. Putrescine is thus apparently ruled out as an intermediate between ornithine and tropine, and its presence in various plants would seem to represent an alternative pathway of ornithine metabolism. The work of James[10] with enzyme extracts of belladonna indicates that α-keto δ-amino-valeric acid is a probable intermediate in the synthesis of tropine, the δ-nitrogen of this acid becoming the tropine nitrogen. Thus the present experiment with [α-^{14}C]-ornithine would be expected to yield tropine labelled on only one of the bridge-head carbons; however, the symmetry of the molecule renders it impossible to differentiate between the two bridge-head carbons by chemical methods.

Since no activity was found in the hyoscine, it would seem that tropine is not a precursor of scopine. It is possible that it is produced from a hypothetical hydroxy-ornithine which could conceivably be obtained from hydroxyproline.

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Electrophoretic Migration of Contents of Intact Liver Nuclei

During attempts to separate rat liver nuclei from fragments of cell membrane by electrophoresis, we have observed movement of the nuclear contents, the nuclei remaining stationary.

The nuclei were obtained by homogenization of fresh rat liver in a glass tube with stainless steel non-rotating conical plunger. The suspending fluid was either 0·29 *M* sucrose or 3·3 *M* glycerol, with the addition of 0·01 *M* sodium chloride or of 0·001 *M* calcium chloride; in the latter case the free calcium concentration was theoretically maintained at this value by the addition of 0·0025 *M* dipotassium salt and 0·0075 *M* potassium calcium salt of nitrilotriacetic acid. The *p*H was adjusted to 6·9, or, in a few cases, to 8·0, with 0·003 *M* barbitone buffer. The nuclei were partially freed of whole cells and mitochondria by centrifugation, and then observed in a modified Abramson[1] micro-electrophoresis cell, under a phase-contrast microscope.

When potential gradients of 10 V./cm. and above were applied, the nuclei remained stationary; but the nuclear contents, including the nucleoli, moved to the side of the nuclei towards the anode (Fig. 1). This produced a half-dark, half-light appearance of the nucleus, called for convenience an 'eclipse'. If after a few seconds the current was switched off, the contents flowed back to their original position, and the normal appearance was restored. However, after several repetitions of this procedure with higher potential gradients (50 V./cm.) the 'eclipses' became irreversible and persisted on switching off the current; this irreversibility was sometimes accompanied by shrinkage and appearance of granularity in the nuclei. The 'eclipses' were seen at *p*H 6·9 and 8·0, and at both *p*H's and in all the media used red cells and bacteria moved immediately and rapidly towards the anode and cathode respectively, and stopped directly the current was switched off.

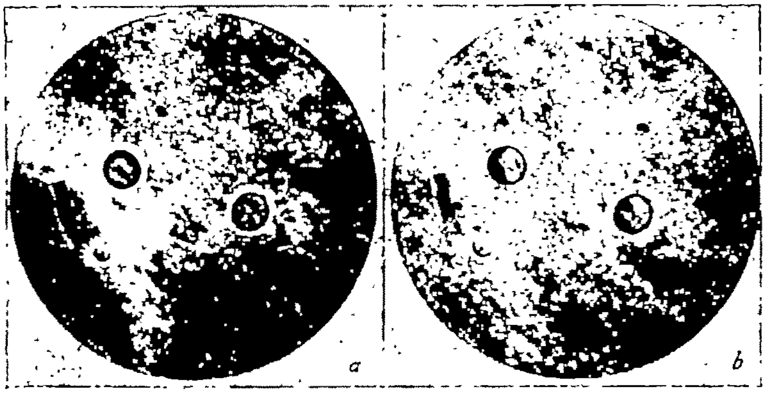

Fig. 1. (*a*) Liver nuclei. (*b*) The same under potential gradient of 38 V./cm. Note anodic migration of nuclear contents including nucleoli. The anode is on the left

An attempt was made to increase the net negative charge on the nucleus as a whole, and so to make it move, by addition of potassium polymethacrylate to a final concentration of 0·0002 *M* (about a fifth of the concentration required to release nucleic acid from combination with histone). There was some suggestion that in this medium 'eclipses' were formed less readily, and that the nuclei moved slowly towards the anode. However, the results were not clear-cut.

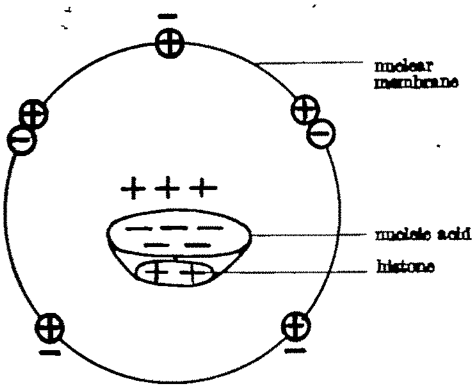

Fig. 2. Diagrammatic interpretation of electrophoretic behaviour of nucleus

An interpretation of the 'eclipse' phenomenon is expressed crudely in Fig. 2. The plus and minus signs represent ions, of which the encircled ones are imprisoned either inside the nucleus or on the nuclear membrane, whereas the unencircled ones can move freely through the nucleus and its membrane. The imprisoned ions are shown predominantly negative within the nucleus and positive on the membrane, the totals being equal, in order to explain the non-migration of the whole nucleus and the anodic migration of the contents. The net negativity of the contents could be due to a slight predominance of nucleic acid over histone in the nucleoprotein, whereas the unused histone might perhaps be responsible for the net positivity of the membrane.

The above experiment shows that the contents of reasonably undamaged resting nuclei have a high electrophoretic mobility, and is of interest in connexion with the question whether movement of chromosomes during anaphase can be electrophoretic. The potential difference maintained by us between opposite poles of the nucleus was of the order of 10 mV., and caused the contents to pile up against the membrane in a few seconds. Chromosome migration is slower than this, and the potential difference needed for it should be easily maintainable biologically.

We wish to thank Miss B. Hunt for assistance, the Bersworth Chemical Co. for a gift of nitrilotriacetic acid and Dr. P. Alexander for a gift of polymethacrylic acid.

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Participation of Pyridoxal Phosphate in the Enzymic Synthesis of Serine

Evidence that pyridoxal phosphate is involved in the synthesis of serine by micro-organisms has been provided by Lascelles and Woods[1], who found that incorporation of pyridoxal phosphate in the medium stimulated serine synthesis by washed cells of *Streptococcus faecalis* R. and enabled *Leuconostoc mesenteroides* to grow in the presence of glycine and a CO_2-rich atmosphere instead of serine. Participation of pyridoxal phosphate in serine synthesis in chickens was suggested by the observation that liver extracts from pyridoxine-deficient chickens showed a reduced ability to incorporate [^{14}C]formate into the β-position of serine[2]; but hitherto attempts to demonstrate a direct activation by pyridoxal phosphate of serine synthesis by liver extracts have been unsuccessful[3].

The role of pyridoxal phosphate in serine synthesis has been further studied with an enzyme preparation which was extracted from acetone-dried rabbit liver powder and partially purified by heat treatment and ammonium sulphate fractionation at pH 7·5. The enzyme was incubated with glycine, formaldehyde, tetrahydropteroyl glutamic acid (tetrahydroPGA) and bicarbonate buffer, pH 7·2, at 37° for 1 hr. Serine was determined by manometric estimation of the carbon dioxide produced by periodate oxidation. A control in which tetrahydroPGA was omitted provided an adequate correction for small amounts of carbon dioxide produced by periodate oxidation of material other than serine.

Addition of pyridoxal phosphate to the otherwise complete system appreciably increased the rate of serine synthesis, increments of more than 100 per cent being sometimes obtained in the presence of 5×10^{-4} M pyridoxal phosphate. Although added pyridoxal phosphate consistently increased serine synthesis by these enzyme preparations, they nevertheless exhibited considerable activity in the absence of added pyridoxal phosphate. Prolonged dialysis, even after subjecting the enzyme to high salt concentrations at temperatures up to 60°, did not significantly reduce the activity in absence of added pyridoxal phosphate, provided the pH was kept within the limits 5·0–7·5. After the enzyme had been incubated for 30 min. at pH 8·6 and 37°, however, it was almost inactive for serine synthesis. An enzyme preparation so treated could be largely reactivated for serine synthesis by incubation with pyridoxal phosphate at pH 7·2 and at 37° prior to addition of substrates. The degree of reactivation increased as the period of incubation of the enzyme with pyridoxal phosphate was increased up to 2 hr. Under these conditions serine synthesis with the pyridoxal phosphate-reactivated enzyme was up to one hundred times greater than that with the inactivated enzyme.

Similar though less striking effects of pyridoxal phosphate on serine breakdown were also observed, both with normal and inactivated enzyme preparations. The reaction was in this case followed by measuring formaldehyde produced by the enzyme from DL-serine[4].

A more detailed report of this work will be published elsewhere.

I wish to thank Prof. A. H. Ennor for helpful advice and Mr. T. Curtis for technical assistance. I am indebted to Dr. A. L. Morrison of Roche Products for a gift of crystalline pyridoxal phosphate.

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The Precursor of 2-Carboxy-Pyrrole in Mucoproteins

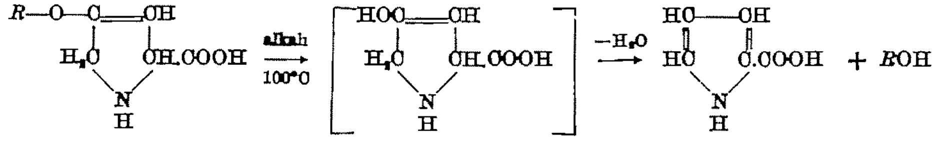
We have previously reported[1] the isolation of a pyrrole derivative from the alkaline hydrolysate of bovine submaxillary gland mucoprotein and its identification as 2-carboxy-pyrrole (III). On reduction it yielded 2-carboxy-pyrrolidine (proline), chromatographically it showed the same behaviour as synthetic III, and it gave in the cold a purple colour with Ehrlich's reagent. Recently, the ultra-violet absorption spectra of both the substance prepared from mucoprotein and synthetic III were found to be identical.

The presence of about 4 per cent of the Ehrlich-reacting substance in the mucoprotein together with the high molecular extinction coefficient of III ($\epsilon_{max.}$ 256 mμ = 11,118 in phosphate buffer pH 7·0, ionic strength 0·05) prompted us to carry out a spectroscopical analysis of the untreated mucoprotein. Contrary to expectation, no peak at 256 mμ was exhibited, though admixture of III corresponding to 2·6 per cent of the dry weight of the mucoprotein present gave rise to an easily detectable peak at 256 mμ.

Like many other mucoproteins, the bovine submaxillary gland mucoprotein inhibits influenza virus hæmagglutination. Interaction between inhibitory mucoproteins and purified influenza virus (or the receptor-destroying enzyme of *Vibrio cholerae*) was shown[2] to result in the liberation of a dialysable compound consisting of a non-amino sugar and a nitrogenous component. The compound decomposed on treatment with dilute mineral acid. It coupled with p-dimethylaminobenzaldehyde to give a purple colour even after prolonged treatment with alkali, though alkali treatment was not necessary for colour formation[3]. These properties strongly suggested the identity of the colour-producing component with III which we had isolated previously from the substrate for the viral enzyme or for receptor-destroying enzyme. When the compound split off from the purified bovine submaxillary gland mucoprotein by action of receptor-destroying enzyme was analysed spectroscopically, no indication for the presence of III was obtained. Upon treatment of the split product with $0 \cdot 1 N$ sodium carbonate for 10 min. at 100° C., however, an ultra-violet absorption spectrum became apparent practically coinciding with that of synthetic III. Paper partition chromatography of the alkali-treated split product confirmed the presence of III.

It would thus appear that mucoproteins contain an amino-acid which on very mild alkali treatment is readily transformed into III. The possibility that one of the following compounds, glutamine, 2-carboxy-pyrrolidone, 2-carboxy-pyrrolidine, 4-hydroxy-2-carboxy-pyrrolidine (hydroxy-proline), N-acetyl-glucosamine, may be the precursor was examined, but in each case with negative result.

We conclude from these data that the most probable structure of the precursor of III in the biological material tested is 4-hydroxy-2-carboxy-pyrroline (II), stabilized by the engagement of its enolic hydroxyl group in a glycosidic linkage apparently with a pentose (I). The glycosides of enols easily yield to alkali hydrolysis; therefore, mild alkali treatment of I will release II which, being unstable, instantaneously becomes stabilized to III by a shift of the double bond and loss of 1 mol. H_2O.



(I) (II) (III)

It seems probable that neuraminic acid ($C_{16}H_{13}O_8N$) prepared by Klenk[4] as its methoxy derivative from bovine submaxillary gland mucin is identical with I ($C_{10}H_{15}O_7N.2H_2O$), and that sialic acid[5] and *lactaminsaure*[6] are closely related to I. On the other hand, Hiyama's[7] claim that a crop of 2-carboxy-pyrrole crystals may be obtained by treating the mucoprotein primarily with 10 per cent potassium hydroxide at 100° C. for 10 hr. could not be substantiated in our laboratory, nor is his interpretation of the origin of III consistent with the above observations.

Details of these results will be published elsewhere.

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Effect of Ephedrine on Dark Vision

THE effect of drugs on night vision and dark adaptation is a problem of both theoretical and practical importance which has already received a good deal of attention, particularly during the Second World War. Of the various drugs the effects of which have been investigated systematically, ephedrine has apparently featured in only one experiment, namely, that of Rose and Schmidt[1]. These authors report no significant effect on dark adaptation. Further studies on the influence of ephedrine and other sympathicomimetic drugs are particularly desirable in view of the claims of Babskii[2], Kekcheyev[3] and their associates that the sympathetic nervous system exerts an 'adaptive influence' on the visual analyser, and of recent research at the Institute of Psychiatry which suggests that the impaired dark vision of neurotic patients may be due to sympathetic over-activity. To obtain further information on this point, an experiment was undertaken with four subjects using a test of night visual ability which had previously been shown in several studies to differentiate normal from neurotic groups.

This test involves recognition of the position of a triangular test object against a circular, uniformly illuminated, field subtending about four degrees. Threshold judgments, expressed in grades of brightness, are obtained at four times—three, five, seven and ten minutes—after dark adaptation begins. The criterion of 'success' at a particular level of brightness is two consecutive correct judgments. Although the test makes demands on the subject's dark adaptation, it is more accurately termed a test of visual ability under conditions of low illumination, for it involves factors other than mere light sensitivity.

A four-by-four Latin square design was employed for the experiment, each subject receiving one of four 'treatments' on each of four consecutive days. Treatments were as follows: (1) control; (2) drug (dark vision being tested one hour after the subject had received the drug); (3) drug 1 (test administered one and a half hours after receiving drug); (4) placebo. Ephedrine was given orally, each subject receiving 1 gr.

The resulting table of dark-vision grades for three, five, seven and ten minutes was submitted to analysis of variance to determine the relative effect of the various components, individuals, days and treatments. Results of this analysis show quite clearly that the drug treatment had no significant effect on dark-vision grades. The analysis of variance table for threshold measures at three minutes is reproduced herewith; tables for five, seven and ten minutes are essentially similar in general form. The mean dark-vision grade for control and placebo treatments was 27·65 compared with a mean of 28·34 for the two

Source of variance	Sums of squares	Degrees of freedom	Mean squares
Individuals	75·5	3	25·16
Days	5·5	3	1·83
Treatments	3·0	3	1·00
Residual	11·0	6	1·83
Total	95·0	15	

drug treatments. Day-to-day variation within individuals was not significant.

Taken in conjunction with the results of Rose and Schmidt's experiments on light thresholds, these findings cast[1] some doubt upon the validity of any general hypothesis concerning the positive or negative effect of sympathetic activity on dark vision. They do not, however, necessarily invalidate more specific types of hypothesis. Thus, it is conceivable that ephedrine would exert a significant effect on visual ability during the latter part of the adaptation period. Indeed, closer examination of Rose and Schmidt's results suggests a definite impairment of sensitivity from about 15–40 min. after the beginning of dark adaptation, even though there is no appreciable effect before that time. Although the deviations were not statistically significant according to the tests applied, the consistent trend during the 15–40 min. period points to the need for a repetition of their work and an extension of the present study to include the latter part of the adaptation curve. It is hoped to undertake these further studies as part of a general programme of research on visual and ocular processes in psychiatric patients.

I am indebted to Mr. A. S. C. Ehrenberg, Dr. J. G. Thorpe and Dr. D. S. Troughton for their helpful discussion when the experiment was planned. To Mr. Ehrenberg I am also grateful for the Latin square design.

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Maintenance *in vitro* of *Fasciola hepatica*

A necessary preliminary to a study of the physiology of helminths is their maintenance *in vitro*, a rare accomplishment. Some nematodes and a few cestodes have been maintained for some time with moderate success, and this is also true for certain small trematodes[1], but not for *Fasciola hepatica*. This common liver fluke of the sheep has so far lived *in vitro* only for short periods of about 60 hr. and never more than about three days. These were the best results of experiments[2] in which worms were taken from the livers of cattle or sheep which had been dead for 1–6 hr. and transported from the abattoir to the laboratory in cold bile. Batches of seven to nine worms were then immersed in 500 c.c. of various saline solutions and incubated at 37° C., solutions being changed after 16 hr. and after a further 24 hr. In my opinion, an over-elaborate series of experiments failed because the medium (which contained sodium borate) was unsuitable and the trematodes often moribund at the outset. "Many flukes," we are informed, "never moved in the laboratory except on strong stimulation", and results were collected on the basis of 50 per cent survival. More satisfactory methods of culture will serve to keep worms alive in a state of active movement, and such worms will retain the reddish colour and fleshy appearance which is normal to them.

My own experiments have convinced me that *Fasciola hepatica* will live in Stephenson's 'saline III' for about two days; but that at the end of this period they are in a dying condition. No better results are obtained when any one of several other salines are used as media; but Hédon–Fleig solution has given excellent results. This is a buffered, borate-free medium with the following composition: sodium chloride, 7·0 gm.; potassium chloride, 0·3 gm.; calcium chloride, 0·1 gm.; sodium bicarbonate, 1·5 gm.; disodium hydrogen phosphate, 0·5 gm.; magnesium sulphate, 0·3 gm.; glucose, 1·0 gm.; distilled water, 1,000 c.c. This medium is "very useful for any work on living cells of terrestrial or fresh water invertebrates"[3]. It has been used once before[4] for the culture of a trematode—*Aspidogaster conchicola*, a parasite of freshwater mussels of the genera *Anodonta* and *Unio*; but in this instance it proved to be inferior as a medium to mussel blood or even a crude mixture of the body liquids and the liquid abstracted from the viscera and mantle cavities of the hosts. If we believe that a certain close degree of compatibility exists between the tissues of trematodes and those of molluscs (in which larval trematodes develop), this saline medium is a logical choice, because it serves well for the culture of molluscan tissues.

Be this as it may, Hédon–Fleig solution is far superior to Stephenson's 'saline III' as a medium for *Fasciola hepatica*. Many preliminary experiments of mine have proved that the worms will continue to live in this liquid for more than three days and sometimes for five to six days without loss of movement or natural coloration. Clean methods were used in these experiments, and solutions were changed several times each day; but no attempt was made to obtain sterile cultures. The results have been confirmed by a pupil working under my direction, and a technique has been developed which avoids the contamination of the cultures with certain airborne bacteria which exert a lethal effect on the worms after three or more days, no matter how often solutions are changed.

This technique is briefly as follows. Hédon–Fleig solution is passed through a Gallenkamp filter using a 6 cm. Ford 'Sterimat' (grade *SB*) and a number of 25 c.c. portions are set up in sterile 3 in. × 1 in. tubes, plugged with cotton-wool and set in a water bath until required. Warm livers are brought to the laboratory in an insulated container. The surface of each liver is cleansed by swabs soaked in absolute alcohol and the liver is then placed in a small, 'Dettol'-sprayed chamber for dissection, which is carried out by means of sterile instruments. The extracted worms are placed separately in the portions of medium, which also contains a droplet of phenol red to indicate alkalinity. The tubed worms are then incubated at 37° C., with changes into fresh sterile medium as desired.

By this simple method it is possible to maintain *Fasciola hepatica* more or less normal in appearance and in a state of active movement for twelve days. So far, the worms have been killed by fixation at the end of this period, and there is a good prospect of keeping them in this state for fourteen days or longer. (Since this note was written, three isolated worms have been maintained in an active state for fourteen, fifteen and sixteen days respectively.) Moreover, it is now certain that worms can be obtained from excised livers of sheep in a sterile condition. Some failures are inevitable, but they are rare; in general, cultures remain sterile throughout. Whereas formerly[2] the conclusions drawn from physiological experiments with liver flukes maintained *in vitro* for only three days have been far from convincing, because for most of this period the worms were in a dying condition, the prospect is now much more satisfactory, because worms are often more lively after they have been maintained *in vitro* for more than a week than they were on the first day after their removal from the liver. From a nutritional point of view the medium used is very imperfect; but its enrichment holds further promise of extending the period of survival *in vitro* of *Fasciola hepatica*, and providing a sound basis for physiological experiments.

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Seasonal Regulation in British Dragonflies

It has long been recognized that the reproductive stages of different species of dragonflies tend to be restricted in incidence, each being characteristic of a given season. During the period 1950–53, the life-histories of several British species were studied with the view of determining the principal ecological factors responsible for their seasonal regulation.

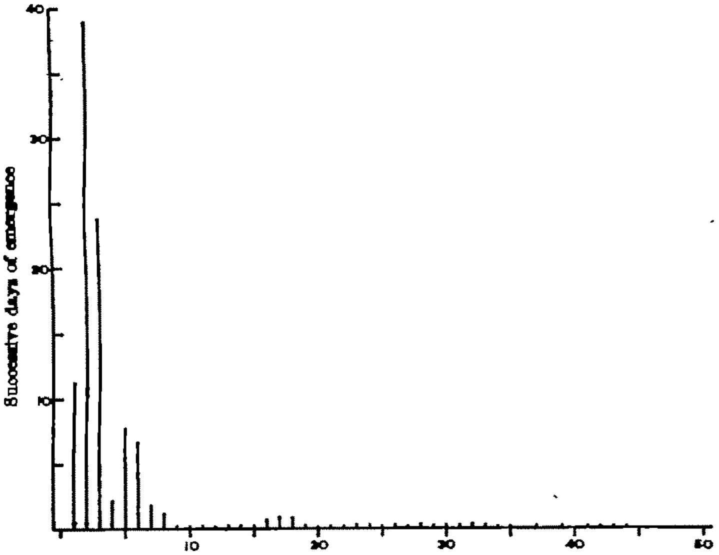

Fig. 1. Time-frequency distribution of adult emergences in a population of *Anax imperator* during 1953. Emergence began on May 25 and finished on July 7

In the Emperor dragonfly, *Anax imperator* Leach, it was found that, although larval populations showed a wide measure of temporal variation, yet emergence was restricted regularly to a period of about forty-five days each year, lying between mid-May and mid-July. The first fourteen days of adult life were spent away from water; after this, when sexually mature, adults returned to the aquatic habitat for reproduction. Oviposition extended from late June to early September. Adults did not survive the summer. The eggs hatched in about twenty-four days and larvæ were half-grown (c. 24 mm., instar 11) by October, after which low temperature prevented further development. In the following April growth was resumed, and the final larval instar (c. 50 mm., instar 15) was entered in August, approximately one year after hatching of the eggs. A diapause occurred in the final instar, and morphogenesis was suspended until diapause development had been completed in the autumn. This did not take place until the temperature had fallen below the threshold permitting metamorphosis. In this way it was assured that final instar larvæ embarked upon metamorphosis simultaneously, as soon as conditions became favourable in the spring. Thus, the temporal variation accumulated during the long period of larval development was effectively erased in the final instar. Eclosion, which directly succeeded metamorphosis, was closely synchronized, more than 90 per cent of the annual population of adults emerging within the first ten days of the emergence period (Fig. 1).

In this life-history the synchronization of emergence can be seen as a direct consequence of the diapause in the final larval instar. Recognition of this causal relationship means that species with a time-frequency pattern of emergence resembling that of *A. imperator* may be expected to feature diapause in the final instar and vice versa. This expectation has been confirmed in *Pyrrhosoma nymphula* (Sülzer)[1], the only other species of which the emergence curve is known throughout the flying season. Dragonflies typified by these two species have been termed 'spring' species, in contradistinction to 'summer' species in which a diapause, if present, is located elsewhere in the life-history. In summer species the final larval instar is usually entered in the year of emergence and, since growth is uninterrupted at this stage, larval variation finds expression in the emergence curve, which is temporally dispersed. Although not invariably the case, summer species usually emerge later in the year than spring species, since they have at least one extra instar to complete before commencing metamorphosis.

This ecological classification has been found to hold good throughout the British dragonflies, of which approximately half are spring and half are summer species. It corresponds with recognized taxonomic affinities at a generic level but shows departure when families are considered.

It is likely that the principles of this classification apply generally where there is a biological demand for rigorous seasonal regulation, and comparative treatment of other insect groups may throw an interesting light upon the colonization of temperate regions and upon the evolution of different types of life-history.

This work was financed by the Department of Scientific and Industrial Research, and is to be described more fully elsewhere.

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Direct Microscopy for Study and Count of Soil Protozoa

It is generally accepted that only direct microscopy is able to give a reliable estimate of the total numbers of micro-organisms present in soil. Suitable direct techniques have been developed for counting the bacteria, fungi[1] and algae[2]. No adequate technique is available for the protozoa. A recently developed culture technique[3] is a considerable improvement, but tends to be selective and is time-consuming in operation.

The direct examination of protozoa in soil has been made difficult by their low numbers and by the lack of a suitable differential staining technique. The following method overcomes these difficulties.

A known amount of 1 : 5 soil : water suspension is spread on a slide and fixed wet with osmic or formalin vapour. After drying, it is stained with erythrosin, washed, and then counterstained with methyl green. The preparation is mounted in immersion oil.

Colloidal particles in the soil appear green, protozoa pink with a purple nucleus. Flagella and cilia are readily visible. Contrast is sufficient to enable effortless counting with a low-power objective lens. The selective influence of cultural methods is eliminated.

The technique is of general use for soil studies. Bacteria, fungi and algae are stained purple and may be picked out quite readily against the green background of soil particles.

The details of this method will be published elsewhere.

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The Sorghum Midge Diapause

The sorghum midge, *Contarinia sorghicola* (Coq.), is an important pest of grain sorghums in Queensland, where its incidence and intensity of attack vary considerably from season to season and from early to late crops. Activity commences about two weeks after wet weather and high humidity, and crops flowering at the time may suffer severely. In central Queensland, where the rainy season is concentrated in late January and February, the mid-season crops are often damaged whereas those flowering in March and early April escape the pest. Farther south the wet season is not so well defined, although the peak often coincides with late flowering. In these districts the midge is seldom a pest of early and mid-season crops.

Laboratory experiments have demonstrated that larval diapause is broken and midge will emerge after the infested material is thoroughly wetted and incubated at relative humidities of 94–100 per cent, at temperatures of 25°–30° C. Emergence commences a fortnight after wetting, and may continue for a further four weeks. Under these conditions midge and its parasite, *Eupelmus australiensis* Gir., have emerged in appreciable numbers even from infested grain which had been stored for four years.

These laboratory findings are being correlated experimentally with midge behaviour in the field, and a full account will be published at a later date.

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Internal Infection of Tomato Seed by *Didymella lycopersici* Kleb.

Previous studies have indicated the importance of infected seed as a source of the stem and fruit rot disease of tomatoes caused by *Didymella lycopersici* Kleb. Hickman[1] reported 25–34 per cent infection of an outdoor crop grown from seed, a proportion of which was infected. Schoevers[2] demonstrated the presence of mycelium and pycnidia of the fungus on the seed coat and radicle of germinating seed, and Ogilvie[3] observed the fungus on the cotyledons and hypocotyl of tomato seedlings.

These studies were concerned with the location and effect of the fungus after germination had occurred. There appears to be little information, however, on the way in which the seed becomes infected and the location of the fungus on or in the ungerminated seed. Since such information is likely to be of value in determining the best methods of obtaining clean seed, a study has been made of the matter in the course of research now being conducted on the disease.

Sections of naturally infected fruit (var. Stonor's Money-Maker) bearing black lesions at the calyx end approximately ½–1 in. in diameter showed that the fungus had grown down the placenta and invested many of the seeds. Sections of the seeds revealed the presence of numerous hyphæ and pycnidia within the tissue of the funicle and also a more extensive internal invasion of some seeds. In these, the fungus had grown beneath the outer seed coat as far as the distal end of the seed and had formed numerous pycnidia. The main site of fungal growth was within the gaps which form between the layers of the seed coat as it matures. No fungal hyphæ were seen in the embryo. Dried seed from infected fruit also contained hyphæ and pycnidia.

Following these observations on naturally infected material, ripe tomato fruits (var. Radio) were artificially infected at the calyx end with a spore suspension from an isolate of *Didymella* known to be pathogenic to tomato stems. After thirty days, seed

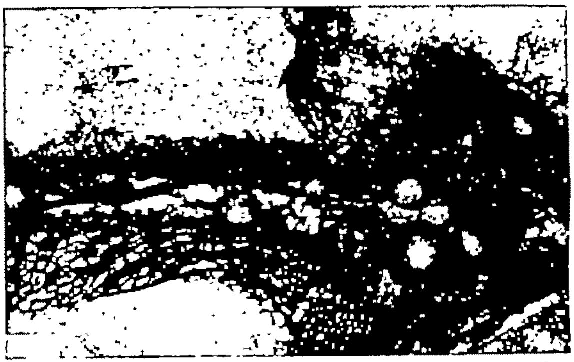

Fig. 1. Section of tomato seed (var. Radio) infected with *Didymella lycopersici* Kleb. showing hyphæ and pycnidia of the fungus in the funicle region and beneath the outer hairy seed coat. × 45

infection similar to that described above for naturally infected fruit was seen (Fig. 1). Isolations were made of the fungus from the inside of the infected seeds, and it was found to be identical with that inserted into the fruit.

Internally infected seed was found to germinate at least as well as comparable healthy seed.

These observations and experimental results indicate that the infection of tomato seed by *Didymella* is not solely due to external contamination by spores but also involves internal fungal invasion.

DOROTHY E. FISHER

National Vegetable Research Station,
Wellesbourne, Warwick. June 18.

[1] Hickman, C. J., *J. Pomol. and Hort. Sci.*, 22, 69 (1946).

[2] Schoevers, T. A. C., *Med. Plantenz. Dienst, te Wageningen*, 56, 12 (1934).

[3] Ogilvie, L., *Gard. Chron.*, 118, 71 (1945).

Crystal Defects in Freshly Worked Surfaces

RECENTLY, it has been suggested[1] that the emission phenomena (Kramer effect) and the blackening of photographic plates (Russell effect) observed with freshly worked or evaporated surfaces of certain metals may be due to the presence of sites of low work function, since photoelectric emission can be observed in the visible range of light.

Using a number of overlapping optical filters of narrow band-width, the photoelectric response of such surfaces has been explored by means of an open-ended Geiger counter, operating in an air–alcohol mixture at 10 cm. mercury, and it has been found that with aluminium (abraded and evaporated) and zinc (abraded) an emission peak is present at a wave-length of 4700 A. Evaporated copper and gold were found to be inactive. From these and other experiments it was concluded that this selective photoelectric effect is found mainly with metals which are known to form 'excess-metal' oxides, such as aluminium, zinc or cadmium, and that the effect is due to the presence of crystal defects in the oxide. It is suggested that the selective photoelectric effect observed, and other associated phenomena, are due to oxygen ion vacancies acting as electron traps. The mode of formation of these imperfections in metal films, evaporated in the presence of traces of oxygen, is considered to be similar to that of 'additive coloration' used for producing *F*-centres in alkali halide crystals. The centres formed in abraded surfaces, on the other hand, may result from the encounter of an ion vacancy pair with a metal atom.

An oxygen ion vacancy is divalent; it would be expected, therefore, that it could accommodate one, two or three electrons. From experiments on the luminescence of zinc oxide, three impurity-levels at 3·1, 2·6 and 1·9 eV. are known to exist[2], and the 2·6-eV. level is probably identical with the impurity level at 2·64 eV. responsible for the selective photoelectric effect at 4700 A. The centres may therefore be identified with oxygen ion vacancies occupied by two electrons.

It appeared of interest to establish whether blackening of photographic plates (Russell effect) could be achieved with deformed ionic materials such as rock salt. Friction tracks were made on crystals of rock salt by sliding a hemispherical steel specimen over the surface. Blackening of photographic plates (Q2 Ilford) only occurred after the deformed part of the surface had been exposed to the action of X-rays. The formation of the image is not due to the action of hydrogen peroxide (Russell effect), as is the case with certain abraded and evaporated metals[3], since the interposition of a sheet of mica did not prevent blackening. It was concluded that the blackening of the photographic plate was due to luminescence centres which were formed during the irradiation of the highly deformed surface layer in the friction track. Fig. 1(*a*) shows micrographs of three tracks on a rock salt crystal made under three different loads and Fig. 1(*b*) shows the record obtained. Apart from the three black bands corresponding to the three friction tracks, a fourth band is strongly evident from a track made in a previous experiment, which had been thought to have been completely removed by washing the crystal with water. The fourth band indicates that deformation during the friction experiment extended to great depth.

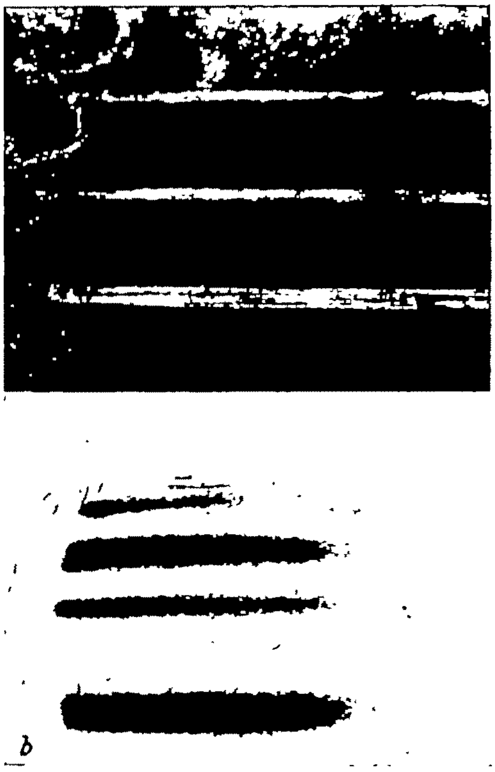

Fig. 1

From the response to photographic plates of various sensitivities, the range of wave-lengths within which the luminescence lies was estimated to be approximately 2000–3000 A., corresponding to a radiative transition of between 4 and 6 eV. This could be explained by a transition of an electron either from the *F'*-band to the valency band, or from the conduction band to an acceptor level of the V-centre type.

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[1] Grunberg, L., and Wright, K. H. R., *Nature*, 71, 890 (1953).

[2] Miller, jun., P. H., "Semiconducting Materials" (edit. by H. K. Henisch; Butterworths, London, 1951).

[3] Grunberg, L., and Wright, K. H. R., *Nature*, 170, 466 (1952).

Spontaneous Ignition of an Inflammable Gaseous Mixture on Release from Compression

THE 'shock-tube' method of producing one-dimensional shock waves has found many applications in recent years. It was first used by Vieille[1] to study the establishment and propagation of discontinuous waves in columns of air. Payman and Shepherd[2] applied the method—in their 'bursting-diaphragm apparatus'—to examine, by means of schlieren photography, the nature and spread of the discontinuous disturbance in the expansion chamber. Their results[3] linking shock-wave speed and air flow with the initial pressure in the compression chamber fitted accepted theory. The theory of shock tubes has since been more deeply considered, for example, by Hertzberg[4] in the United States, and by Lukasiewicz[5] in Canada. A shock tube has also been used by Perry and Kantrowitz[6] for demonstrating the luminosity caused by an intense shock wave being propagated in air. Recent developments have been directed towards the use of the shock tube for the generation of shock waves of high Mach number, and for this purpose gases of high acoustic speed have been used in the compression end as the driver agent, the high speed and pressure being obtained by exploding inflammable mixtures of low density behind the diaphragm. Hertzberg and Smith[7] describe some anomalous results in such experiments, and it is to offer perhaps an explanation of these that this communication is made.

The underlying purpose of Payman and Shepherd's investigation was to study, in a simple way, the ignition of a gas mixture by a shock wave transmitted through the mixture, with the view of finding if the shock wave from a detonating coal-mining explosive could, *per se*, cause ignition if the explosive were fired in an atmosphere containing methane and air. An account of early experiments with methane – oxygen and with ethylene – oxygen mixtures in the bursting-diaphragm apparatus (made of drawn steel tubing 2·5 cm. in diameter, the mixture being in the expansion chamber, and air in the compression chamber) has already been published[8]. Ignition by the shock disturbance released by the rupture of the diaphragm was obtained over a wide range of oxygen mixtures with each of these two gases. With the most sensitive mixtures, bursting pressures of the order of 50 lb. per sq. in. sufficed to cause ignition. For most of these experiments diaphragms of copper were used; ignition was also caused when 'Cellophane' (and even strong paper) was used and also, with some mixtures, when the disturbance released by the rupture of the diaphragm had to traverse a column of air before reaching the explosive mixture; these experiments showed that ignition was not associated with any frictional or mechanical effect arising during the actual rupture of the diaphragm. The far end of the expansion chamber was fully open, so that pressure-piling effects associated with a closed end did not arise. Indeed, the schlieren photographs showed ignition was caused near to the diaphragm.

Attempts to ignite methane – air mixtures were unsuccessful, even with diaphragms bursting at 1,100 lb. per sq. in.; rather, they were unsuccessful in that a stab of flame observed (through windows in the expansion chamber) near the diaphragm did not develop into an established explosion accompanying the disturbance as it was propagated through the column of mixture. Evidence was collected which suggested that the spread of flame was prevented by an air gap interposed in the column of inflammable mixture by the dissolution of a vortex ring of air (from the compression chamber) travelling initially *through* the column of mixture, this vortex being the pioneering effect released when the diaphragm ruptured, by shearing cleanly around the periphery of the circle exposed to pressure. The formation of the vortex was a purely mechanical effect, and it always occurred. With sensitive or with strongly explosive mixtures, the explosion was readily transmitted across the gap, but this was not so with methane – air mixtures. Thus, the failure to establish flame in the latter mixtures might not have been due, physically, to a deficiency in the 'igniting power' of the shock wave. Experiments made to verify this explanation brought to light an interesting phenomenon.

It seemed reasonable to expect (though it would not provide conclusive proof of the explanation) that if the vortex could be made to consist of an explosive mixture, its dissolution would not break the continuity of the inflammable column of methane – air in the expansion chamber. The apparatus was therefore modified so that the compression chamber could be filled with an explosive mixture, in the first place of methane and oxygen. The static bursting pressure of the diaphragm was known to within a few pounds per square inch, and the partial pressures to provide roughly the required mixture could be calculated. The oxygen was introduced first and then, quite slowly, methane was passed in through a perforated tube held axially along the chamber until ultimately the diaphragm burst. The exact composition of the mixture was calculated from the observed bursting pressure of the diaphragm. The expansion chamber, in the meantime, had been filled with the methane - air mixture. Very violent explosions, with flame spreading far outside the open end of the expansion tube (100 cm. long), were obtained with many combinations of mixtures in the two chambers. The point of interest, however, is that equally violent explosions were found to occur when the open expansion chamber contained only air.

This finding that ignition could occur when a compressed gaseous mixture was suddenly released into air was investigated further. The mixtures of methane and oxygen in the compression chamber were all on the lean side as a precaution against the destructive violence that seemed likely to develop with intrinsically more explosive mixtures under high compression. Experiments were made with a compression chamber 15 cm. long, and an air-filled open expansion chamber 100 cm. long. Selected results are shown in Table 1; there was in fact some scatter

Table 1

Mixture in compression chamber Per cent methane in oxygen	Pressure at release (lb. per sq. in.)	Result in open expansion chamber
11·8	1,390	No explosion
13·4	775 600	Explosion No explosion
14·8	540 385	Explosion No explosion
15·5	283 245	Explosion No explosion
17·5	193 160	Explosion No explosion

and non-ignitions were sometimes obtained at pressures which were expected to give ignition.

It was found that the pressure on the release of which ignition occurred became progressively higher as the expansion chamber was shortened. Nevertheless, ignition was obtained with mixtures released directly into free air (for example, with a mixture containing 22·3 per cent of methane in oxygen, and a diaphragm bursting at 1,000 lb. per sq. in.).

A photographic investigation of the ignition of a mixture released from compression has not yet been made; however, ignition probably arose as a result of heat transfer from the air compressed and heated in the shock wave to the contiguous layers of explosive mixture (at first cooled by expansion) that formed the driver piston. There was no perceptible delay before ignition.

It seems possible that Hertzberg and Smith's results were confused by the occurrence, in some experiments, of spontaneous ignition when the diaphragm was ruptured before explosion had spread throughout the mixture in their compression chamber. Shock-tubes designed to operate on this phenomenon, with suitably chosen mixtures, might indeed extend their scope. Energy losses during explosion would be minimized, and the design of the tube itself might be simpler since the stressing of the tube would be less severe.

I wish to thank Mr. A. H. A. Wynn, director of the Safety in Mines Research Establishment, Ministry of Fuel and Power, for permission to publish these results.

(The late) W. C. F. SHEPHERD

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June 9.

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Use of Adsorption Columns in the Analysis of Emulsions stabilized with Non-ionic Detergents

DETERMINATION of the constituents of emulsions stabilized with non-ionic detergents has been hitherto restricted by the lack of a satisfactory method of quantitative separation. Following the methods outlined previously[1], a separation of such emulsions has been achieved and shown to be quantitative.

Using columns of 'Bio-Deminrolit' (an intimate mixture of 'Zeokarb 225' and 'De-Acidite *FF*') of 40–60 mesh, percolation of lanolin/'Lissapol *N*' emulsions containing up to 1 per cent of sodium chloride gave clear liquors, which on evaporation left no residue. Columns containing powdered animal charcoal as an added adsorbent were equally effective, but although the grease could be removed quantitatively, the 'Lissapol *N*' was held too firmly for successful solvent elution and, eventually, charcoal was omitted from the columns.

Preparation of the columns involves Soxhlet extraction of the resin with the solvents to be used for elution. The columns were prepared in the dry state in tubing 1·5 cm. diameter to give a length of approximately 10 cm. when wet. Satisfactory volumes of eluant were found to be 10 ml. for each 1 cm. length of column.

Elution with 50 per cent aqueous ethanol gave quantitative yields of 'Lissapol *N*', estimated by the method of Oliver and Preston[2]. Subsequent elution with trichlorethylene gave reproducible results for removal of lanolin. These two fractions were also identified with the original materials by their characteristic infra-red absorption spectra.

It would appear that the first step in breaking the emulsion is the removal of stabilizing electrolyte by the mixed resin, followed by adsorption of the grease and detergent. Evidence has been obtained that a chromatographic separation of grease and detergent occurs during elution with aqueous ethanol.

This procedure has been applied to the analysis of 'Lissapol *N*'/mineral oil (Shell Clavus oil 27) and 'Lissapol *N*'/vegetable oil (olive oil) emulsions, giving a 100 per cent recovery of 'Lissapol *N*' in all cases.

The method was further extended to the analysis of a 'Lissapol *N*'/soap/lanolin emulsion by using two separate columns. The 'Lissapol *N*' was separated as above on a column of 'Bio-Deminrolit' and eluted with 50 per cent aqueous ethanol. Soap and lanolin were separated and estimated on a column of 'Zeokarb 225'/charcoal, as described in a previous communication. 'Lissapol *N*' is strongly adsorbed by the charcoal and is not removed when eluting the fatty acid and grease components of the emulsion. A more detailed account of this work will be published elsewhere.

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August 6.

[1] Harker, R. P., Heaps, J. M., and Horner, J. L., *Nature*, 173, 634 (1954).

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Electrophoretic Movement of Higher Fatty Acids on Filter Paper

ATTEMPTS at the separation of higher fatty acids by paper chromatography have not, in the main, been successful, although Isherwood and Hanes[1] have studied the problem in relation to a number of straight-chain fatty acids, and Nunez and Spiten[2] have evolved a technique, using paper impregnated with olive oil, for chromatographic separation of such compounds. Apart from other considerations, the low aqueous solubility and the low dissociation constants of these acids presented the problem of finding an indicator which would be sensitive enough to enable their presence to be detected on paper. It has been found that the methyl red/bromthymol blue indicator of Duncan and Porteous[3] permits of the detection of small amounts (for example, about 80 µgm. of C_{16}) of acids up to C_{18} on paper. Considerably more care is required, however, in the colour development with the higher acids than with the lower members of the series.

The present work deals with the movement of straight-chain acids from C_{10} to C_{18} in ammonia solution, on paper, in a closed vessel under electrophoresis, and it has been shown that the observed rates of movement, under 6 V./cm., for the C_{10}, C_{12}, C_{14}, C_{16}, C_{18} acids were respectively 4·5, 1·5, 0·33, 0·07 and 0·0017 cm./hr. These observed velocities are presumably the result of the electro-endosmotic flow (approximately 1·6 cm./hr.), a differential adsorption of the acids on paper resulting in a range of R_F values and ionic mobilities of the organic acid anions. When these influences are taken into account, the ionic mobilities would appear to be 42·1, 22·5, 16·4 and 13·9 × 10^{-4} cm./sec./V./cm. for C_{10}–C_{16} respectively. It is not possible to say directly what the figure for C_{18} would be, because this acid is adsorbed so strongly on paper that we have been unable to determine its R_F value under the experimental conditions employed with the other acids, but the extrapolated value is of the order of 13·0 × 10^{-4} cm./sec./V./cm.

The above results for ionic mobilities may be compared with the corresponding figures of Gonick[4] and McBain *et al.*[5] (see Fig. 1).

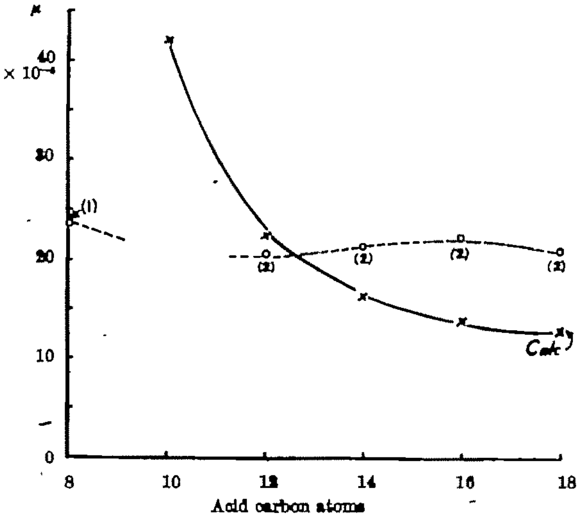

Fig. 1. Ionic mobilities of straight-chain higher fatty acids. ×—×, as determined by the electrophoretic method described; O–O, as determined by other workers: Gonick (2); McBain *et al.* (1)

Oleic, elaidic and stearic acids move at similar rates, and no separation of these from one another is possible; but it has been demonstrated, by the above electrophoretic method, that lauric and myristic acids are present in oleic acid B.P. to the extents respectively of 0·04 per cent and 1·5–2·0 per cent. In addition, another acid, so far unidentified, has been found in oleic acid B.P. which moves more quickly than C_{16} and more slowly than C_{14}. The existence of this acid was confirmed by chromatography[3]. A full account of this work will be published elsewhere.

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June 9.

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[1] Isherwood, F. A., and Hanes, C. S., *Biochem. J.*, 55, 824 (1954).

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Production of Electric Power by mixing Fresh and Salt Water in the Hydroelectric Pile

When a volume V of a pure solvent mixes irreversibly with a much larger volume of a solution the osmotic pressure of which is P, the free energy lost is equal to PV. The osmotic pressure of sea-water is about 20 atmospheres[1], so that when a river mixes with the sea, free energy equal to that obtainable from a waterfall 680 ft. high is lost. There thus exists an untapped source of power which has (so far as I know) been unmentioned in the literature.

There are many methods (using osmotic and other forces) which might, in theory, be used for obtaining power by reversibly mixing fresh water and sea-water. In any such process, the extraction of the energy will cool the liquids by a fraction of a degree. The one which appears most practicable depends on the ionic nature of salt and uses membranes (incorporating ion exchange resins) selectively permeable to ions of one sign or the other. If such a membrane separates two salt solutions of different strengths, a potential difference appears across it.

If alternate layers of salt and fresh water are separated by alternate basic and acidic membranes[2], the membrane electromotive forces (each of order 30 mV.) are effectively connected in series, and an e.m.f. large compared with electrode polarization voltages can be built up.

An apparatus (the 'hydroelectric pile') has been constructed; in it 47 acidic and 47 basic membranes, each 8 cm. square, are separated by 93 spaces each 1 mm. thick. Fresh and salt water pass through a system of holes and washers and flow across alternate spaces between the membranes, and current is led off from compartments at the ends of the pile. A continuous supply of electricity is thus obtained. The fresh water becomes slightly salt during its passage through the pile, and the current drawn from the pile accounts for about 90 per cent of the salt transferred.

The maximum e.m.f. obtained has been 3·1 V.; the membranes used (of polythene mixed with resins based on cross-linked polystyrene) have resistivities higher than those of the pure resins, and give the pile an internal resistance of about 250 ohms at 10° C. The maximum external power obtained has been 15 mW. (at 39° C.).

The internal resistance is higher, and the power output is lower, at low temperatures. The pile is therefore likely to be more economic in a warm and equable climate. Its economics probably hinge on the time for which it will run before the membranes need replacing or the interior needs cleaning; the present pile has run satisfactorily for three months on $N/2$ sodium chloride solution and tap water.

This work was carried out at the Chemical Research Laboratory (Department of Scientific and Industrial Research), by permission of the Director of which this communication is published. The gift of membranes by B.X. Plastics, Ltd., and the assistance of the National Research Development Corporation, are acknowledged.

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[2] Pattle, R. E., Brit. Pat. Application 1939/53 (Jan. 22, 1953).

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, October 4

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Miss Marjorie Lovell Burgess: "The Influence of Murdoch on the Modern World".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the LONDON SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. L. Streatfield: "Some Industrial Applications of Metal Cleaning".

Monday, October 4—Wednesday, October 6

SWISS FEDERAL COMMISSION FOR STUDYING HAIL FORMATION AND HAIL PREVENTION (at Zurich)—International Symposium on "Experimental Meteorology".

Tuesday, October 5

INSTITUTION OF GAS ENGINEERS (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. Alexander Fleck—Murdoch Memorial Lecture

Wednesday, October 6

PHYSICAL SOCIETY, COLOUR GROUP (in the Physical Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Prof. W. D. Wright: "Colour Measurement Applied to Natural Phenomena, including a Report on Observations made during the Total Solar Eclipse, 30th June 1954".

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the CORROSION GROUP and MICROBIOLOGY GROUP, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. F. Wormwell and Mr. T. W. Farrer: "The Influence of Micro-organisms on the Corrosion of Metals".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6.45 p.m.—Dr. H. M. N. H. Irving and Mrs. H. S. Rossotti: "The Theoretical Basis of Sensitivity Tests and their Application to some Potential Organic Reagents for Metals"; Dr. H. M. N. H. Irving and Mr. R. G. W. Hollingshead: "An Investigation of 5-Nitroso-oxine as an Analytical Reagent".*

Thursday, October 7

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. Eccles: Presidential Address.

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Chairman's Address: "Some Men of Metallurgy".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the South-East Essex Technical College, Longbridge Road, Dagenham), at 7 p.m.—Dr. Tudor S. G. Jones: "Chromatography—Theory and Some Applications".

Thursday, October 7—Saturday, October 9

SOCIETY FOR WATER TREATMENT AND EXAMINATION (at Bournemouth).—Autumn Meeting.

Friday, October 8

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICAL CHEMIST to work on macromolecules of biological interest—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3, quoting "Physical Chemist" (October 9).

LECTURER IN ANTHROPOLOGY at the University of Otago, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

LEVERHULME FELLOW AND LECTURER (with good experience of research work in nuclear physics) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Liverpool (October 16).

PRINCIPAL OF NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE—Clerk to the Joint Education Committee, Exchange Buildings, Nottingham (October 16).

PRINCIPAL (with bacteriological and immunological experience) OF THE WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 18).

CHAIR OF CHEMICAL ENGINEERING—The Registrar, University College, Singleton Park, Swansea (October 25).

SENIOR LECTURER IN ANTHROPOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 30).

SENIOR RESEARCH FELLOW (with a first-class degree in physics or electrical engineering and extensive research experience, preferably in high vacuum and electronic techniques); RESEARCH FELLOW (with a first-class honours degree in physics or electrical engineering and good research experience); JUNIOR RESEARCH FELLOW (with a first- or good second-class degree in physics or electronics, with some research experience), IN THE DEPARTMENT OF INSTRUMENT TECHNOLOGY—Prof. J. D. McGee, Physics Department, Imperial College, Imperial Institute Road, London, S.W.7 (October 30).

ASSISTANT LIBRARIAN (preferably graduate in biology, with knowledge of German and French and with library experience) IN THE DEPARTMENT OF FORESTRY—Librarian, Department of Forestry, The University, Oxford (October 31).

LECTURER IN ANTHROPOLOGY, LECTURER IN GEOGRAPHY, and a LECTURER IN PHARMACY, at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

ASSISTANT LECTURER (preferably with experience in some branch of the organic chemistry of natural products) IN ORGANIC CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs.

ASSISTANT (with a good honours degree in a biological subject and at least two years postgraduate experience in research, university teaching, or scientific administration), to be responsible for the biological sciences (excluding medicine) IN THE SCIENCE DEPARTMENT, London Headquarters—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Biologist".

CHEMIST (with good honours degree, or equivalent qualification, industrial experience and the ability to prepare correspondence and reports) in the London Transport Central Laboratory, Chiswick, to be responsible for a section concerned with a wide variety of analytical and investigational work, dealing with detergents, cleaning materials, fire extinguishing materials, textiles and leathercloths, and many others—Staff Officer, London Transport, 55 Broadway, London, S.W.1, quoting F/HV507.

GEOLOGIST (with first- or second-class honours, division 1, degree in geology) IN THE GEOLOGICAL SURVEY DEPARTMENT, Gold Coast Government, for work in the field, on geological mapping and the application of geophysical methods to water supply and engineering problems—The Adviser on Recruitment, Office of the Gold Coast Commissioner, Melbourne House, Aldwych, London, W.C.2.

METEOROLOGIST (with first- or second-class honours degree in mathematics or physics and preferably with postgraduate experience in meteorology) in the East Africa Meteorological Department, for work including administration, forecasting and other technical meteorological duties—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.57/38/01.

PRINCIPAL or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in physics, engineering or mathematics, or equivalent qualification, and with experience in the field of microwave valves) at the Ministry of Supply Radar Research Establishment, Malvern, for work on the design and construction of millimetre wave magnetrons and other microwave valves, involving fundamental research into processes occurring in such valves and solution of technological problems on construction—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A247/54A.

RESEARCH ENGINEER (with a good honours degree or equivalent, and specialised knowledge and experience in fluid mechanics) for work on hydraulic torque converters and allied subjects—The Director, The Motor Industry Research Association, Lindley, near Nuneaton.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with H.S.C. or equivalent, and considerable experience of routine mechanical testing, particularly creep testing, and preferably familiar with vacuum techniques) at Culcheth, near Warrington, to supervise work in a creep laboratory using unconventional types of testing on a wide variety of metals and alloys involved in the construction of nuclear reactors—United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 669.

SENIOR PHYSICS MASTER—The Headmaster, Bradford Grammar School, Bradford.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry or equivalent, and three years postgraduate experience of inorganic analysis), to take charge of a group engaged on research and development work in inorganic analytical chemistry, including the application of modern analytical methods (Ref. 659); SENIOR EXPERIMENTAL OFFICERS (with H.S.C. (Science) or equivalent and considerable experience in analytical chemistry), to supervise laboratories engaged on analyses of materials used in atomic energy processes (Ref. 660); and ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. in science subjects or equivalent and experience of chemical analysis, preferably in the inorganic field), for analytical work on materials used in atomic energy processes (Ref. 661) with the United Kingdom Atomic Energy Authority, Capenhurst, near Chester—U.K.A.E.A., Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting appropriate Ref. No.

SENIOR LECTURER (with wide experience of flight testing and flight research techniques) IN FLIGHT EXPERIMENTS—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

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AGRICULTURAL RESEARCH UNDER REVIEW

THAT very useful, if sometimes rather perturbing body, the Select Committee on Estimates, has in its latest report* turned its attention to agricultural research in Britain. It visited some of the research stations and examined some of the directors as well as the chief officials of the Government and other bodies concerned. Besides the verbal evidence, the report includes interesting memoranda by the Ministry of Agriculture, the Agricultural Research Council, and the Treasury ; also a financial appendix showing the funds provided for the various research institutes for the sessions 1953–54 and 1954–55. The inquiry was directed to "the administration of, and expenditure on, agricultural research by the various Departments and organizations involved, but did not extend to the organizations concerned with the practical application of the results". The Committee further decided that policy and the assessment of the scientific and practical value of the work being done lay outside its terms of reference. It is highly gratifying to learn that the Committee "found no evidence of waste or inefficiency in the running of the individual institutes they examined". It did, however, find the overhead organization complex and cumbersome and suggested some simplification.

The complexity arose from historical reasons. Agricultural research in Great Britain is much older than Government interest in it. Rothamsted was founded in 1843 by a private landowner, John Bennet Lawes, and was carried on entirely at his private expense until 1889, when he transferred it to a Trust which he established and endowed and which is within the jurisdiction of the Public Trustee : it received its first Government grant in 1911. Long Ashton was started in 1893 under the ægis of the Bath and West and Southern Counties Society in the grounds of a Somerset landowner, Mr. R. Neville Grenville, for the purpose of introducing scientific methods in the making of cider ; when its supporters wanted to put it on a permanent basis they were advised to form themselves into a limited liability company of a non-profit-making character under licence from the Board of Trade in conformity with the Companies' Act of 1867. The Cheshunt Experiment Station was started in 1914 by a group of glasshouse growers : they, however, were advised to register under the Friendly Societies' Act, though for the new Station at Littlehampton they are to be reconstituted under the Companies' Act. Other stations began as departments of a university ; others, again, were founded by the Development Commission about 1912. From 1911 onwards these institutes received grants from the Development Fund, through the Ministry of Agriculture ; but they had other resources also, usually grants from county councils and subscriptions or donations from societies or individuals interested in their work.

The receipt of a Government grant necessitated submission of the programme of work, estimates of cost, final accounts, and report on work done. Serious difficulties rarely arose so long as the Government grant formed only a moderate part of the whole income: directors and the officials concerned were on very friendly terms and could satisfactorily settle matters in advance of the formal correspondence. The system worked in the usual English fashion in spite of some illogical features. Indeed, it was so successful, and the research institutes expanded so greatly, that by 1931 it was felt necessary to set up the Agricultural Research Council to act as scientific adviser to the Development Commission and the Ministry, to advise the agricultural departments on the programmes of the research institutes, to review, co-ordinate and facilitate all agricultural work in progress and to initiate new investigations where gaps required filling, for which purpose it had funds of its own and could set up its own stations and units. The Council consists of fifteen members: not less than ten are chosen with the approval of the president of the Royal Society for their eminence in science; the others are agricultural. Directors of research institutes are not, in fact, appointed.

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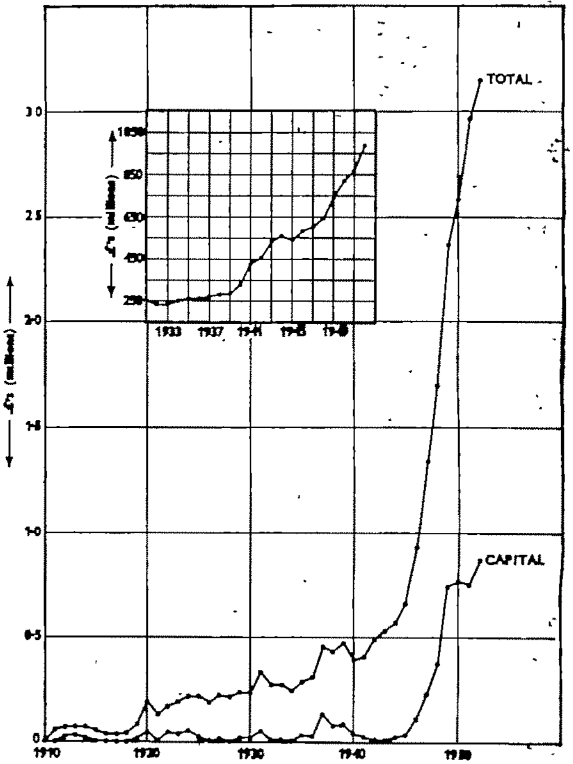
* Fifth Report from the Select Committee on Estimates, etc. Session 1953–54. Agricultural Research. Pp. 218. (H.M.S.O.) 6s. 6d. net

The steep increase in cost and the rapid increase in the amount of work has necessitated an enormous increase in the grants (see accompanying graph). Up to 1918 the total annual grants had been about £80,000 a year; by 1944 they somewhat exceeded £500,000; by 1951 they were well above £3 million; and for 1954–55 nearly £6 million. The Government grant, formerly only a fraction of the total income of the research institutes, now amounts to 98 per cent or more of the total, and the Committee considers that this justifies closer examination of the relations of the institutes to the Government. The present relations can only be described as historical accidents. Of the thirty-eight stations reviewed, two are directly controlled by the Ministry of Agriculture, fourteen are independent but come under review by the Ministry jointly with the Agricultural Research Council, and fourteen are directly under the latter body. Of the independent institutes, neither Ministry nor Council is represented on the governing body of Rothamsted, the Ministry has two representatives on that of Long Ashton, and it appoints all the governing body of the Agricultural Engineering Institute. In short, there is just that kind of administrative untidiness that a committee would enjoy straightening out—or recommending that others should do it.

In point of fact, the untidiness is not as serious as it looks. The Ministry's chief work is administration of the various Acts dealing with agriculture; but some of this work—such as plant and animal diseases, seed testing, quarantine—necessitates investigations which are much better carried out on the spot under the eye of the officer concerned than delegated to a research institute miles away. Moreover, the Agricultural Research Council has cognizance of all the research work in all the institutes, either directly or through its committees: there need be no overlapping through ignorance of what is being done elsewhere.

The Select Committee on Estimates, however, was more concerned with finance than with research. The Agricultural Research Council is described as a sister body to the Department of Scientific and Industrial Research, which draws its revenues largely from industrial concerns; and the question arose whether the farming industry could not contribute in like manner to the cost of the agricultural institutes. This was found to be impracticable; indeed, Government grants had dried up rather than stimulated voluntary financial efforts.



State expenditure on agricultural research in Great Britain. Inset: annual gross value of agricultural output in Britain. From "The Agricultural Research Service", by courtesy of the Controller of H.M. Stationery Office

The Committee was much impressed by the fact that no one body is charged with the oversight o the total expenditure on agricultural research. Th Ministry's share of expenditure comes out of th Vote, and the Council's by direct negotiation wit the Treasury; but the Committee found no on whose duty it was to add up these quantities for th purpose of ascertaining the total. The Committe is strongly of opinion that overall savings could b effected if all the institutes could be brought "under one hat", either the Council or the Ministry. Th institutes' representatives preferred the Council: it had more understanding of scientific work, mor flexibility, and was quicker in action. At present th scientific staff is under Council regulations and th non-scientific staff under those of the Ministry; these, however, are quite unsuited to a research institute.

Some of the witnesses were rather perturbed b the fear that they might be brought more directly under the Council than hitherto they have been. S long as the Council remained a purely advisory body the eminence of its members and their persona friendships among the staffs of the institutes gave special value to any criticisms or suggestions the made in regard to the work being done. But, as was pointed out to the Committee, the Council, in its recent booklet, "The Agricultural Research Service", describing its activities, now claims to 'supervise' the State-aided research institutes. The Oxford Dictionary gives as one of the meanings of this word "to superintend", and this in turn means "to have or exercise the charge or direction of". Is this what the Council is aiming at ? The institutes have their own governing bodies chosen for their special knowledge of the subjects dealt with, and it would be a heavy loss if they were abolished or so weakened that no busy man would consider it worth while to serve on them. Sir William Ogg suggested that the happiest relation between the Council and the institutes would be that of the University Grants Committee to the universities, and this idea certainly seems worth following up. Alternatively, the relationship of the Medical Research Council to its institutes might be worth studying. The Committee took it for granted that the large Government grants necessarily entailed loss of independence ; but claims that "the system of direct administration by the Agricultural Research Council promoted greater flexibility both of administration and of the research programmes". The Committee expressed its belief that "this could be done without interfering with the supervision at present exercised by their Governing bodies". It all turns on what exactly is meant by "direct administration". One member of the Committee suggested that there should be on the Council a non-specialist "business brain" to "judge between what is necessary and what is not". Any attempt to do this could lead only to disaster.

Public expenditure on agricultural research is now on so large a scale that full inspection of accounts must be, and indeed is, willingly accepted. The great problem is to find a system that satisfies the canons of sound finance without interfering with the freedom of action essential to the proper conduct of scientific investigation. The Committee learned that Ministers have this under consideration and therefore felt precluded from bringing it within its purview. Our present system no doubt needs tidying up ; but it has, in fact, worked without waste or inefficiency as the Committee recognizes, and, we may add, it has produced a volume of work that in its relation to the available resources will bear favourable comparison with any done elsewhere.

SCIENCE AND LIFE

The Nature of Science and Other Lectures

By Edwin Hubble. Pp. viii+83+2 plates. (San Marino, Calif.: The Huntington Library, 1954.) 2 dollars.

WE owe to the Trustees and Friends of the Huntington Library this last testament of one of the greatest astronomers of our time. The six lectures contained in the book are divided into two groups—three on the nature and meaning of science, and three on scientists and war. Science to Edwin Hubble was the adventure in which man, equipped with his five senses, explores the universe around him. Unlike wisdom, which is peculiar to the individual, knowledge accumulates through the ages and can be passed on from one generation to the next. It piles up against some barrier, until a weak spot is found by an alert research worker, often one who is following a by-path which has stirred his curiosity. Exploration sweeps forward, guided by existing knowledge; old theories are revised, and new theories are formulated as temporary working hypotheses. New laws may be derived to be tested by further observation and experiment.

The success of the scientific method is illustrated by a quotation from George Sarton: "The saints of to-day are not necessarily more saintly than those of a thousand years ago : our artists are not necessarily greater than those of early Greece ; they are likely to be inferior ; and, of course, our men of science are not necessarily more intelligent than those of old ; yet one thing is certain, their knowledge is at once more extensive and more accurate. The acquisition and systematization of positive knowledge is the only human activity that is truly cumulative and progressive".

A by-product of science is technology, the application of the results of science to the service of mankind. Hubble gives an account of the amazing growth of industrial research in the United States during the past thirty years. In this connexion he notes how expanding knowledge, which can be used for evil as well as good, has swept across the danger level, so that men are now in a position to wreck the civilization of the world. The last lecture in the book, "The War that must not happen", gives a grim account of what may take place if we leave our new knowledge at the disposal of traditional politics. Hubble was no pacifist. Before the days of Pearl Harbour, he was urging with all his might the duty of the United States to enter the Second World War and to pay whatever price was necessary to secure liberty for the world. It was with the utmost reluctance that, when war came, he obeyed orders to apply his scientific knowledge to problems of ballistics instead of returning to active service in the United States artillery. But he learnt at the Aberdeen Proving Ground what it meant to face the problems of active warfare unprepared: "The army would come to us with an urgent problem that had arisen in the actual fighting. I would say, 'We don't know, but of course we can find out'. 'Go ahead, find out', the army would say. 'All right. It will take so many men, so much equipment, so much time if we stop other work and give it priority'. 'Time', the army would say, 'hell, we have to cable the answer to-night'."

It is clear that Hubble would have supported wholeheartedly research work to face in advance the problems of the next war, if it should come. But he clearly saw that the modern war of technology is suicide for both sides. War must be stopped if we are to enjoy the potential blessings of new knowledge. Hubble was clear that treaty agreements are not enough. He saw one possible solution—a world authority armed with a police force for the strictly limited purpose of preserving order among the nations. It is the responsibility of all individuals to work to this end—to read up the subject, discuss it and urge the politicians to accept it. The necessity for decision and action is here and now. "We may not like the price, but it is cheap for what we buy—civilisation and life itself." F. J. M. STRATTON

THE CLEAVAGE IN EUROPEAN SCIENCE

Die Krisis der Europäischen Wissenschaften und die Transzendentale Phänomenologie

Eine Einleitung in die Phänomenologische Philosophie. Von Edmund Husserl. Herausgegeben von Walter Biemel. (Husserliana, Band 6.) Pp. xxii + 560. (The Hague: Martinus Nijhoff, 1954.) Paper, 23.50 guilders; cloth, 27.50 guilders.

In this sixth volume of "Husserliana", one is faced with a fact which must be reckoned with before there is any possibility of appraising its contents, or for that matter, even of stating its purpose. This is that, in these pages, Husserl has delivered himself of an act of faith; they represent for him a creed, a system and a philosophy, united in one complex order of thought, and bound together by strong ties of urgency. He appears (as often before) in the role of an Old Testament prophet, telling the savants of Europe what has gone sadly adrift, and how yet all may come right in the end. To read this book (the German syntax of which is sometimes as exasperating as the massive prose of our own John Ruskin, and in some ways not unlike it) is to listen to a cathedral organ, sounding its deepest notes, reverberating and undergoing all manner of reflexions as their waves ascend from nave to triforium.

Thus, the judgment of science upon science itself is seen to consist in the perception of a rift between positivistic objectivism, and transcendental subjectivism. We note that, on this view, it is the cleavage itself more than the tenets involved which is at the root of the development of all subsequent European thought.

As Dr. Walter Biemel so well says in his introduction, the operative phase of the work is the subtle contrast between sections A and B of Part III, wherein phenomenology itself is the only escape from the dilemma: "via the living world or via psychology". The latter, nevertheless, needs adjustment to the appropriate *Methodik* if it is to be effective. The sense of awareness is introduced by the call to philosophy to make mankind awake to the spiritual nature of its end. There is obviously a strong teleological slant in all this, at one with Husserl's veneration for much of the Aristotelean tradition. In fact, he stresses what is well known when he asserts that the basic contribution of Greek thought to the world was its enthronement of theory, not only, so to say, placing it upon a pedestal, but firmly cementing it there. So the split begins to appear as a kind of no-man's-land wherein are likely to be found the logical presuppositions of science (*Sinnesfundament*), which have all too long remained unexamined, and which, thus occluded, have tended to deprive modern science of much of its meaningful content. In a word, why scientists do this or that is, fundamentally, more important than how they do it.

Odd as it may seem, there is a very healthy 'muscular' element at work in all this erudition, as witnessed by Husserl's spontaneous denunciation of a certain type of ***intellektualistischen Snobismus***, connected clearly in his mind with the excesses of higher education. Making every allowance for the prolixity of Teutonic expression, this is always a valuable lesson, and leads on naturally to the essence of the 'cure' to which Europe should submit. In the present book, this appears in the text of a lecture given in May 1935. While science and philosophy remain 'separated', there is little chance of healing the wounds of a discordant civilization, capable—in theory—of a real degree of unity, but kept apart by an artificial competition for the perfection of techniques. When one observes that the gist of all this was expounded at Vienna nearly twenty years ago, it is only too manifest how perfectly it describes our present distresses. Not in vain maybe did Husserl once again assume the part of a seer.

Yet, to British ears something very like this was said (and majestically said) a full century ago in Dublin, and with no less an impact upon the progress of thought. Thus, John Henry, Cardinal Newman, in "The Idea of a University", argued that knowledge was a good in itself, an end for which to strive regardless of gain or loss. But he went further: he said that if, by the exclusion from the curriculum of some essential branch of learning, a gap is left unfilled, then other—and perhaps less worthy—knowledges will be 'tempted' to spill over into it, and thus ultimately to obliterate the original concept. How close this is to the rift between the two domains taken by Husserl as the primary cause of Europe's malaise. Then comes his prescription (in effect) for psychology to make haste to fill it, with philosophy keeping a watchful eye on the process; and, above all, men should not weary. Thus do transcendent minds produce (within limits) a common way for mankind to tread.

"Of possessions," says the Stagirite, "those rather are useful which bear fruit; those liberal which tend to enjoyment. By fruitful, I mean, which yield revenue; by enjoyable, where nothing accrues of consequence beyond the using."

F. I. G. Rawlins

PRINCIPLES OF THE MEASUREMENT OF COLOUR

The Science of Color

By the Committee on Colorimetry, Optical Society of America. Pp. xiii + 386 + 25 plates. (New York: Thomas Y. Crowell Company; London: Constable and Co., Ltd., 1953.) 63*s*. net.

This important work by the Committee on Colorimetry of the Optical Society of America gives an authoritative statement of the principles upon which the measurement of colour is based. The text has been compiled by a number of distinguished American writers over a period of twenty-two years and has now been thoroughly revised and brought up to date by the Committee as a whole. The precision of statement could scarcely be better, and many experienced in the measurement of colour will find a clarity of ideas often lacking in lesser works.

There is also a breadth of view which is refreshing. The first chapter provides a history of colour which begins in prehistoric times, and in further chapters the reader is led by easy stages through the anatomy, physiology, psychology and physics of colour to the technical details of colorimetry itself. No one can pretend that this vast field has been completely described in 340 pages, but the principles of the subject are well set out.

The book is one of principles issued by authority, and as such might be called "The Dogma of Colour" except that the modern meaning of this word tends to include the ideas of arrogant presentation and a disregard for experimental facts, which are by no means in evidence here. The narrative is humbly written, and the authors have clearly been striving to eliminate partisan statements and to give well-informed references to the older workers where these are relevant. The ideas given here so clearly will enable many a worker in the field of colour to tidy up his own mind and liberate himself from loose thinking.

Chapter 1, on the history of colour, is followed in Chapter 2 by a survey of the whole field in general terms. This is illustrated by a number of colour plates built from Munsell papers. Chapter 3, on the anatomy and physiology of the eye, deals mainly with its anatomy, since much of what in the past has been called physiology is given in Chapters 4 and 5 under the heading "Psychological Concepts". Here one finds Müller's and Weber's law, dark adaptation and flicker data and an account of colour-defective vision together with many other subjects. The final Chapters 6, 7, 8 and 9 deal with the technique of colorimetry itself. Chapter 6 on the measurement of radiant energy is followed in Chapter 7 by an account of the standard luminosity data and related subjects, an explanation of the three-colour method of colorimetry and the use of the chromaticity diagram. Chapter 8 details the calculations normally undertaken in colorimetry, and the text is lavishly supplemented with tables. Few books on colour will contain so much useful numerical information. In Chapter 9 colour-measuring instruments and standards are discussed.

In such a work one looks for the very best, and it is a pity that the presentation is not uniformly good. Chapters 7, 8 and 9 are well set out and readable; but the rest of the book, aside from Chapter 1, is dull, and only someone with missionary fervour could read it through completely. Exactness of statement has often been achieved at the expense of easy and interesting reading. The presentation of Chapters 4 and 5 is particularly bad. There are only eleven line-drawings and one colour plate for 72 pages of double-column text, and this alone would bring many a reader to a halt. As a whole, the printing is good, but the colour plates are not up to the standard necessary for a book on the measurement of colour.

The biologist interested in visual mechanisms will find this book a disappointment, and the student is unlikely ever to read it completely; but for the thoughtful colorimetrist it is a statement of basic principles for which he has long been waiting.

L. C. Thomson

BRIDGES

The World's Great Bridges

By H. Shirley Smith. Pp. xi+180+43 plates. (London: Phoenix House, Ltd., 1953.) 15s. net.

When a real authority on a subject can spare the time to write a book about it for the general reader, there is a chance that he will produce a masterpiece. Perhaps this book may be counted as such, for it is at once readable, informative and authoritative. The author was himself responsible for the construction, in Calcutta, of the bridge with the world's longest cantilevered span. He accordingly writes with an intimate knowledge of the problems involved in the building of a great bridge, although the word "great" in the title of the book is not so narrowly interpreted as to refer only to size; in the words of the author, it is used "in its widest sense to include bridges distinguished in their conception and design, those which advanced the science of bridge building, those in which the most formidable difficulties were overcome during construction, and last but not least the mighty spans of today".

Many popular compilations about bridges have been published; but the present book is not another rearrangement of old material. The author has, where possible, studied the original documents relating to each bridge described in detail. The first five chapters, which are concerned with the historical origins, have clearly entailed considerable research, in which the author has been assisted by Mr. Rowland J. Mainstone, who has provided twenty-four pen-and-ink illustrations, which are always clear and often distinguished. An instance of the refusal to accept current notions without verification on the site is afforded by the conjecture that the four arches still standing of the famous Pont d'Avignon are not part of the original twelfth-century structure, as was generally believed. Investigation of the original piers has revealed the presence of springings on a slightly different alignment from the present spans, which may have been reconstructed in the fourteenth century.

Continuing the chronological treatment, the author describes more recent bridge construction, by dealing successively with iron bridges, cantilevers, steel arches, reinforced concrete construction and finally with suspension bridges. The book has an adequate index and a bibliography of source material. A special chapter is devoted to "British Bridges Overseas", on which topic the author is particularly well qualified to write. The large collection of half-tone plates with which the book is embellished have been skilfully chosen to illustrate the author's discussion and are excellently reproduced.

The author himself quotes the statement that "Spain is the land of bridges. In all Europe they have few rivals, . . ." and it is disappointing, therefore, that more space has not been devoted to describing and illustrating Spanish bridges, especially as such quaint legends are attached to some of them: it is said of the bridge of St. Martin in Toledo, for example, that when the architect was finishing it he became aware of a grave error he had made, and, as he was certain that when the centre scaffolding was removed the bridge would collapse, he fell ill from anxiety. His wife, in order to conceal his mistake, set fire to the wood during the night and the bridge did indeed collapse. The architect next time made better plans and no one discovered his first error, as it was believed that the fire had been accidental. The sculptured head above the keystone of the main arch is said to be that of the architect's wife.

If a second edition of this book is required, it is hoped that the author will add a further chapter to give the reader an idea of modern trends in construction and some of the most interesting bridges which are projected. There is at present no mention of the use of new materials such as aluminium, the use of new methods of fabrication such as welding, or the potentialities of two-pin prestressed construction in steel or reinforced concrete; it would be interesting to have the author's views on all these topics and also to hear something of the work already done on such projected bridges as those across the River Severn and across the Straits of Messina.

R. H. Macmillan

50–100 Binomial Tables

By Harry G. Romig. (Wiley Publications in Statistics.) Pp. xxvii+172. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 32*s*. net.

THIS book is concerned with the tabulation of the individual terms in the binomial expansion of $(q + p)^n$ where $q = 1 - p$, and with the cumulative sums of these terms. For each value of $x(< n)$, there are a corresponding term $\binom{n}{x} q^{n-x}p^x$ and a corresponding cumulative sum formed by the addition of all the terms up to and including this particular one. Clearly, all the sequences of cumulative sums are strictly increasing to the limit unity.

The tables provide for values of n lying between 50 and 100 (inclusive) in steps of 5, with p ranging from 0·01 to 0·50 at 0·01 intervals. For values of p between 0·51 and 0·99 we merely replace x by $n - x$ and interchange p and q. All the entries are to six decimal places, and the values of x thus cease in any particular expansion when the corresponding term in that expansion is zero to this order of approximation. For example, when $n = 75$ and $p = 0{\cdot}50$, the largest significant value of x is 59, and the smallest 16.

With the aid of these tables it is thus a matter of seconds to determine the probability of the occurrence of a given number of events (or of that number or less) in a sample of appropriate size. The usefulness of such a book in the field of quality control of manufactured products is thus assured, but (to quote the foreword) there will evidently be many uses for it outside this field.

The author, who was for many years engaged on quality control as a member of the technical staff of Bell Telephone Laboratories, has included a comprehensive introduction to the tables, describing their use and the methods of computation and interpolation used in their construction.

Les Fonctions Orthogonales dans les Problèmes aux Limites de la Physique Mathématique

(Monographies du Centre National de la Recherche Scientifique.) Par Théodore Vogel. Pp. 192+4. (Paris: Éditions du Centre National de la Recherche Scientifique, 1953.) 1200 francs.

MOST engineers and physicists are familiar with the simple but powerful method of solution of the differential equations which occur in problems of wave propagation, heat transmission, etc., and which is applicable in cases where the variables are separable and where consequently the solutions are expressible in series of orthogonal functions. However, a detailed mathematical discussion of these functions is rarely included in text-books of mathematical physics, and T. Vogel's monograph should therefore prove most useful. The mathematical treatment is direct and rigorous, but only as rigorous as is required for use in problems in applied physics.

The contents consist of three chapters. The first is devoted to a study of the general properties of orthogonal functions and differential systems including perturbed systems; the second to some particular closed series, for example, the Fourier series, and other series of orthogonal polynomials and Bessel, Legendre and Mathieu functions; and the third considers several applications to particular problems, including those involving the wave equation with boundary conditions, Laplace's equation in potential theory and in the theory of elasticity, the heat equation $c\rho \frac{d\theta}{dt} = Q + \text{div}\,(\text{grad}\,\theta)$ in heat and hydrodynamics, and examples of calculations in which perturbation and variational methods are most suitable.

S. WEINTROUB

The Moon Puzzle

A Revived Classical Theory correlating the Origin of the Moon with many problems in Natural Science. By N. O. Bergquist. Pp. xiii+378. (Copenhagen: Grafisk Forlag, 1954.) n.p.

THE author of this book, who is a chemical engineer, believes that his theory forms a synthesis between the many puzzles confronting the geologist, palæontologist, geophysicist and astronomer. The main thesis of the book is that about 60 million years ago a planetoid struck the earth and lost so much energy by the collision that it fell into the sun; as a result of the impact a portion of the earth was torn off and afterwards formed the moon. The crust of the earth was given a sliding motion over the core which was tilted some degrees so that the rotational axis of the globe received a new inclination; before the collision there were no seasonal changes on the earth, "because the axis of the earth was not tilted against the ecliptic as it is now" (p. 292). So many changes are said to have occurred on the earth as a result of the collision that it is impossible to refer to all of them, but one in particular may be mentioned. Although the first flood-wave—the immediate consequence of the original impact and the quick acceleration of the earth's rotation—must have caused the death of vast numbers of saurians, the latter were not then completely exterminated. The expulsion of the material that formed the moon, followed by the creation of the Pacific and Indian Oceans and the successive flattening out of the earth, resulting from its increased rotational speed, was followed by the appearance of much dry land. This was unsuitable as breeding places for the saurians and, with other factors, was responsible for a swift end to their existence. Most of the book runs on similar lines, and in its compass of about 100,000 words little is left unexplained. It is doubtful if Mr. Bergquist's appeal to mathematicians to examine his theories will meet with any response.

M. D.

Introduction à la Lecture des Cartes Géologiques

Par Antoine Bonté. Second edition. Pp. 278. (Paris Masson et Cie., 1953.) 1660 francs.

THE subject-matter of M. A. Bonté's book can be roughly divided into those chapters which are primarily concerned with the interpretation of geological maps and structures, and those dealing with ancillary topics—mapping methods, block diagrams, aerial photography, and descriptions of French topographic and geological maps. The book opens with a brief outline of the principles of stratigraphy and correlation, and then goes on to describe tectonic structures in general. The numerous examples are unfortunately illustrated in plan or in section only; more block diagrams would help to remind the reader that geological structures are three-dimensional. Map interpretation proper begins with simple examples of superficial deposits, horizontal beds, V-ing into valleys, etc., and continues with examples taken from the 1 : 80,000 "Carte Géologique de France". Elementary graphical constructions—three-point problems, stratum contours, completion of outcrop, etc.—are explained with carefully drawn diagrams. Igneous intrusions are badly neglected; no mention is made of dykes, sills, ring-structures, or other minor bodies, and even batholiths are dismissed in one page containing a very simple diagram.

This book would be helpful to students who have already had some preliminary instruction in map interpretation, and seek to broaden their outlook. The general standard of the problems lies between that required for intermediate and that of a general degree. It is a useful reference book, because it contains illustrated descriptions of many French tectonic terms, index maps of the "Carte Géologique de France", and a summary of official geological maps of the countries surrounding France, together with names of agents from whom they may be obtained.

GILBERT WILSON

Manual of the Polarizing Microscope

By Dr. A. F. Hallimond. Second edition. Pp. 204. York : Cooke, Troughton and Simms, Ltd., 1953.) 15*s*.

THIS very useful practical handbook is written with particular reference to the series of polarizing microscopes and accessories made by its publishers; but it will be eminently useful to all who have occasion to work with any kind of polarizing microscope. The present, second edition, is greatly enlarged and virtually a new work. The approach is essentially a practical one, with little of the mathematical theory of the microscope, but with emphasis on the necessary adjustments of the apparatus, on he errors consequent on maladjustment, and on the various methods available for the measurement of hose optical constants for which the polarizing microscope is particularly adapted.

After a short historical introduction and chapters on the construction of the polarizing microscope and its accessories, Dr. A. F. Hallimond discusses in detail the methods available for the measurement of optical path-differences, extinction angles, and pleohroism in transparent media. Apparatus for the examination of opaque materials by reflected polarized light is then described, and the theory of the eflexion of polarized light at normal incidence from anisotropic absorbing media is clearly outlined. This leads to the methods of measurement of the constants of absorbing media, including the reflecting power, xtinction angles, rotation of the plane of polarization n reflexion, and path-difference on reflexion, and to the accurate measurement of the constants of an lliptically polarized beam of light. The universal stage is then discussed, including both orthoscopic and conoscopic techniques, and its use in determinations of refractive index. A final chapter deals with the grinding and polishing of opaque minerals, with mphasis on those aspects which differ from metallurgical practice.

M. H. HEY

College Chemistry

A Systematic Approach. By Harry H. Sisler, Calvin A. Van der Werf and Arthur W. Davidson. Pp. x + 23. (New York: The Macmillan Company, 1953.) .25 dollars.

AFTER a decade of teaching, the three authors combined their ideas and wrote "General Chemistry: a Systematic Approach", a text for rst-year (American) university students. In this work they expounded, as well as customary introuctory matter, the electronic theory of valency, the structures of solids, and other theoretical principles elpful in explaining chemical behaviour. Then, instead of leaving these ideas isolated in their several chapters, they applied them faithfully and consistently to explain the chemistry of the elements and compounds they describe. The resulting book contains the finest simple account of the selected modern theory and of its use in interpreting chemical action that the reviewer has so far met.

In response to an appeal the text of 870 pages has been abridged to make the "College Chemistry", now under review. The plan of the smaller book and the logical presentation of subject-matter are as before. The authors explain new terms such as ionization potential, ionic size, ionic radius, atomic crystals and ionic crystals, and point out the bearing of these on chemical action; they describe the Brönsted and the Lewis conceptions of an acid, discourse on the relation of acidity and basicity to electronic structure, and generally throughout the book stress the dependence of property on structure. Electronic configurations of atoms and molecules are extensively used. The subject-matter covers approximately the requirements in general and inorganic chemistry of British intermediate examinations. In addition, there is a section (47 pp.) on organic chemistry and its importance in the world of to-day. There are numerous illustrations and ample sets of questions and numerical problems. This is the kind of inorganic text for which many teachers and students have been looking.

G. FOWLES

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 2, Part B: Alicyclic Compounds. Pp. xiv+489–1092. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) 105*s*. net.

IT is in no way derogatory to the sections of this work already published to state that the appearance of this volume has been awaited with particular interest, including, as it does, two highly topical but somewhat complex subjects, the steroids and the triterpenes. For a worthwhile review of these two classes, the middle path of mere competence is of no use whatsoever; the task must be done superbly well or not at all. Fortunately, the editor has ensured the necessary excellence by calling on Prof. D. H. R. Barton to expound the intricacies of the triterpenes, while the steroids are in the able hands of Prof. and Mrs. C. W. Shoppee (steroid studies seem conducive towards husband and wife partnerships). From these authoritative sources one expects a great deal, and expectation is fully justified. The complicated elucidations of structure are clearly described, and stereochemical implications are kept well to the fore. Especially welcome is the admirable and timely survey of the recent remarkable synthetic feats in the steroid field.

Prof. Barton (aided by Dr. S. H. Harper) has also shouldered the burden of describing the simpler mono-, sesqui- and di-terpenes. Much of this work is solidly classical; but recent studies are also fully discussed, one of the most interesting being the elucidation, at long last, of the structure of caryophyllene and its congeners.

In a book of this scope, clear presentation of the complex formulæ involved is essential, and here one can only regard the feats of the compositor with awestruck gratitude. The flow-sheets, especially, are models of clarity and, although errors inevitably occur (for example, omission of the 11-keto group in some formulæ on p. 976), they are few and relatively trivial.

R. A. RAPHAEL

RESEARCH ON THE MAMMALS OF AFRICA

By Dr. L. HARRISON MATTHEWS, F.R.S.
Director, Zoological Society of London

LITTLE more than a hundred years have passed since hunters such as Gordon Cumming were at their work among the vast herds of big game in the southern quarter of Africa, and little more than fifty since Selous was making a living by ivory hunting somewhat farther to the north. All those countless thousands of animals have now disappeared for ever; a few survivors are scattered over parts of the country, and some herds remain where they are preserved in the National Parks. The opening-up and white settlement of East Africa did not come until later, but although the same process of decimation began, and many parts of the country have been cleared of game, it is still possible to see great herds of wild animals that recall the accounts of conditions in South Africa given by the early travellers.

Nevertheless, the presence of enormous herds of game animals is quite incompatible with the economic exploitation of the country and the rapid expansion of the native population; the game must go, and there can be no hope of its survival outside the National Parks and game reserves. It is probable that within a century all the game of Africa will be enclosed within fences (or excluded without), and some species will have been exterminated. As yet, however, there is practically no information available on the biology of these mammals, information that is essential for successfully managing such parks and reserves. Little if anything is known of the carrying capacity per acre, in terms of game animals, of any African territory, nothing exact about the numbers of animals normally present or their fluctuations, about breeding-cycles, food preferences and requirements, or the effects of game on the environment, about the relationships of prey to predators, the incidence of parasites, and innumerable allied subjects.

Although such vast numbers of animals have been available to observation, it is surprising that so little is known about the biology of any species. A great quantity of scattered notes has been recorded about the distribution of game animals, and a small amount about their habits; but few indeed are the naturalists who have set out patiently to investigate all the details of the life-history of any one species. The information available comes mostly from sportsmen whose main interest is in killing animals, or from the casual observations of the tourist who has neither the ability nor the inclination to make a really serious study of them. Much incidental information has been collected by the numerous scientific expeditions that have gone into the field; but the main object of even their activities has been to collect dead specimens for museums rather than to study living animals. A notable exception, though it worked in Malaysia and not Africa, was the Asiatic Primate Expedition of 1937[1,2], financed by the Carnegie Institution and other American bodies, which devoted much time to studying the biology of pes as well as to collecting material for laboratory xamination and for museum exhibition at home.

Many museums throughout the world have been at pains to send out expeditions for collecting specimens "before it is too late"—yet how many complete skeletons of such a common animal as the tiger, for example, are available for study among the institutions up and down Great Britain? Now at last some zoologists are trying, also before it is too late, to make some study of the biology of the numerous interesting mammals that may not be available for study under completely wild conditions in the not so distant future. During the past twenty years a start at least has been made, and several workers have made reports upon the biology o single species that form a modest beginning to the volume of work that may be hoped for in the years to come.

Although the African elephant-shrew is a smal species and cannot be classified with the game animals, the researches of the late Prof. C. J. Van der Horst[3-5] on this creature must be mentioned here for they were among the first that offered an intensive study of any species of African mammal. They were concerned chiefly with problems of the breeding cycle, with the extraordinary phenomenon of superovulation that is very pronounced in this species and with placentation and development. Van der Horst's untimely death was a great blow to the study of African mammals; it is much to be hoped tha worthy successors will be forthcoming to fill the gap left by his loss.

In the years before the Second World War I was able, thanks to a grant-in-aid of expenses from th Royal Society, to spend some time in East Africa studying the reproduction, bionomics and systematic of the spotted hyæna[6-8]. The results were incorporated in several papers, and were privileged to be among the first to present an attempt at a comprehensiv account of all the main aspects of the biology of any of the larger African mammals. The investigation o the reproductive anatomy and habits of the hyæna which had been the subject of peculiar legends sinc the time of Aristotle, and probably long before showed that the hyæna's well-known propensity fo prolonged bouts of ribald laughter is, by anthropomorphic standards, not without foundation. During the course of this research it was possible to collec much information on the biology of some of th smaller mammals of Tanganyika.

Immediately after the War, Prof. P. A. Buxton was struck by the great waste of biological materia inseparable from the methods of elephant control i tropical East Africa, and was the moving spirit i forming the Elephant Research Committee that wa responsible for sending Dr. J. Perry to Uganda fo two years, primarily to study the reproductive cycl of the African elephant in the wild. Perry's papers[9,10] on this subject, and on several other aspects of th biology of the elephant, are an important contributio to African zoology, and his incidental researche on other African mammals have provided a larg amount of valuable material.

Concurrently, Dr. Lorna Kellas was working in Tanganyika on similar problems in the dik-dik, one of the lesser species of antelope that, by reason of their small size and the luxuriant cover available, are among the less conspicuous of the game animals. The results of her researches[11], now in the press, give a complete account of the breeding cycle and the placentation, and much other information on the biology of these beautiful little creatures. Dr. Kellas has recently been in Africa again, collecting biological material during a great 'kill-out' of game in a campaign against the tsetse fly in the southern Sudan, and it is confidently expected that her studies will add considerably to our knowledge of the biology of African mammals. An endeavour is being made to continue this collecting when operations are resumed next season.

Investigations into the incidence of yellow fever in East Africa and into methods for its control have necessitated considerable studies on the biology of the mammals other than man that act as reservoirs for the parasite causing the disease. The researches of A. J. Haddow[12] on the biology of the red-tailed monkey of East Africa, made in connexion with the yellow fever research, form one of the most complete investigations of any single species of African mammal, and bring together with a mass of original observations all that is known of the species, from its habits, ecology and parasites to the native legends clinging to it. Further contributions on other species are awaited from this author.

The latest similar investigation, which is still in progress, is that of Allan Brooks, who while holding a Colonial Research Fellowship has made a three years study of all aspects of the biology of the Thompson's gazelle of Tanganyika Territory. During his work he has been attached to the Tanganyika Game Department, from which he has received unlimited support and to which he has been able to render no little assistance.

It is greatly regretted that when the clearance of the country for the abortive ground-nuts scheme was undertaken no zoologist was informed of the material that might have become available for scientific examination. As a consequence, more than nine hundred black rhinoceroses were slaughtered and left to the hyenas and vultures—a timely postcard to the right quarter could have ensured that a zoologist would have been enabled to take advantage of this great destruction and have turned it to some use in elucidating many of the unanswered questions about the life-cycle of this interesting species. It is hoped that arrangements can be made to take advantage of a 'kill-out' of black rhinoceros on a much smaller scale (about fifty animals) that is shortly to be undertaken in an area of Uganda.

The desirability of making a proper scientific investigation of the mammals of Africa while there is yet time has now received official recognition, for the Game Subcommittee of the Tsetse Fly and Trypanosomiasis Committee of the Colonial Office has recommended the establishment of a team of biologists for the purpose. It was proposed that this team should work in one of the East African territories, and that it should be financed by the Governments of Tanganyika, Kenya and Uganda jointly; the arrangements were nearing completion two years ago when the promised financial support was withdrawn by one of the Governments at the last moment, and since then political disturbances have precluded a renewal of negotiations. The matter will no doubt be taken up again as soon as conditions are more favourable.

In the meantime, it is interesting to note that a fully qualified zoologist has now been added to the establishment of the Game Department of Tanganyika Territory, and one, unfortunately only temporarily, to the Veterinary Department of the Sudan; both these officers are now at work in the field. It is much to be hoped that other Governments will follow these examples and make similar appointments. The Scientific Council for Africa South of the Sahara, and the Colonial Office, are both supporting the efforts being made in various quarters to promote research on African mammals, and the Colonial Office is at present employing a zoologist to prepare a historical survey of the past and present distribution of the more important mammals. This work is being done by Miss O. J. Sidney, who has been provided with accommodation in the library of the Zoological Society of London; her researches are approaching completion and will be an invaluable background for future field workers.

The latest enterprise to promote research on the African fauna is a study-leave course primarily for officers in the Game Departments but also for those officers in other Colonial services who have the inclination and opportunities for field-work. The course is designed to give officers who have had no academic biological training some understanding of the biology of mammals and of the scientific approach to its study, and in particular to give some help in the problems that can profitably be taken up in the field by those whose tastes lie in that direction. The course consists of a fortnight's instruction at the Zoological Society of London, including demonstrations, practical work and reading; a week in the Department of Mammals at the British Museum (Natural History), where systematics and local faunas are studied; and a fortnight of instruction and demonstrations on problems of the breeding-cycle at the Royal Veterinary College. The first experimental course was held in the autumn of 1953, and at the request of the Colonial Office a second course is being provided in 1954. It is hoped that this course will become an annual event and that its usefulness will grow as experience is gained in meeting the special needs of those attending so that they may derive the utmost benefit from it.

Time is short, practically everything still remains to be done; but there is a considerable body of enthusiastic people who, if given some basic instruction and guidance, can lay the foundations for the proper investigation of the fauna of tropical lands. The information that they can collect is desirable in itself for academic science, and is essential for arriving at the correct methods of wild-life management in the National Parks and reserves where all the large species of land animals will sooner or later be segregated.

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GENETICS AND THE ADVANCEMENT OF SCIENCE

THAT zoologists and botanists, on September 6 devoted a whole day's joint session at the British Association meeting at Oxford to discuss genetics in relation to other biological sciences is perhaps evidence enough for its importance and central position. The subjects covered by the speakers, which included taxonomy and evolution, biometry and animal and plant breeding, medicine, physiology and microbiology, confirm this view. If this were not proof enough, the different methods of exposition adopted by the speakers—the historical, the broad generalization, the concrete examples illustrating one or two points, the read paper and the extempore—were in themselves a living and immediate demonstration of the great influence genetics has on human behaviour—that subtle character which is generally believed to be most tractable. This unconscious genetic experiment had its control group, for three of the speakers, all of them different in their methods, come from the same environment—the school founded by Bateson. If identical twins, trained in different schools, had been included among the speakers the experimental design would have been well-nigh perfect.

In discussing taxonomy, Prof. J. Heslop-Harrison said that almost every aspect of genetical research is relevant to taxonomy, but it would not cause a revolution in the system. Its contribution was to be found in the concept of a species as a biological unit, and that species differed generally in complex genic or structural chromosomal differences which had accumulated gradually over a long period. Genetics had revealed the nature of interspecific barriers, and a study of breeding systems as well as chromosomal analysis was essential for the proper assessment of a group: evidence for this was seen in the difficult taxonomic genera which had since been found to have an unorthodox breeding system such as apomixis. Because the full effect of genetical research had not yet been felt in taxonomy, a plea was made for reciprocal exchange of ideas and results from the two disciplines. Perhaps the speaker was unaware that geneticists are often greatly impressed with classification, because its groupings are usually confirmed by genetical studies. It would be too much to hope that genetics could give to the whole of classification the meaning and unity which atomic physics has given to the far simpler classification of the atomic table, but in some families a comparable correspondence between taxonomic differences and genetic structure can be found.

Prof. K. Mather, in his historical account of the internecine war within genetics between the Galton–Pearson group of biometricians and the Bateson school of Mendelians, traced its origin to the entirely different experimental approach adopted by the two sides to the problem of heredity. Mendel studied single sharply defined characters in carefully chosen material, the pure breeding pea, and he ignored all other variation. The confirmation of Mendel's laws by Bateson in many other plants and animals showed its wide application. Galton and Pearson, on the other hand, attempted to take into account the whole of the variation by measuring individuals, and dividing the variation into heritable and non-heritable from the correlations of these measurements for parent and offspring. The type of continuous variation found by Galton did not agree with the discontinuous variation found by Mendel. The synthesis of these was made by Sir Ronald Fisher in 1918 when he showed that a continuously variable character such as height in man could be explained on Mendelian laws by merely postulating a number of genes each with a small effect. This synthesis has been developed and is now being applied to practical breeding. But Prof. Mather pointed out that present biometrical methods such as the analysis of variance were unable to cope with the great complexities of gene interactions which occur with such polygenic systems.

Darwin was handicapped when formulating his theory of evolution by not having a basis for heredity, for he was unaware of Mendel's work. This importance of genetics for the interpretation of evolution was illustrated by Dr. E. B. Ford, who described his recent researches in the laboratory and field with butterflies. Much of Dr. Ford's earlier work had shown that the expression of a heterozygote could be altered by selection, as originally postulated by Fisher. In other words, the dominance properties of a gene could be changed. A colour pattern which in the wild was controlled by a gene with incomplete dominance—the heterozygote being intermediate between the two dominants—could be easily changed to full dominance by selection in the laboratory. That dominance was not present in the wild indicated that the heterozygotic intermediate phenotype had some selective advantage over the two homozygotes. Polymorphism for wing spotting in wild population in south-east England and the Scilly Isles had been mapped in relation to natural barriers. Small changes in vegetation in areas across an island were enough to separate populations having either a bimodal or a unimodal distribution of spots.

Turning to the practical application of genetics: Dr. A. Robertson pointed out how the early attempts in animal breeding to combine high milk yield and high fat content had failed to give the expected results on Mendelian theory, because the synthesis of biometry and mendelism had not then been made. The large number of genes concerned in these two characters, even without the complication of linkage, would require very large progenies to recover the desired combination. But the biometrical background had since been applied to practical problems with great success, particularly in the United States. A principle had emerged that with a character of high selective value there would be little genetic variation left on which to make further selection, but with a character of low selective value there would be a store of genetic variation. The application of genetic principles depended upon the type o breeding system adopted by the whole society o stock raisers. The selling of bulls from a few herds—bulls which conform to the fashionable but false standard of shape—means that all the herds of a breed are permeated with the genes from the few bull-selling herds. The use of such bulls within the existing breeding system was the cause for the failure of artificial insemination to increase milk yields. To get the full value of artificial insemination the criteria for selecting bulls must be changed.

The plant and animal breeders' problems are fundamentally similar, but differ in detail such as the number of individuals that can be raised. The large and expensive animal is a severe limitation on numbers which would never trouble a wheat breeder

Prof. S. C. Harland described how plant selectors and hybridists without any genetical knowledge had obtained great success. But this was due to the accommodating nature of their material, and the use of genetical principles would have speeded the results. The concept of 'gene erosion' was a problem which all breeders had to face. Rigorous selection for one character was usually accompanied by a loss of 'fitness' genes. For example, the selection of large flowers in sweet peas had produced sterility under certain conditions. Such unbalanced types would not survive in the wild; but the unbalance was to a certain extent counteracted by the artificial environment of agriculture. Thus the main problem is one of genotype and environment, the study of which requires both genetics and physiology. Another important factor was mutability, for the problem of releasing variability in some material is a real handicap to the breeder. To-day, plant improvement rests largely on complex characters such as disease resistance, and hence a full knowledge of the genetics and biochemistry of physiological races is necessary.

The problems of human genetics have to be tackled differently from those in animals and plants. Prof. L. R. Penrose showed how many different morphological and physiological peculiarities are known now to be due to single genes. Some of these effects can be mitigated by treatment, others cannot. There was a fallacy in the argument advanced by some geneticists that under the cover of improved hygiene and nutrition the population is said to be deteriorating genetically. The example of the relationship between sickle-cell anæmia and resistance to malaria was evidence for this fallacy, for it showed that a gene need not necessarily be wholly good or bad. The gene for sickle-cell anæmia in a heterozygote confers complete resistance to malaria, a property which is of obvious advantage in tropical countries. In this case the hygienic control of malaria actually reduces the incidence of the sickle-cell gene. The full physiological effects of genes and the future requirements of the human race are not known, and since variety is generally advantageous it was an unsound policy to try and get rid of genes by sterilization.

The physiological effects of genes was discussed by Dr. D. Lewis, who stated that the gene, although its conception had changed from the billiard ball to a piece of chromosome of varying complexity and length, was still a working physiological unit. The effects of the gene controlling sexual incompatibility in plants was known in sufficient detail to enable us to draw a close parallel between the type of genetic control and the physiological mechanism. This relationship between genetics and physiology had a predictive value which could be applied to quite different systems; for example, to the relationship between a host plant and its fungal parasite. The cytoplasm—that other hereditary factor, less rigorous and usually subservient to the gene but a factor which plays the major part in differentiation, ageing and perhaps short-term adaptation—was now beginning not to obey rules but at least to show remarkably similar properties in organisms as diverse as the tomato, fruit fly, *Paramecium* and yeast. Since the gene was the prime cause of all physiological effect, and the cytoplasm was the means of transmitting that effect, a genetic study from the gene outwards and a physiological study inwards provided a fruitful meeting ground for collaboration.

The application of genetics to micro-organisms, particularly those which have no normal sexual cycle, was described by Dr. J. A. Roper (in a joint contribution with Dr. G. Pontecorvo). On the classical genetic theory the reassortment of genes required sexual reproduction, but in several asexual micro-organisms a 'para sexual' phenomenon occurred which made genetic analysis possible. In bacteria, transformation by a pure nucleic acid occurred; in filamentous fungi, exchange of whole chromosomes or even somatic crossing-over occurred. Micro-organisms were particularly suitable for physiological genetics where the specificity of each gene determining a single biochemical reaction had been found in great numbers.

The importance of micro-organisms was emphasized by Prof. C. D. Darlington in his summing-up. In micro-organisms development was telescoped in such a way that the gene was closer to the character, until in the virus the gene and the character were one. The almost unnoticed demonstration in 1924 of the precise segregation of characters in the four spores of a moss transferred Mendel's laws from a statistical to a direct observational basis. The taking of genetics into the field and city, that is, into real life, had begun, and a similarity of the field-work of Dr. Ford on butterflies and the sickle-cell anæmia by Allison referred to by Prof. Penrose indicated that the whole of human society could be a vast genetic experiment. But Prof. Darlington ended his talk by saying that in view of the failure of the universities and especially the social scientists to keep abreast of the advances in fundamental or genetic biology, Dr. E. D. Adrian's suggestion, in his presidential address, that mankind should be handed over for treatment to the social scientists made him "gasp".

The genes are, to use Darlington's phrase, the "long-range determiners" of not only morphological peculiarities but also of human behaviour: this is still not realized in universities and many research institutes. As for the public, it has always loathed the idea of genetic determination and has clung to the cherished and flattering old wives' tales that come within the framework of Lamarckism and not of genetics.

D. LEWIS

WEATHER FORECASTING

THE discussion on weather forecasting, arranged by Section A (Mathematics and Physics) of the British Association and held in Oxford on September 6—as might be expected after a disastrous summer with weather more than usually a matter of public concern—drew a large gathering to the Sheldonian Theatre. The chair was taken by Prof. E. H. Neville and later by Sir Harold Spencer Jones, who introduced the guest speaker from Sweden, Prof. C. G. Rossby, now director of the Meteorological Institute of the University of Stockholm but equally renowned for his work in the United States, having held chairs in both Chicago and the Massachusetts Institute of Technology.

In opening the discussion with a paper on weather forecasting as a problem in physics, Dr. R. C. Sutcliffe first remarked that weather forecasting is something more than the science on which *it* rests; it is a scientific profession with some hundreds of practitioners issuing some thousands of forecasts daily for a wide variety of purposes. In a short paper it was possible only to indicate the general nature of the scientific problems; but in weather forecasting where it is impossible for every interested member of the public to be given personal advice on his own particular problem, it is particularly important that the client should have some understanding of the subject.

The problems of weather forecasting may be regarded as falling within the scope of hydrodynamics, but the methods which have been successful in other fields have so far contributed relatively little to the practical problems of weather prediction as they arise from day to day. This is because the problems are extremely complex, being concerned with non-steady and turbulent motions in the compressible fluid of a heat engine working against friction. The system is not even closed, and the composition of the fluid is continuously changing by evaporation, condensation and precipitation. Meteorology must therefore be studied as a science in its own right, and predictions about the atmosphere must depend on its observed structure and behaviour.

Dr. Sutcliffe was mainly concerned to emphasize the different scales of atmospheric systems. On any one day the circulation of the atmosphere differs widely from the long-term climatological mean, and examples from surface and upper-air weather maps of the northern hemisphere were used for showing how depressions and anticyclones frequently form over periods of one or two days. These systems are well understood scientifically and, as Prof. Rossby showed later, can be predicted by hydrodynamical theory; but they are essentially a form of large-scale turbulence and after a period of one or two days predictions become very uncertain.

Variability is present on many smaller scales—frontal systems, vertical convective systems down to variations on the scale of kilometres and metres. Much of this variability is beyond the reach of regular observations and can only be treated in statistical terms.

Weather forecasting, Dr. Sutcliffe remarked, can be regarded as based on five considerations: (1) the change in the large-scale synoptic situation; this can give for one or two days ahead the broad character of the weather and wind; (2) the effects of fronts—allowing fairly accurate timing of rain areas and major changes of wind, temperature, etc., for periods of some 12 hr. ahead; (3) the convective properties of the air masses—permitting statistical-probability statements on showers, thunderstorms, convective cloud, visibility, etc.; (4) diurnal changes—these are major considerations for temperature, humidity, convective phenomena and visibility; and (5) topographical effects—these introduce many local differences in weather.

Although formally these aspects may be considered separately, they are not independent.

Owing to the rapidity with which changes take place and to the element of dynamical instability which enters into the developments, there seems no present prospect of eliminating uncertainty from weather forecasts. Dr. Sutcliffe expressed himself as optimistic about dynamical meteorology, which has made great progress in very recent years; but he was not optimistic about persuading the atmosphere to behave in a more orderly way.

Mr. V. R. Coles spoke of the work of a practising forecaster. The forecaster depends in the first place on obtaining adequate observations, and the absence of reporting ships in some areas, for example, south of Greenland and even in the Bay of Biscay, is often a serious handicap. The stationary ocean weather ships in the Atlantic are a great boon. The erratic behaviour of depressions was illustrated by examples where extrapolation would give a good prediction and others where it failed completely. In recent years much attention has been given to upper-air conditions, and relationships between the consideration of the upper thickness or thermal patterns and the development and movement of surface depressions have been established. Mr. Coles illustrated the success of this method with an example of the rapid formation of a new anticyclone which had been very satisfactorily predicted. The methods of extrapolation, the use of tendencies and the indications from the upper air are not always consistent, and Mr. Coles thought that if much greater accuracy in forecasting is to come, it will probably be by the use of objective methods of calculation using electronic methods.

The first two speakers were mainly concerned with forecasts for some 24 hr. ahead made familiar to the public by Press and broadcasting, and it fell to Dr. J. M. Stagg to consider the possibilities of prediction for longer periods. Experience has shown, he said, that attempts to extend the forecasts to a few days ahead by the methods discussed by earlier speakers meet with little success; the accuracy falls away very quickly after the first 30–36 hr. But nevertheless, it is a commonplace observation that weather has a 'moodiness', and generally bright or dull or rainy weather may persist for long periods. Meteorologists have therefore looked for something in the atmosphere more enduring than the simple depressions and anticyclones.

Dr. Stagg referred first to certain purely empirical methods to which much attention has been given. The field of surface pressure has been elaborately analysed for periodicities and correlated with measures of geomagnetic and solar activity, and although much has been learned about the modes of oscillation of our atmosphere, little of prediction value has resulted. A phenomenon referred to as symmetry in the pressure–time curve has been discovered in Germany, in which variations of pressure have been shown to repeat in reverse order after a point in time known as a 'symmetry point'. But tests made in England were no more successful than others based on extrapolations of pressure trends; by the time a trend has become established it is already on the way to another rhythm or pattern. Methods of correlation, although they have had some success in India for monsoon prediction, generally fail in a similar way. It is not surprising that the atmospheric machine produces good relationships for a time in a particular area, as these would reflect the mode of circulation during the period; but if the mode changes, so will the correlations, and their prediction value may well be slight.

Dr. Stagg sees more of scientific interest in the dynamical-synoptic studies using mean weather charts for periods of days. In the United States, the Weather Bureau has introduced forecasts for five days, and more recently for thirty days ahead, on the basis of continuity in the evolution of mean upper-air charts over these periods. The methods have apparently had a measure of success, but are still mainly empirical, depending largely on the extrapolation of trends which may suddenly change for no known reason.

In the U.S.S.R. most attention has been given to the movements of anticyclones as the more enduring features of the synoptic patterns, and Dr. Stagg thinks it is no coincidence that long-range forecasting has been established in the great continental areas. Over the British Isles we are next door to one of the world's worst cockpits of weather disturbances, and even a slight error in predicting the mean tracks of depressions can make a forecast completely wrong for the whole country. Dr. Stagg stressed the need for physical understanding of the processes, and referred to research going on in the Meteorological Office; but he also reminded the audience of a remark made by Sir Gilbert Walker, speaking to the British Association twenty-one years ago: "Though the prestige of a meteorological service may be raised for a year or two by the issue of longer range forecasts, the harm done to the science will inevitably outweigh the good if the prophecies are found unreliable".

Prof. Rossby introduced the subject of 'numerical weather forecasting' by referring again to the broad spectrum of frequencies in atmospheric disturbances which was the theme of Dr. Sutcliffe's paper. 'Weather', in the sense of clouds and rainfall, is produced mainly by the smaller-scale disturbances which have relatively large vertical components of motion. The largest scale motions, with dimensions of some 5,000 km., are necessarily quasi-horizontal, and it is these motions which have now been shown to be amenable to direct calculation with useful accuracy. The calculations will not produce a detailed weather forecast; but they may still prove to be of much assistance to the forecaster by keeping him on the correct broad lines over periods of one or two days.

The conception of forecasting by calculation on the basis of the physical equations originated in Britain with the late L. F. Richardson some thirty years ago, but the ideas were at that time quite premature as there was no practicable way of carrying out the heavy computations. It was not until 1947 that the subject was taken up seriously at the Institute of Advanced Studies in Princeton, and since then there has been rapid progress on a research basis not only in the United States but also in Britain, where the work of Sawyer and Bushby is outstanding. In Sweden, with its present limited facilities for electronic computing, Prof. Rossby has confined attention to the simplest model of large-scale atmospheric behaviour, but he expects to be in a position to introduce more elaborate and realistic calculations in the near future. The basic idea was put very simply by Prof. Rossby. It has been shown that the vorticity (about the vertical axis) of the mean motion of the atmosphere is nearly a conservative property. It can therefore be advected with the mean motion. But by integration, with known boundary conditions, the motion itself can be calculated from the vorticity field so that, using a step-by-step method, it is possible to begin with the present known motion, determine the new field of vorticity for, say, one hour ahead by advection, compute the new field of motion by integration and so continue indefinitely until such time as accumulated errors render the calculations worthless. Mathematical refinements have improved on this simple scheme, but the principle remains the same.

Prof. Rossby remarked that "a weather forecast is a rather perishable commodity which must be marketed quickly". Only electronic methods can reduce the time of calculation to anything reasonable, as even in his present simple model there are 10^7 operations to carry out to produce a 24-hr. prediction. But it now seems that the time spent in calculation will not be the most serious item. Much more time will be spent in making, transmitting and collecting the observations from the large area involved (some six hours) and in plotting and analysing the charts (some three hours). Attention will have to be given to these factors, and already objective analysis and diagrammatic recording are being studied.

To show once more that the computations can deal only with the broad synoptic situation and not with the details of weather, Prof. Rossby provided a diagram showing the distortion which may take place in a layer of fluid over a period of a day or two. Beginning as a chequered square of some 500 km. side, the 'fluid element' altered shape by hydrodynamical 'deformation' as though it were a handkerchief flourished in the magician's hand, with all pattern becoming confused in the folds. To analyse such motion in the practical case would require the number of observations to be increased by one or two orders of magnitude.

It was regrettable that time did not permit of general discussion after the papers, but perhaps the mistake had been in making the subject so broad. Weather forecasting is concerned to some extent with almost the whole science of meteorology, and any one of the four papers could have provided the basis for a profitable morning's symposium.

OBITUARIES

Dr. E. S. Russell, O.B.E.

In the death of E. S. Russell, on August 24, zoology lost one of its foremost thinkers. Many knew Russell as a friendly and quiet companion, who even as president of the Linnean Society of London always seemed to be as it were 'off duty'; but the formidable character underneath was revealed, for example, in the concluding passage of "Form and Function" (Murray, 1916):

"Dogmatic materialism and dogmatic theories of evolution have in the past tended to blind us to the complexity and mysteriousness of vital phenomena. We need to look at living things with new eyes and a truer sympathy. We shall then see them as active, living, passionate beings like ourselves, and we shall seek in our morphology to interpret as far as may be their form in terms of their activity.

"This is what Aristotle tried to do, and a succession of master-minds after him. We shall do well to get all the help from them we can."

Those were remarkably confident words from a man not thirty years of age. By now, thirty-eight years later, we have experienced part of the fulfilment of his demand, in the insight gained into the nature of animals by von Koehler and Bierens de Haan, by Lorenz, von Fritsch and Tinbergen; and the corresponding morphology is clearly on its way, indeed begun, by Baerends and others.

All Russell's books are exciting, alike for their scholarly marshalling of facts and for their heterodoxy. Lamarck and Samuel Butler receive honour only a little less than that accorded to his chosen guides: Aristotle, Cuvier, von Baer and Johannes Mueller.

From 1921 to 1945 Russell was director of fishery investigations in the Ministry of Agriculture and Fisheries. As a fishery naturalist he had shown a talent for handling statistical material, conjuring biological and ecological discoveries from the records of quantities and sizes of fish on the fish-markets. Later, he decided to clarify the problem of the relation between the yield of a fishery and the vital processes that produce it: growth and reproduction, less mortality. Starting from first principles, he published, in 1931, "Some Theoretical Considerations . . .", and, as it transpired, ushered in a period of new understanding of this problem.

In the Conseil Permanent International pour l'Exploration de la Mer, Russell was an active officer; and it was there that during 1930–35 he persuaded the European governments to embark on regulation of mesh of nets and size limits for fish in the over-fished regions.

This was clearly a man of great and many-sided ability: a critic who shaped irreversibly the course of zoology and of fishery research; a sensible and humane administrator; fond of animals, naturalists and fishermen—he would always help any of them. He led a staff of scientists wisely, teaching us reliance on personality rather than in arrangements, and handing on his own sceptical appreciation that things are rarely what they seem. Would that there were more like him.

MICHAEL GRAHAM

Dr. Jean White-Haney

THE death occurred in the United States on October 21, 1953, of Dr. Jean White-Haney, daughter of the late Mr. E. J. White, one-time assistant government astronomer in Melbourne. She was born in 1877, and after attending the Presbyterian Ladies College entered the University of Melbourne in 1901 to study biology, and graduated as B.Sc. in 1904 and M.Sc. in 1906. She was awarded a McBain Research Scholarship in the same year, and began research in the Botany Department under Prof. A. J. Ewart, at the same time taking University tutorials and teaching science at several schools, including her former one. She was also a University examiner at the public examinations. In 1908 she began full-time research under a grant from the Victorian Government. Between 1907 and 1911 thirteen papers bearing her name were published, eight papers on joint studies with Prof. Ewart and others on the flora of Australia, and also an appendix to his paper on longevity of seeds. In 1909 she was awarded a doctorate of science, being the second woman in Australia to receive this degree, for a thesis entitled "The Ferments and Latent Life of Resting Seed" which was published in the *Proceedings of the Royal Society of London*. Two papers on bitter pit in apples aroused great interest and controversy among horticulturists and staffs of State agricultural departments; the tentative view put forward by herself and Prof. Ewart, that bitter pit could be caused by arsenical spraying, was warmly debated. She was unable to complete the investigation, which was taken over by others under a joint arrangement between Federal and State Governments.

In 1912 she was appointed officer in charge of the Queensland Prickly Pear Board's research station in Dulacca, to initiate work towards eradication of this pest. In this she established the value of arsenical injections and sprays in killing the Dulacca prickly pear (*Opuntia inermis*) and of the wild cochineal insect in killing *Opuntia monacantha*, which was spreading in North Queensland and was afterwards eradicated by the insects. This work was recorded in four reports.

In 1916 she discontinued scientific work, having married Mr. Victor Haney in 1914. She continued to live in Queensland, and was member, and for a time secretary, of the Lyceum Club in Brisbane. In 1928, after further school teaching in Melbourne, she joined the staff of the Council for Scientific and Industrial Research as biological assistant and field officer. While in this position she wrote a history of Australian scientific work on the prickly pear. In 1929 she began a field investigation of the Noogoora burr (*Xanthium pungens*), which was a trouble in sheep pastures in New South Wales, and completed the basic taxonomic studies and survey of its distribution. In 1930 she joined her husband in the United States, and thereafter retired from active scientific work. Apart from one visit to Australia in 1936, she remained in that country until her death.

Dr. White-Haney is remembered by friends and former pupils for her genial personality and the enthusiasm she showed for anything she undertook, and which she succeeded in communicating to others. Several of those whose interest in biology she aroused at school, or at the university, have since made it their life's study. Even after her retirement she maintained an interest in science, and she regretted that the circumstances of her life prevented further active work, and also that she had to leave to others the completion of those investigations that she started.

R. O. TRAILL

Prof. L. J. Stadler

THE death occurred on May 11 of Lewis J. Stadler. Born at St. Louis on July 6, 1896, he received his B.S. degree at the University of Florida in 1917, and his doctorate from the University of Missouri in 1922. After working at Harvard as a National Research Fellow in biology, he became professor of field crops at the University of Missouri. At various times he occupied the position of visiting professor at the California Institute of Technology and that of senior geneticist and later principal geneticist to the Bureau of Plant Industry of the U.S. Department of Agriculture (1930–37).

Prof. Stadler was a member of the Botanical Society of America, the Genetics Society of America (of which he was president in 1938), the American Philosophical Society and the National Academy of Sciences.

His researches were principally in the field of induced mutations in plants, and his important contribution, "The Experimental Alteration of Heredity", published as Chapter 1 in "Science in Progress", Series II, contains the gist of his findings. His work has been of great significance for plant breeding, since the induction of mutations by the use of X-rays, ultra-violet light and other agents is now a valuable technique, which has been the means of effecting valuable improvements in agricultural plants. The *American Scientist* rightly says of him: "A great scientist with a friendly spirit has departed. He will long be remembered for his devotion to scientific research and especially its application to human needs".

S. C. HARLAND

NEWS and VIEWS

Council for British Archæology: Scientific Research Committee

On October 1, the Executive of the Council recommended the formation of a Scientific Research Committee. This is to co-ordinate, and advise on, the applications of scientific research to archæology, to organize and screen the submission of archæological material for expert examination, and generally to act as a clearing house for information and ideas which are of mutual value to archæologists and other scientists. When the Council was formed in 1944, one of its first actions was to consider the many ways in which the natural sciences might be used to interpret and expand the results of archæological field-work. Much, for example, can be learnt of the ecological conditions in primitive settlements from a study of buried soils, peat, pollen and charcoal, while animal bones and even snail shells provide further valuable information about environment in early times. The petrological examination of stone axes, a study already begun by the Council for British Archæology, and the metallurgical analysis of implements and coins also throw light on prehistoric trade and intercourse.

These and other methods of augmenting the results of archæological discoveries were briefly outlined in "Notes for the Guidance of Archæologists in regard to Expert Evidence", published in 1947, which gave details of the facilities then available. The "Notes" are now out of date, not simply in detail, but also with respect to new scientific techniques such as the dating of archæological material by carbon-14 and fluorine content. Developments in science and technology are continually yielding new methods of potential use to archæologists who, in turn, are able to contribute to scientific research by providing accurately dated evidence for the study of metallic corrosion, cellulose degradation, and the earth's magnetic field. To promote further co-operation between scientists and archæologists, therefore, the Council had been considering the establishment of some form of permanent liaison. The proposal was first put forward earlier this year by Mr. L. Biek; and in April, a conference on "Archæology in the Laboratory" was held by the Council, at which scientists of various disciplines were invited to give their views. As a result of the conference, the Executive of the Council decided to recommend the formation of a Scientific Research Committee. Further information may be obtained from the Secretary, Council for British Archæology, 10 Bolton Gardens, London, S.W.5.

National Technical Information Services Officers

The first meeting of National Technical Information Services Officers, organized by the European Productivity Agency of the Organization for European Economic Co-operation, was held at the Department of Scientific and Industrial Research during September 27–October 2. Representatives from the following countries attended: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, The Netherlands, Norway, Sweden, Turkey and the United States. On September 27 Dr. A. King, chairman of the Productivity and Applied Research Committee of the European Productivity Agency and head of the Intelligence Division of the Department of Scientific and Industrial Research, welcomed the delegates. In the United Kingdom, the Department of Scientific and Industrial Research has been convinced for some time that technical information has an important part to play in the productivity drive; recently attention has been diverted from the mechanics of putting out information to the arrangements made in small and medium-sized firms to use such information. Speaking of the way in which technical information services at the national level can be run, Dr. King said that in the United Kingdom, which has a number of information services, the general policy is decentralization, leaving certain residual and co-ordinating functions to the Headquarters staff of the Department. This arrangement may not be suitable in many O.E.E.C. countries.

At one session of the meeting, 'question and answer' services in the United States, Germany and Great Britain were described, and there was general agreement that such services cannot be organized so that they pay for themselves. It was felt that O.E.E.C. could help by preparation of a paper on how question and answer centres were financed in different countries. As regards the interchange of questions and answers between national centres, it was thought that so far as possible questions should be directed to those countries in which specialized sources of information exist appropriate to the question. O.E.E.C. could facilitate this by treating as urgent the preparation of a guide to specialized technical information services in Europe. The preparation and distribution of technical digests were discussed, and in particular the problem of developing a European digest service was considered. It was thought that the best way of starting such a service would be for the European Productivity Agency to place contracts for the preparation of digests from the national literature in member countries. So far as possible these contracts would provide for the translation of the digests into one of the official languages, and would specify the type and quantity of digests required. In the meantime, the United Kingdom offered to make available copies of the United Kingdom digests at present prepared for circulation within the United Kingdom to any interested national centres. During the conference visits were made informally to the different sections of the D.S.I.R. Headquarters information services, and to the British Productivity Council, the Science Museum, the Patent Office and the Chemical Research Laboratory, Teddington.

Human Relations in Industry

A leaflet, "Human Relations in Industry" (London: H.M.S.O., 1*s.* net), which is being distributed through employers' organizations, trade unions, industrial and professional organizations and other agencies in Great Britain, contains the recommendations and conclusions of a Sub-committee of the National Joint Advisory Council. The Sub-committee concluded that neither the hard facts of Britain's economic and trading position nor the differing circumstances of individual firms are sufficiently understood in industry. The remedy for this does not lie solely within an individual firm, and the Sub-committee accordingly calls for much greater clarity and consistency in government pronouncements on this subject. The Press and other organs which help to mould opinion can also do much more to help by ensuring that what they say is itself informed by a clear and consistent understanding of our national position. The responsibility for achieving good relations is placed primarily on employers, though their efforts can be frustrated unless work-people on their side are ready to understand that any increase in their own real income depends on an increase in the prosperity of the country as a whole, and that an increase in the efficiency and prosperity of their own firms or establishments is an essential contribution to that general prosperity. Employers must therefore accept a responsibility for giving their work-people full and frank information about the fortunes of the firm. Good industrial relations are built on good faith and on mutual respect between employers' and workers' organizations, and the Sub-committee recommends that employers' organizations, nationalized industries and trade unions should increase their activities and those services which will assist in the development of such relations and that their attention should be directed to professional and other associations engaged in this field with the view of encouraging or supporting such work. The leaflet summarizes certain activities, advisory services and training courses in this field and briefly describes the work of the Committee on Human Relations in Industry which has been set up by the Department of Scientific and Industrial Research and the Medical Research Council.

Science in New Zealand

The address delivered by H.R.H. the Duke of Edinburgh before a meeting of New Zealand scientific workers in Wellington on January 13 has been published as Bulletin No. 4 of the Royal Society of New Zealand (pp. 4. Wellington: Royal Society of New Zealand, 1954). After a tribute to the work of New Zealand men of science and to the contributions of New Zealand in scientific development, the Duke said that, although sub-division and specialization are inevitable, the interest of the individual scientific workers need not be lessened by this specialization. The day of the private adventurer in science, however, is over. Even the universities cannot meet the demands of their science faculties and are increasingly dependent on public support. Although in general the public is sympathetic and understands that this is a necessary investment, he continued, the public can only be expected to provide the funds for scientific work for national purposes such as health, agriculture, transport and defence, if it is persuaded that science for itself is a good thing, that scientific workers and their leaders are worthy and that science directly affects conditions of life and work. Those working in science have a duty to help people to understand its various branches and methods and the conditions essential for scientific work, particularly in respect of freedom of thought and investigation and communication. No country can afford to wait for the fruits of scientific research to be handed to her, and New Zealand must herself participate in the search for new knowledge. The Duke thought that the efforts of New Zealand would be best applied to problems now at hand, and that if the right conditions are created New Zealand might expect to foster centres of original scientific work of which she could be proud. In applied research, however, particularly for military purposes, he thought it would be of enormous advantage if the countries of the British Commonwealth could pool their resources. There are not enough workers in any one country of the Commonwealth to provide all the up-to-date equipment necessary to ensure that each unit is properly prepared for a possible war, and he welcomed the creation of the New Zealand Defence Science Corps.

World Population and Resources

Prof. E. P. Stebbing, Romden Castle, Smarden, Kent, in a letter to the Editors, directs attention to what appears to be a serious omission in the PEP broadsheet with this title (see *Nature*, July 3, p. 1) and in the report of the symposium given by members of the executive of the International Geographical Union (*Nature*, June 26, p. 1218). He suggests that the conservation of water supplies is an even more pressing problem than those of finding food, materials, fuel and power for the rapidly increasing world population listed as the most urgent by PEP. In most parts of the world the maintenance of forests over catchment areas to secure an even flow of rivers and to prevent soil erosion and flooding is vital, though financially unproductive in a direct sense. Doubtless the authors of the PEP broadsheet would readily agree that water is the most vital of 'raw materials'; and the International Geographical Union has established a Commission on Arid Lands to study the problem, and its president, Prof. L. D. Stamp, has repeatedly urged that the control of water is the foundation of progress in the under-developed lands, notably Africa. The Food and Agriculture Organization has set up a Permanent European Working Party on the Conservation of Land and Water Resources and has asked all member countries to survey their areas. Unfortunately, no response has been received from the British Government, which indeed has suspended the work of the Inland Water Survey as an economy measure.

J. A. von Segner (1704–77)

A physician who made distinguished contributions to physics and mathematics, Johann Andreas von Segner was born in Pressburg (Bratislava), Czechoslovakia, two hundred and fifty years ago, on October 9, 1704. After studying philosophy at Debrecen, where the Cartesian teachings were still followed, he graduated M.D. at the University of Jena in 1730. Attending the lectures of Georg Erhard Hamberger, professor of medicine, he acquired his lifelong interest in mathematics. In 1733 he was appointed associate professor of philosophy at Jena, and two years later professor of physics and mathematics at the newly founded University of Göttingen, where after the death of J. W. Albrecht in 1736 he was for a time the only professor in the medical faculty. In 1755 he accepted the corresponding chair at Halle. An indefatigable worker and a voluminous writer of dissertations on physics, chemistry, mathematics, geometry and medicine, he introduced a naval barometer in 1743, and in 1750 constructed a water-wheel which bears his name. While he made no original discoveries in medicine, he refuted the theories of the iatromathematical school, establishing mathematics as a handmaiden of medicine. His acquaintance with the principles of Christian Wolf led him to abandon the Cartesian philosophy. Segner's scientific merits were recognized by his contemporaries, for he was created a privy counsellor and was granted letters of nobility by the king of Prussia. He died on October 5, 1777, at the age of seventy-three.

Steroid Reference Collection

The Clinical Endocrinology Committee of the Medical Research Council has been concerned for some time about the supply of reference compounds for work on steroid metabolism. Difficulties have been felt particularly since the introduction of paper chromatography. A few compounds have already been made available through the National Institute for Medical Research, and arrangements are now being made to supply a wider range of steroids. The reference steroids, particularly hormone metabolites, will be provided to recognized laboratories as standards for paper chromatography, colour reactions, infra-red measurements, and mixed melting-points; also, in some cases, as standards for new methods of determination in urine and blood. The preparation of this reference collection has begun, with the help of generous gifts of steroids from industrial firms in Great Britain and overseas. The following firms have contributed materials: British Drug Houses, London; CIBA A.G., Basel; Glaxo Laboratories, Ltd., Greenford, Middlesex; Merck and Co., Inc., Rahway, N.J.; Organon N.V., Oss, Holland; Organon Laboratories, Ltd., London; Parke, Davis and Co., Detroit, Michigan; Syntex S.A., Mexico; G. D. Searle and Co., Chicago, Illinois. Further details and lists of the materials at present available can be obtained from the Medical Research Council, 38 Old Queen Street, London, S.W.1. Requests for materials not listed, and suggestions for other steroids to be added to the collection, should be submitted to Dr. W. Klyne (Postgraduate Medical School, Ducane Road, London, W.12), who is organizing the preparation of the collection. Attempts will be made to find a source or to prepare small quantities of other materials if possible. If workers have other materials which they would be willing to put into the common pool, this would enable the scheme to progress more rapidly. Offers of such materials should be sent to Dr. Klyne. A similar scheme for the provision of reference steroids is already in operation in the United States under the auspices of the United States Pharmacopoeial Convention. It is hoped that it may be possible to arrange for the exchange of samples between the two schemes.

Solar Phenomena recorded at Kodaikanal Observatory

Bulletin Nos. 132 and 134 of the Kodaikanal Observatory embody the results of observations of prominences made at the Observatory during the year 1950. Supplementary data computed from photographs supplied by Meudon and Mt. Wilson Observatories for those days on which Kodaikanal had imperfect or no observations have been included in the bulletins. In addition to the prominences results, the results of magnetic observations made at the Observatory are included in each half-yearly Bulletin, starting with Part 2 of No. 132. The Magnetic Observatory was restarted in January 1949 as part of the post-war development programme of Kodaikanal Observatory, and this was due to the growing importance of geomagnetic observations in relation to solar phenomena and also to the proximity of Kodaikanal to the magnetic equator. Bulletin No. 133 gives the results of a statistical study of the sunspots observed at Kodaikanal during 1903–50, and compares the scheme of sunspot classification suggested by Cortie (*Astrophys. J.*, 13; 1901; and also *Mem. Brit. Astro. Assoc.*, 23; 1921), and Waldmeier's scheme (*Quart. Bull. Sol. Act.*, No. 77; 1947). A discussion of the relative merits of the two schemes leads to the conclusion that, in the absence of necessary arrangements for routine daily observations of the magnetic polarity of sunspots, and the necessity to adopt a scheme of visual classification which covers all the types met with in day-to-day observations (and this conforms to the usually observed life-cycle of the majority of sunspot groups and can be used unambiguously in daily work), Waldmeier's classification is more satisfactory.

The Pacific Islander and Modern Commerce

Under the title "The Pacific Islander and Modern Commerce", the South Pacific Commission has issued as Technical Paper No. 54 (pp. 29. Noumea, New Caledonia: South Pacific Commission, 1954; 2*s*.) a report by V. D. Stace, based on field investigations in Fiji, American and Western Samoa, Papua and New Guinea, including New Britain and New Ireland, Netherlands New Guinea and New Caledonia, during July–October 1952, on the current situation and needs of the indigenous people of the region. The most urgent problem is to deal effectively with the growing desire of these people to participate more effectively in the modern world. The chief conclusions of the investigation are that while improved credit and banking facilities could promote the economic welfare of the indigenous people, at the present stage of their economic and social development, technical and administrative assistance is much more urgently needed. In promoting economic development, the main requirements are incentives, organization and practical education. Village co-operative systems, which modify and rationalize but do not discard the basic elements of the traditional communal methods of organizing production in the Pacific Islands, are more valuable than methods and facilities developed to meet the needs of environments where individualism is the rule and not the exception.

Ethnobotany of Gilbert Islands

Prof. Katharine Luomala, anthropologist in the University of Hawaii, has written in some detail on the ethnobotany of the Gilbert Islands (*Bernice P. Bishop Museum Bull.*, 213, pp. 1–129, Honolulu, Hawaii, 1953). This report affords a useful collation of the available but scattered information about plants of the Gilbert Islands (Micronesia), with special reference to the ethnobotanical aspect in Tabiteuea, based on the author's own observations. The paper gives a general description of the Gilbert group, in terms of location, population, geographical features, climate, domestic plants and animals, etc., and then proceeds to a survey of the sources of botanical information relating to the whole archipelago. Finally, two annotated check lists of plants of the Gilbert Islands are presented: the first groups the plants by families—a comparatively small list; the second list, which occupies some seventy pages, deals alphabetically by local name with all known plants, some of these still awaiting formal botanical identification and naming.

Coryndon Memorial Museum: Report for 1953

The annual report of the Coryndon Memorial Museum, Nairobi, for 1953 (pp. 26+2 plates; from the Museum, Nairobi; 1954; 1*s*.), emphasizes the large amount of cultural activity which can be undertaken by an energetic curator and staff, even in a state of emergency. A fall in income from door receipts has been offset by an increase in certain grants. It is also recorded that the curator, Dr.

L. S. B. Leakey, owing to his special knowledge of the Kikuyu and their language, has devoted much time to duties connected with the Mau Mau disturbances. The year also witnessed the official opening of the new wing by which the exhibition area in the Museum is more than doubled. The extension includes some specially designed screens with paintings of botanical subjects arranged in taxonomic order; habitat groups of coral reef and freshwater and marine fish; a large-scale relief map of the East African Territories; illustrations to explain volcanic formations, rift valleys and river meanders; minerals; Miocene and Pleistocene faunas; and the Hall of Man. A large amount of routine museum work has also been carried out in spite of the extra pressure connected with the new wing.

Growth of Wounded Etiolated *Avena* Seedlings

By using the infra-red image-converter viewing apparatus, C. L. Mer (*Ann. Bot.*, N.S., 18, 157; 1954) has studied the effects of accurately placed localized wounds on the growth of etiolated *Avena* seedlings. It was essential to manipulate and wound the plantlings in complete darkness; the method by which this was achieved is fully described. A hypodermic needle was used for the actual wounding operation. It is shown that the brief exposure to infra-red radiation does not affect the subsequent growth of the plants in darkness. The greatest effect on mesocotyl growth occurs when the node is wounded. A superficial wound in this region reduces growth by 22 per cent; a further reduction of 10 per cent takes place when the vascular system is interrupted. The growth of the coleoptile is also reduced when the node is wounded; the greater part of the reduction is due to the interruption of the vascular bundles. Wounding the plumule also reduces the growth of the seedlings; but the data are considered to be too meagre to warrant drawing firm conclusions. The results indicate that the node is the centre controlling mesocotyl growth.

College of Aeronautics: Awards

THE award of the English Electric Research Fellowship in Aeronautics for the academic year 1954–55 has been made to Mr. M. E. Filby, of 6 Hillview Avenue, Brockworth, Gloucester. Mr. Filby is a former student of Crypt Grammar School, Gloucester, and of Lincoln College, Oxford, where he obtained an honours degree in physics. He is at present a member of the staff of the Research Department of Gloster Aircraft Co., Ltd.

The award of the Perring Scholarship for the two-year course which begins in October 1954 has been made to Mr. G. E. Smith, of 12 Grenoble Gardens, Palmers Green, London, N.13. Mr. Smith was educated at Glendale Grammar School, London, and graduated at the Imperial College of Science and Technology, where he obtained a first-class honours degree in civil engineering.

Pan-African Congress on Prehistory

THE third meeting of the Pan-African Congress on Prehistory will be held in Livingstone, Northern Rhodesia, in July 1955, the provisional dates being July 11–16. During the course of the meeting the centenary will be celebrated of the discovery of the Victoria Falls by Dr. David Livingstone and the beginning of the systematic exploration of the interior parts of the African continent north of the Zambesi. The work of the Congress is at present divided into three sections (though additional sections may be added if deemed necessary), namely: quaternary geology, general palaeontology and climatology; human palaeontology; and prehistoric archaeology. At the meeting, symposia will be held on the Kalahari Sands, their definition, age, distribution and method of formation; the dating of the Australopithecinae; marine strand lines, their definition, altimetric and faunal correlations; the early pebble-tool cultures, their definition, dating and distribution; and the importance and application of the carbon-14 method of dating to African prehistoric cultures. It is also proposed to hold discussions on terminology, research programmes in prehistory and allied subjects in the various African territories, the control of excavations and the care and protection of sites, and the preparation of resolutions on these subjects. A number of excursions have been arranged both to sites of prehistoric remains and to the Victoria Falls, game reserves and other places of natural beauty or general interest. The organizing secretary for the meeting at Livingstone is Dr. J. D. Clark, curator of the Rhodes–Livingstone Museum. All correspondence should be directed to the Organizing Secretary, Third Pan-African Congress on Prehistory, Rhodes–Livingstone Museum, P.O. Box 124, Livingstone, Northern Rhodesia.

International Association of Applied Psychology

THE next Congress of the International Association of Applied Psychology will be held during July 18–23, 1955, in London, plenary sessions being in the Beveridge Hall of the Senate House, University of London, and sectional meetings in Birkbeck College (which adjoins the Senate House). In addition to the opening and closing sessions, four plenary sessions will be held on the following themes: the psychologist and society; the evaluation of methods in applied psychology—the problem of criteria; the relationship between research and practice; and the assessment of attitudes and the relation of attitude to behaviour. Only invited papers, taking up about half the time, will be given at these plenary sessions, the other half being for open discussion. The rest of the Congress will be taken up by meetings at which questions relating to particular aspects of applied psychology—especially educational, clinical and occupational psychology—will be discussed. Members wishing to offer a paper should send a summary of 250 words, before December 31, to the organizing secretary, Mr. Alec Rodger, at 14 Welbeck Street, London, W.1.

Conference on Endocrinology

A WHOLE-DAY conference on "Endocrinology" has been arranged by the Joint Biology Committee and will be held at the County Hall, London, on November 13. The speakers will be Dr. A. E. Stuart Mason, of the Medical Unit, London Hospital, on "Aspects of Endocrinology: Medical Research"; Dr. H. Gardiner-Hill, senior physician at St. Thomas's Hospital, London, on "Endocrinology from the Clinical Point of View"; Dr. T. Mann, of the Molteno Institute of Biology and Parasitology, University of Cambridge, on "Aspects of Endocrinology: the Biological Approach"; and Sir Francis Knowles, senior biology master at Marlborough College, on

"Opportunities and Limitations in the Teaching of Endocrinology at the pre-University Level". The final session will be thrown open for discussion on the points raised by the speakers earlier in the day. Applications for tickets (price 6*s.*) should be made to the Secretary, Joint Biology Committee, c/o British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1, from whom further particulars may be obtained.

Exhibition of Kinematography in London

An exhibition of kinematography, comprising films, wall displays and apparatus, will be held by the Kinematograph Group of the Royal Photographic Society in the Society's House, 16 Princes Gate, London, S.W.7, during December 3–18. The exhibition revives an event held regularly before the outbreak of the Second World War. The films will be divided into five sections on the application of kinematography to, respectively, industry, science, medicine, education and other specialized fields. Lectures and demonstrations will also be given. Films for the exhibition may be submitted in any gauge, sound or silent, black-and-white or colour, but the running-time of any one film should not exceed forty-five minutes. It is not essential that films should be the work of one person; they can be made by groups, societies or commercial undertakings. Intending entrants should obtain an entry form as soon as possible from the Honorary Secretary, Kinematograph Group (Exhibition Committee), 16 Princes Gate, London, S.W.7, and return Part 1 of the form, duly completed, as soon as possible. The films, accompanied by Part 2 of the entry form, should be sent in by October 30.

Radio Industry Council Awards

Since January 1, 1952, the Radio Industry Council has awarded premiums of 25 guineas each, up to an average of six a year, to writers of published articles, the object of the premiums being to encourage the publication of articles reporting technical progress and development of radio, television and electronics in Great Britain. The main points to be taken into consideration will be the value of the article in making known British achievement in radio and electronics; the originality of subject; technical interest; and presentation and clarity. Any writer will be eligible who is not paid a salary wholly or mainly for writing and not earning 25 per cent or more of his income from fees for articles or from book royalties. For articles written jointly, each author must be eligible, and the premium will be divided. Papers or periodicals which can be bought by the public on bookstalls or by subscription, at home or abroad, will be eligible, but not journals circulating exclusively to members of a trade, manufacturers' journals, or the privately published journals of professional institutions or learned societies. Entries should be made before December 31 by submitting five copies of the published article to the Secretary of the Radio Industry Council, 59 Russell Square, London, W.C.1.

Announcements

The nineteenth Parsons Memorial Lecture will be delivered at the Institution of Mechanical Engineers by Mr. F. Dollin on October 29 at 5.30 p.m.; Mr. Dollin will speak on "Factors Influencing the Continuing Development of the Steam Turbine".

In connexion with the celebration of the jubilee of the invention of the thermionic valve by Sir Ambrose Fleming on November 16, 1904, a conversazione and exhibition will be held during November 16–18 in the Electrical Engineering Department of University College, London, and a plaque commemorating the occasion will be unveiled by the Lord President of the Council. Admission is by ticket, application for which should be made to the Assistant Secretary, University College, Gower Street, London, W.C.1.

The twenty-eighth annual general meeting of the Bedson Club will be held in the Chemical Laboratories, King's College, Newcastle upon Tyne, on October 15, after which Prof. T. S. Westoll, J. B. Simpson professor of geology in King's College, will deliver a lecture on "Fossils I have Known". Other Bedson Lectures for 1954–55 are: Prof. A. R. Ubbelohde, "Some Physicochemical Studies on π-Electron Compounds" (October 29); Dr. F. G. Mann, "The Comparative Organic Chemistry of N, P and As" (November 12); Dr. R. P. Bell, "The Place of Theoretical Chemistry in Chemical Education" (February 11); and Prof. F. J. W. Roughton, "Rapid Reactions of Hæmoglobin with O_2 and CO" (March 11).

British Celanese, Ltd., announces the award of research studentships in chemistry, tenable for two years from October 1 at the institutions mentioned, as follows: Mr. R. B. Pearson (University College, London), Mr. A. M. North (University of Birmingham), Mr. J. L. Tayler (Imperial College of Science and Technology, London) and R. L. Vale (University of Birmingham).

The Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, commencing in October at the university or centre shown: *Husbandry:* I. C. Beattie, J. Frame, I. A. Munro and Miss S. M. Sweeney (University of Reading); D. C. Graham (University of California); A. M. M. McFarquhar (University of Leeds); Miss M. W. Murray (Ohio State University); W. C. Smith (Massey Agricultural College, New Zealand). The following current awards are being continued for a further period: *Husbandry:* J. Eadie (University of Edinburgh); T. D. MacLean (University of Reading); T. M. Sutherland (Iowa State College); *Agricultural Economics:* A. V. Vickery (Agricultural Economics Research Institute, Oxford); *Agricultural Engineering:* J. Roddan and J. H. S. Torrance (King's College, University of Durham).

A Conference on "Design and Application of Small Digital Computers" will be held at the Bellevue-Stratford Hotel, Philadelphia, during December 8–10. The programme includes papers on computer comparisons, input–output devices, computer systems and characteristics, mathematics, programming, and business and scientific applications. Further information can be obtained by writing to P. O. Box 7825, Philadelphia 1, Pa.

Referring to the communication entitled "Velocity of Electron Pulses" published in *Nature* of August 28, p. 398, the authors write: "We regret we omitted acknowledging the generous assistance of Imperial Chemical Industries, Ltd., which enabled one of us (D. L. R.) to carry on the work in the first year, and the maintenance grant of the Department of Scientific and Industrial Research, for the second year of these investigations".

SOCIAL AND INDIVIDUAL SIGNIFICANCE OF AGEING

THE presence of some five hundred delegates from more than fifty countries in London during July 19–23 for the third Congress of the International Association of Gerontology must be considered an important stage in the gestation of a 'science of ageing' in Great Britain. The three main sections were: (1) Biology and Pathology; (2) Geriatric Medicine and Psychiatry; and (3) Social and Psychological. This report will be restricted to the sixty or more papers in the third section. Dr. J. H. Sheldon in his presidential address stressed the dominance of the social implications of gerontology, and said that "in many countries old age is likely to become the major social problem over the next twenty years". He emphasized the necessity for keeping a sense of proportion, "remembering that those aspects of the therapeutic art which happen to possess greatest technical interest and challenge are not necessarily those of the greatest social importance".

There was considerable appreciation in this third section—though not confined to it—that the major concern should be with the quality rather than the quantity of the later years; that fundamental and applied research should now be directed more towards social and individual adjustments to an already greatly increased expectation of life, rather than to adding still further years to life. A prime objective, as Dr. Sheldon put it, is "so to maintain the general vigour of the old that their capacity to contribute to the common effort and above all to maintain their domestic independence, is retained as long as possible".

The sessions in this third section could be grouped into three main divisions, with the first providing the background. The second such division, here considered as "The Care and Welfare of the Aged and the Ageing", related more to the negative aspects of age, those of atrophy, degeneration and decline, and was concerned with ensuring better provision of medical and social care for those requiring this as a consequence of the infirmities of ageing. These sessions were: "Residential Care", "Integration of Plans for Care in Health and Infirmity" and "Personal Services, Community Activities, Casework and Counselling". The third grouping of sessions took greater cognizance of the positive aspects of ageing, those of growth, development and maturation: "Employment Problems of Older Workers", "Employment of the Elderly" (plenary session), "Experimental Study of Skill in the Elderly" (joint session with Section 1) and "Education for Later Maturity in the U.S.". A general heading here would be "The Utilization of Later Maturity".

Social Policy and Practice

The three main speakers in the first session, "Introduction to Problems of Social Policy", were Prof. A. Sauvy (Paris), dealing with the historical basis of gerontology, Sir Godfrey King, who provided a descriptive analysis of the operation of contemporary provisions for old age in Great Britain, and Prof. E. W. Burgess (Chicago). Prof. Sauvy outlined the three successive ways in which society has looked after its old people—a 'family phase', an 'individualist phase', and a developing 'social phase'. He considered that "the whole problem of old age must be placed on a new basis, or rather it is posed for the first time in an urgent fashion". Sir Godfrey stated that "if in general terms, we define our policy as being an intention to make old age as tolerable and pleasant as we can, many things will have to be done which will call for social decisions of the widest possible character", and that "we have only recently started to give special attention to problems of old age in this country".

Prof. Burgess discussed "The Human Aspects of Social Policy". He laid stress on a need, in planning for the well-being of older persons, for the realization that they "have essentially the same basic values and wishes as all other human beings". A social policy commensurate with the problems of ageing must take this into account—and also "the deteriorating role of older people in modern society". Older people, Prof. Burgess affirmed, have the desire common to others to engage in meaningful activities and to participate in and identify themselves with society: their need for a feeling of security is psychological as well as economic. In "meaningful activities" he included both work and recreation: "the findings of research indicate that work is not solely or even primarily a way of earning a living. It is a way of life by which people regulate and routinize their time, associate with their fellow workers, make use of their skills, gain recognition, achieve status, nurture a feeling of usefulness and find expression in creative activity and in the service of others".

The "Symposium on National Programmes" was not very informative, and it would appear that, strictly speaking, such programmes on age and ageing are not yet in evidence.

Mr. Clark Tibbitts, the chairman of the plenary session, "Critique of Surveys", specified the three areas of inquiry as: general conditions and adjustment of the elderly, their health status, and various aspects of employment of older people. The three papers provided illustrations of these. Dr. M. L. Barron (Cornell) described a nation-wide longitudinal investigation initiated in 1952 to study the effects of occupational retirement and the relationship between health, economic, psychological and social factors in old age; Dr. J. V. Zonnefield reported a medico-social survey of the aged in the Netherlands; and Mr. L. Moss commented on the data from the 1950 Ministry of Labour sample survey on the employment of the elderly. The chairman had pointed out that the primary concern for that session was in survey methods: "are the methods in use satisfactory for getting the kind of information wanted?"

Mr. Moss stated that the main purpose of the Social Survey inquiry was to get "an all-round appraisal of the problem". He gave an account of the rationale of the cross-sectional representative sample survey, showing its relation to detailed inquiries concentrating on one special aspect of a problem. Dr. Barron pointed out that longitudinal studies of the ageing process are better equipped to show relationships between certain factors than are cross-sectional surveys. In his address opening the discussion, Mr. Mark Abrams expressed doubts whether the survey methods in use in Great Britain are fully satisfactory: "we are in danger of merely multiplying our stock of familiar facts". He advocated a considerable widening of the age-span normally considered in old-age surveys, the use here of longitudinal studies of ageing, and also the necessity for a multi-discipline approach: "Hitherto statisticians and medical men have tended to have a monopoly of the planning, direction and interpretation of surveys; research would be more illuminating if their tasks were shared with experts from other fields—sociology, economics, architecture, government and even history".

Care and Welfare of the Aged and the Ageing

There was general agreement among the speakers on the need to prevent any undue increase in the institutional care of the aged. Apart from the shortage of existing hospital and similar accommodation and the mounting social burden involved, Dr. G. Evans, among others, emphasized that it is in the interests of older people that "residential care should be exceptional rather than normal"; main emphasis should be put on preventive work and rehabilitation. But though infirmity was not accepted as a dominant or necessary characteristic of later years, it was recognized that a greater incidence of this must be expected in the final years of life, and also that the increased numbers and proportion of the aged have already made heavy demands on available medical and nursing facilities. Dr. R. C. Walsh spoke of an inadequate response to the problem of the elderly sick and infirm as an "overshadowing challenge" calling for "an imaginative response from health and welfare organizations".

In his paper, "Making the Best of Available Accommodation", Dr. G. W. H. Townsend advocated that hospital beds should "be occupied by the right people and for as short a time as possible" and that "if we are to decrease the demand for beds, every precaution must be taken to see that the aged persons remain self-sufficient or at any rate members of their own family as long as possible". He stressed the value of day hospitals such as that pioneered by Dr. Cosin in Oxford. Dr. Nain Cowen spoke later of the Rutherglen Health Centre for Old People, the chief purpose of which is to keep older people active and healthy at home.

From the chair, Mrs. M. M. C. Kemball had directed attention to a required partnership embracing the family, the voluntary bodies and the statutory services for ensuring the health, care and attention of older people. Various delegates spoke of the importance of enabling the family to make its vital contribution to this partnership and gave accounts of ancillary services and aids provided by voluntary and statutory bodies for this purpose, and to help preserve the independence of the elderly.

Many speakers discussed what is in effect another type of welfare as most appropriate to those not functionally old, that being to allow, encourage and enable them to live substantially normal lives for as long as possible with continued exercise of their capacities and for a fuller development of their personalities over the penultimate period of life. Mr. L. Kuplan's paper, "The Community and the Senior Citizen", was a declaration of the principles basic to this approach, as well as a report of what he described as "an exciting demonstration of democracy in action". He said that, following a State-wide conference on the problems of ageing held in 1951, "the State of California and many of its cities and towns have accepted the principle that the older person must be encouraged and helped to remain an integral and contributory member of the community. Accepted also the corollary principle that the older person must be permitted to live through the later years in self-respect, dignity, security and usefulness". Dr. C. O. S. Blyth Brook, for one, spoke of the sense of service to others as well as the physical and mental exercise involved in suitable employment, as factors checking the conversion of senescence into senility. Dr. J. Weil (Ohio) said "the older person content only with leisure must lose his self-esteem—of purpose for living". The place and purpose of recreation for the well-being of the elderly was discussed by Miss G. E. Bowen (Philadelphia) and Miss V. Ingram (New York). They interpreted its true role as re-creation, so as "to bring the older persons back into the stream of life and help them maintain a maximum of mental health and usefulness" in "an active, creative routine instead of a dull, monotonous one".

Utilization of Later Maturity

"The goals of gerontology must not be viewed as revolving around putting oldsters to work, but to assure that older workers who need work, want work, and who can be fitted for work are given equal opportunities with others to obtain work." In saying this, Mr. A. J. Abrams (New York) had in mind "culture-borne negative attitudes to ageing" as an infringement of democratic, equalitarian concepts. He reported discrimination against older workers as universal, and even evident well before the sixties. He spoke also of initial steps being taken to offset this through job analysis, physical examinations, job counselling, re-training and "re-engineering of jobs to adapt them to ageing workers". An international pooling of data was advocated. But Mr. Abrams felt that, though more technical knowledge is required, there are "enough data already available—so that any country, determined to aid its older workers, need not flounder". Mr. J. A. Scott, in his "Placement of Older Workers", described successful Canadian experiments in older-age counselling. Dr. I. M. Richardson suggested that encouragement and enablement of older workers to go on working efficiently longer than at present is the central problem which would help to solve other problems of old age; but that true preventive measures must be made from the fifties or even earlier.

In his earlier commentary on the 1950 Social Survey, which showed that 23 per cent of the men had retired before sixty, average retiring age being sixty-two, Mr. Moss mentioned that the investigation had also shown no marked difference in the age at which men gave up jobs in different industries and occupations. An implication of this was, he felt, that it was not the actual demands of the job which determined time of retirement but rather attitudes—on the part of the workers themselves and of management. Mr. A. J. Abrams considered that though "oldsters themselves tend to accept the community's image of the older worker", there is a changing of attitudes from retirement, even early retirement, as a life goal. One finding of the British survey was that, at sixty-five years of age and older, much larger numbers of people had stated that they went on working because they preferred to be occupied, irrespective of economic necessity. In a later paper, Mr. J. Roberts dealt with factors in the trade union attitude to this question. He indicated that the principle of "the right to work" is now tentatively being extended to "the right to work for all adults irrespective of age".

Several papers touched on attitudes of employers to the employability of older workers. Mr. Moss felt that in spite of "a limited amount of goodwill" on the retention and taking on of such workers, "the prospects do not appear to be very favourable as long as present attitudes are dominant". Mr. A. J. Abrams mentioned the ineffectiveness of 'exhortation' or even 'proof' for removing age barriers in industry, and the necessity "to motivate top-management to examine personally this problem". "A Report on the Effectiveness of 3,000 Older Workers in a Sampling of American Business Firms" was given by Mr. R. L. Peterson. In this inquiry older workers were evaluated by their immediate supervisors, who used as a comparison "their concept of the average younger worker". The report findings, on those more than sixty years of age, showed "a work volume about the same as for younger workers", as well as less absenteeism, greater reliability and work of better quality. He stated that studies of this kind are influencing American employers to modify their employment programmes.

Mr. A. T. Welford outlined "a minimum programme of research" of an experimental psychological nature on capacities and job demands, which he felt would need to be completed "before a confident policy for employment of older people could be framed". But he pointed out that there are other questions demanding "a method of study which so far has been little used for work on ageing". Examples of these given by Mr. Welford were, "the direct measurement of performance at work on the shop floor and . . . experiments in modifying work to older people". In the joint session, "Experimental Study of Skill in the Elderly", Dr. H. E. Jones (California) observed that "the study of age changes in human abilities has a scientific history of hardly more than twenty years"; Mr. W. T. Singleton pointed out, moreover, that "research in the field of gerontology would appear to have been more concerned with somatic changes than with psychological ones". There were a number of references to the decline of certain mental abilities from a quite early age; but Mme. S. Pacaud (Paris), referring to her experimental studies, emphasized the importance of education as a check on the destructive effects of ageing, and Dr. D. Wechsler (New York) discussed the problems of appraising intelligence in older people; he questioned "whether identical tests identically performed measure the same thing" in this connexion; he also suggested that sagacity or wisdom is an added aspect of intelligence at later years.

Although the papers in the session "Education for Later Maturity" were all contributed by American speakers, a number of other delegates in various sessions stressed the importance of this factor. Three aspects of such education were considered: for personnel concerned with the care of the aged, for the ageing person himself, and for the community in general. Mr. A. J. Carlson discussed the value of adult education in "preparation for the senior years". Mr. O. J. Kaplan, in "Communication of Health Knowledge to Older Persons by Radio and Television", observed that "advances in gerontology have little meaning unless they are reflected in the life and habits of older persons . . . though there was much knowledge already it was misunderstood and unknown by many over 60". Two papers on projects for later-age education were given by Dr. Ruth Andrus and Dr. Wilma Donahue, and Dr. W. H. Reals, speaking on "Programmes for the Ageing in American Universities", reported their rapid development during the past six or seven years. From his surveys, Dr. Reals concluded, "there appears convincing evidence that the problems of ageing and educational provision for the older adult himself have become a definite and increasing concern of universities in the United States".

What would amount to a fourth aspect of 'education' on ageing was indicated by Dr. E. Digby, who questioned "whether there is sufficient thinking together of the biological, psychological and social sides". Miss E. I. Black also, as chairman of this third section, felt that it had a lot to learn from the discussion in the other sections—"but that the traffic should not be one way". This consideration, however, presupposes some evenness in the contribution of research data from the different fields of gerontological inquiry. Though ageing has now become "a major socio-medical problem", it is perhaps significant that there were very few papers of an essentially sociological character in this third section originally specified as "Sociology and Psychology". Dr. Sheldon's comment on "a lack of fundamental thinking in our approach to old age" appears to have a bearing here. In his address, however, Sir Godfrey King had remarked that, with other communities in similar demographic circumstances, "we are now going through a process of adjusting ourselves to the facts". There was an agreement among speakers that research findings from different fields of investigation would need to be taken into account by other specialists if the required unified though multi-aspect science of gerontology is actually to be constituted for the welfare of society.

C. Fleming

BEECH MYCORRHIZA

At the British Association meeting in Oxford on September 3, three papers were read before Section K (Botany) under the chairmanship of Dr. J. L. Harley on the subject of ectotrophic beech mycorrhizas. A great deal of progress has been made in recent years on this subject at Oxford by Dr. Harley and his collaborators: the speakers were pupils of his.

The first speaker, Dr. J. K. Brierley, showed that beech mycorrhizas consisted of a fungal sheath 25–40 μ thick which surrounded a core of host tissue. An account of experiments was given which helped to determine a route by which phosphorus passed through the fungal sheath to the host. He showed that when roots which had been exposed to labelled phosphate were transferred to *phosphate-free* aerated buffer solution, part of the phosphorus accumulated by the fungus during exposure to phosphate is redistributed to the host during the subsequent stage in phosphate-free buffer. Although previous experiments have shown that movement of phosphorus to the host takes place during absorption from an external supply, the experiments described here showed that movement could take place from previously accumulated phosphorus in the fungal tissues to the host in the absence of an external phosphorus supply. Redistribution, as this movement was called, was temperature-sensitive and had a Q_{10} of 2 or greater; it was sensitive to oxygen concentration and became very slow in rate when the oxygen concentration in the washing solution was below 3 per cent.

The observations therefore demonstrated that redistribution was a movement which depended upon metabolic processes and was thus an active transport. It seemed probable that active transport of phosphorus from fungus to host was dependent upon oxidative reactions which occurred in the fungal tissue and perhaps in a lesser degree only upon those of the host. Correlating these laboratory experiments with those made in the field, Dr. Brierley showed that the oxygen concentrations of beech litter, in which mycorrhizas are abundant, were high (about 20 per cent) throughout the year. Hence, under these conditions the rate of active transport to the host would not be impeded and the mechanism was potentially capable of maintaining a steady movement of phosphorus to the host from that accumulated in the fungus.

Dr. Brierley went on to describe experiments which showed that redistribution was diminished in rate when roots were washed in buffer containing phosphate. When roots which had been returned to phosphate-free buffer after a period in buffer containing phosphate, redistribution, temporarily prevented, was resumed at a rapid rate. It was suggested that the phosphate absorbed from the external solution competed successfully with the redistribution mechanism for a substance which, produced in respiratory metabolism, was important for phosphorus transport to the host, so that phosphorus accumulated by the fungus was not mobilized for redistribution. In the absence of external phosphate supply, phosphorus already accumulated into the fungus was utilized and redistribution occurred. Movement of phosphorus into the core was mainly from the external solution when this contained phosphate; but was from sheath phosphorus via the redistribution mechanism when the external supply was stopped. Under natural conditions, fluctuations in available phosphorus must occur, and where supplies of phosphorus were abundant redistribution might be unimportant as a source of phosphorus to the host; but when these supplies failed or became very low, redistribution to the host from phosphorus previously accumulated into the fungus might be of great importance.

In order to further understanding of the role of mineral nutrition in the ecology of beech mycorrhizas, experiments are in progress at Oxford on the uptake of another of the major nutrients, the cation potassium, in contradistinction to the phosphate anion. Mr. Wilson presented the results of some of these essentially preliminary experiments with potassium. Factors affecting the uptake of potassium have been studied by two methods: (1) using an EEL flame photometer measuring differences in K^+ concentration of a solution before and after presentation to the roots; (2) using Rb^{86} and an end-window Geiger counter. The uptakes of Rb^+ and K^+ have been shown to be similar under various conditions, when calculated on a millimolar/milli-equivalent basis.

Uptake of these alkali metals is at least partially metabolic, for sodium azide, iodoacetate, low temperatures (Q_{10} of uptake more than 2), and low oxygen tensions all reduce the uptake of Rb^+, and the last factor considerably reduces the rubidium percentage retained in the fungus. Not only do sodium azide and oxygen tensions less than 5 per cent reduce the uptake of Rb^+ from rubidium chloride, but they also cause a great release of K^+ into both demineralized water and into dilute potassium chloride. Stronger solutions of potassium chloride, however, reduce the net loss of K^+ in the absence of oxygen but increase the loss of Rb^+ in air from roots previously charged with Rb^+; further, the loss of Rb^+ into demineralized water has a much lower Q_{10} than has uptake. These facts indicate that the loss of K^+ and Rb^+ is at least partially a physical process. The Rb^+ accumulation ratio in rubidium chloride of nearly six times in the total absence of oxygen is partially by exchange, for approximately seven times as many milli-equivalents of K^+ are lost as are Rb^+ taken up under similar conditions. This loss of K^+ represents but 20 per cent of the original root content of about 3,000 μgm. potassium/100 mgm. dry weight of roots, of which approximately 45 per cent is in the sheath.

Buffering with sodium phthalate/sodium hydroxide showed that the Na^+ ion depressed Rb^+ uptake. Further experiments demonstrated that Na^+, K^+ and NH_4^+ caused depressions in the Rb^+ uptake of 10, 65 and 32 per cent, respectively, when equimolar with the 0·1 millimolar rubidium chloride solution, and that a depression of 50 per cent was produced by potassium chloride at 0·08 m*M* and by ammonium chloride at 1·8 m*M*, while sodium chloride appeared to be above 10·0 m*M*. Curves of uptake/concentration for the single salts sodium chloride and potassium chloride at the points of equal uptake in μ equivalents provided the ratio $\frac{[Na^+]}{[K^+]}$ in millimoles/litre = 1·3, which is far removed from their relative values as competitors with Rb^+. Further experiments are scheduled to determine the rates of uptake of K^+, Na^+, NH_4^+ in the presence of Rb^+ and of each other, and it is hoped these will clarify the nature of this problem.

Mr. J. S. Waid (now at the Grassland Research Station, Hurley) described the fungi which inhabit the surfaces of beech roots. He outlined a method of sampling fungi inhabiting the surfaces of uninfected roots and ectotrophic mycorrhizas: the method also demonstrated the pattern of colonization of roots by fungi, and confirms some visual observations. Roots were washed in sterile water contained in phials which were mechanically agitated. The water was changed at intervals and after twenty changes the roots were cut into 2-mm. fragments and implanted on nutrient agar plates. Dilution plates were made to determine the number of micro-organisms in the washings and showed that large numbers of sporing fungi characteristic of the 'rhizosphere' were removed from the root region in initial washings and very few in later washings. Microscopical examination showed that propagules were absent upon the surfaces of washed roots, and this evidence, together with that derived from sampling the washings, indicated that only the active mycelia of the root surfaces remained upon the washed fragments.

Examination of the roots of single seedlings showed that different types of fungal infection, including mycorrhizal, could occur on adjacent lateral systems. The population appearing from washed samples of laterals from the same host plant also showed great variation, but the majority of fungi on secondary laterals were non-sporing and a flora of clamp-bearing and sterile mycelia grew from mycorrhizas.

The tap roots bore a less variable but denser population, mainly of sporing fungi, but of different quality from the fungi appearing on Warcup soil plates made with soil from pots in which the plants had grown. Fungi were often absent on growing apices; but as the roots aged the population of fungi appearing on plates increased in numbers and was dominated by sporing fungi.

In another experiment seedlings were grown in beechwood soil but in light intensities ranging from 25·1 to 3·6 per cent daylight. Shading not only resulted in a decrease in the dry weight, free sugar content and the extent of mycorrhizal infection of the seedlings but led also to profound changes in the nature of the surface populations of main and lateral roots. However, these effects cannot be attributed to light alone but to other factors also, such as humidity and temperature.

The numbers of *Rhizoctonia* spp. and *Trichoderma viride* were favoured by decreasing and increasing radiation respectively. *Rhizoctonia*, which is pathogenic to seedlings, was antagonized on the sampling plates by *Trichoderma*, and as the season advanced and mycorrhizas developed, the numbers of the antagonist increased, while those of the pathogen decreased. There was evidence, however, that *Trichoderma* did not entirely determine the numbers of *Rhizoctonia* on the roots. It was indicated that the condition of the host plant plays a major part in determining the nature of its surface flora and that the observations were limited by the fact that a cultural technique was employed which favoured *Trichoderma*.

J. K. Brierley
J. S. Waid
J. M. Wilson

FIELD BIOLOGY AT THE KING EDWARD VI GRAMMAR SCHOOL, CAMP HILL, BIRMINGHAM

King Edward VI Grammar School, Camp Hill, Birmingham, has recently published a full report by its Natural History Society of a comprehensive survey of a selected area named for convenience Brown's Coppice, the actual name of the principal woodland on the site ("Brown's Coppice: a Survey". Pp. 79. Obtainable from The Secretary, The Natural History Society, King Edward VI Grammar School for Boys, Camp Hill, Birmingham. 5*s*. including postage). The site is about 130 acres in extent, and comprises eight distinct habitats. Forty members of the Society took part in the survey. The studies were divided into nine sections—botany, zoology, ornithology, entomology, edaphic factor, cartography, specialized photography, geography and local history; and a member was appointed to supervise the work of each section. (Later a pond section, devoted to the study of a flooded bomb crater, was added.)

The report is divided into three parts. Part 1 (Physical Features) deals with geography—general and regional setting, relief, drainage and climate; and land utilization—local history and agriculture. This report is commendably thorough, the first chapter being accompanied by six maps and figures and the second by two maps.

Part 2 (Dependent Factors) reports ecological studies—index of habitats, edaphic factor, biotic factor (plant and animal). The habitats included woodland (40 acres), bog (20 acres), pasture (20 acres), hedgerows, standing water (1 acre) and waste land (about 4 acres). This is accompanied by ten maps, transects and quadrats.

Part 3 (Natural History) covers the main groups of the flora and fauna. Twelve pages are needed to list the plants identified, and these are accompanied by six plates. The various fungi, too, are listed. Some good work in bacteriology is also reported, and this is of particular interest since the subject usually receives such scant treatment in schools. Similar detailed treatment is afforded to the fauna, including invertebrates and mammals; separate chapters are devoted to insects and birds. Further plates illustrate a giant puffball, two birds, a photomicrograph of a blow-fly and one of *Cyclops*.

Three appendixes complete this report, which is the most comprehensive and thorough of its kind which we have seen produced by a school. King Edward VI Grammar School, Camp Hill, Birmingham, is to be congratulated on a very worthy effort.

COMPARATIVE PERFORMANCE OF NICKEL AND POROUS ALUMINA SAMPLE HOLDERS FOR DIFFERENTIAL THERMAL ANALYSIS

During a comparative evaluation of the performance, under identical conditions, of porous sintered alumina and nickel specimen holders for use in differential thermal analysis, it was observed that for certain reactions involving the evolution of a gas, such as the thermal decomposition of a calcium hydroxide ($Ca(OH)_2$) and calcium carbonate ($CaCO_3$) and mixtures of these two compounds, the significant linear portion of the downsweep of the peak occurred at appreciably higher temperatures when using a nickel block than when using an alumina block of identical dimensions. The cylindrical sample holders used were 41 mm. high and 38 mm. in diameter, with sample wells 13 mm. wide and 19 mm. deep. A linear heating rate of 15° C. per min. was employed.

The curves obtained using the two types of sample holder are superimposed to facilitate interpretation (Fig. 1). The peak displacement observed is illustrated in curve 1 for a calcium hydroxide–calcium carbonate mixture, and in curve 2 for pure calcium carbonate.

This anomaly could not be accounted for by considerations of thermal conductivity or heat capacity, and it was also found that the peaks due to phase-changes such as the α–β quartz transformation[1] and the rhombic–trigonal inversion in strontium carbonate[2] showed no such displacement. This suggested that loss of gas in the decomposition of calcium hydroxide and carbonate might be responsible for the anomaly, in that the pores in the alumina sample holder permitted the escape of the gaseous decomposition products, lowering the concentration of the gas in the mass of sample, and so leading to the more rapid completion of the reaction. Following the reasoning that if the porous alumina block could be rendered impermeable to gas this effect would be eliminated, thin impervious linings of vitreous silica were fitted to the sample wells in the alumina block. In this modified block, the anomaly disappeared, as shown in curves 3 and 4, respectively, for calcium hydroxide and calcium carbonate. Bearing in mind

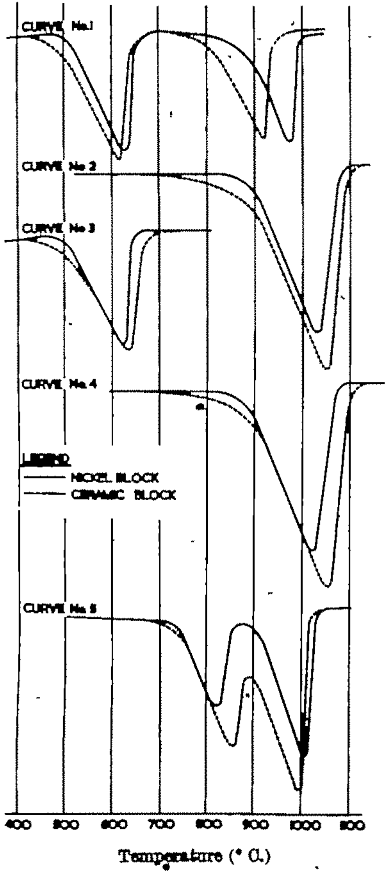

Fig. 1

that in a static atmosphere the thermal decomposition of magnesite appears to be virtually independent of carbon dioxide pressure[3], and according to Stone[4] even in a dynamic atmosphere considerably less dependent than calcite on carbon dioxide pressure, thermal analyses of magnesite were carried out in the unsleeved alumina block and the nickel block. No peak displacement was found, confirming the explanation postulated above. Arising from the report by Haul and Heystek[5] that while reduction of the carbon dioxide pressure in the furnace atmosphere has no effect on the position of the first dolomite peak, it displaces the calcium carbonate peak downwards, determinations on dolomite in both the unsleeved alumina and nickel holders were carried out. These yielded the thermograms shown in curve 5, in which the coincidence of the significant portions of the first peaks, and the downward displacement of the calcium carbonate peak in the thermogram obtained using the porous holder, can be clearly seen, affording further confirmation.

The fact that the displacement of the calcium carbonate peak in the calcium hydroxide–calcium carbonate mixture is far greater than in pure calcium carbonate (curves 1 and 2) is accounted for by the same factor. In the mixture, after the hydroxide has decomposed, the resulting calcium oxide undergoes an exothermic solid-phase reaction[6] with the carbon dioxide produced in the initial stages of the decomposition of the carbonate, particularly in the hotter peripheral parts of the sample well. This exothermic reaction masks the earlier part of the endothermic decomposition of the calcium carbonate by cancellation. This effect is much more pronounced in the impervious walled nickel specimen holder than in the porous alumina cell, where much of the carbon dioxide produced is lost by diffusion.

This effect has also been observed in samples of calcium hydroxide compacted to very different densities in the nickel sample holder; as the density increases, with a consequent decrease in porosity, the peak is displaced to a higher temperature, as much as 20° C. for a change in sample bulk density of 100 per cent.

These observations illustrate the need for standardization of sample holders, the bulk density and porosity of the thermo-active material and also the geometry of the sample well as pointed out by Arens[6].

The comparison of the two types of sample holder has also shown that for endothermic reactions such as the decomposition of calcium hydroxide, calcium carbonate and magnesium carbonate, the nickel block is only slightly less sensitive than a ceramic holder. At temperatures of about 500° C., it gives peak areas which are about 80 per cent of those for the ceramic block and at about 900° C., about 70 per cent. The nickel holder yields peaks which are sharper (that is, they have a greater amplitude in relation to their width) and it also has greater resolving power (hence closely adjacent peaks can be more clearly differentiated), as illustrated in curve 5. This effect is partially due to the more definite point of inflexion on the curve where it first leaves the base-line in thermograms obtained using the nickel block. This characteristic is most clearly shown in curves 3 and 4. The fact that it also occurs in the thermogram for magnesite shows that this effect is not due to porosity. It is ascribed to the higher thermal conductivity of the nickel holder, a factor believed to operate as follows. Endothermic decomposition commences in those portions of the sample nearest the walls of the sample well, and, in the case of the nickel holder, heat is readily available from the large mass of metal of high conductivity in contact with the cooler decomposing material. Rapid heat-flow into this superficial layer masks the early part of the reaction by neutralizing the endothermic effect before it can affect the differential thermo-junction. It is for this reason that the endothermic reaction appears to start at a higher temperature in the nickel holder. When the temperature reaches a value at which the rate of decomposition becomes so rapid that the heat from the nickel can no longer penetrate the increasingly thick layer of decomposed material of low thermal conductivity sufficiently rapidly to neutralize the endothermic effect, the reaction quickly manifests itself, reaching, for the rest of the decomposition period, a rate comparable with that prevailing in the ceramic holder.

Under identical and closely controlled experimental conditions, the variations in all the significant parameters for the calcium hydroxide peak were lower in thermograms obtained using the nickel sample holder, namely, about 1 per cent compared to 2 per cent in the case of the peak areas. The temperature difference between the furnace atmosphere and the centre of the inert reference material is smaller in the nickel holder than in the ceramic, varying from respectively 25 and 40° C. at 100° C., through 11 and 28° C. at 500° C. to 4 and 12° C. at 1,000° C.

A full account of these and related findings will be published elsewhere. This communication is published by permission of the South African Council for Scientific and Industrial Research, and acknowledgment is made to Mr. J. E. Kruger for assistance in this work.

T. L. Webb

National Building Research Institute,
Council for Scientific and Industrial Research,
Pretoria. June 18.

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Somewhat similar experiments to those described by Mr. T. L. Webb have recently been carried out, quite independently, at the Macaulay Institute for Soil Research; but clay minerals were used for all comparisons. Porous sintered alumina and nickel specimen holders with cylindrical sample-wells and of identical dimensions, conforming to those previously described for the same apparatus[1], were used; in addition, the nickel holder could be fitted with a lid. The results corroborate those of Mr. Webb; but as they are somewhat complementary and additional observations were made, a brief note upon the findings seems desirable.

The curves obtained for the main endothermic peak of kaolinite (the 'standard' sample used for differential thermal analysis standardization[2]) using the porous alumina specimen holder, the nickel specimen holder, and the nickel specimen holder with lid are shown superposed in Fig. 1. The difference between the curves for the porous alumina and nickel holders is similar to that described by Mr. Webb for calcium hydroxide, and previously reported by Gérard-Hirne and Lamy[3] for kaolinite; namely, using the nickel holder, the peak is smaller (about 75 per cent the area of that in the alumina holder), the peak temperature is higher by about 6° C., and the peak is sharper and apparently becomes more asymmetric. The apparent asymmetry is not, however, reflected to any extent in the 'slope ratio'[4], which for both curves is approximately 1·12. Additional confirmation of Mr. Webb's hypotheses regarding the effects of nickel specimen holder upon thermal peaks is afforded by the curve for the nickel specimen holder fitted with lid (Fig. 1). This both reduces the ease of diffusion of gaseous products away from the sample and provides an additional nickel surface in contact with the sample. Comparing the curve with that for the nickel specimen holder without lid, the expected features are observed; namely, using the lid, the peak area becomes slightly smaller (about 90–95 per cent of that without the lid), the peak temperature is higher by about 10° C., the peak is somewhat narrower, and the asymmetry increases (slope ratio about 1·30). This asymmetry would, of course, be expected because of the more rapid heat conduction into the sample from nickel than from alumina while the specimen is returning to normal base-line conditions.

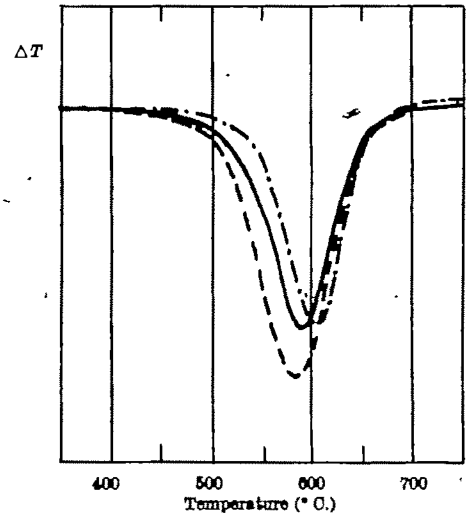

Fig. 1. Thermograms for the main endothermic peak of kaolinite in a porous alumina specimen holder (– – – –), a nickel specimen holder (———), and a nickel specimen holder with lid (—·—)

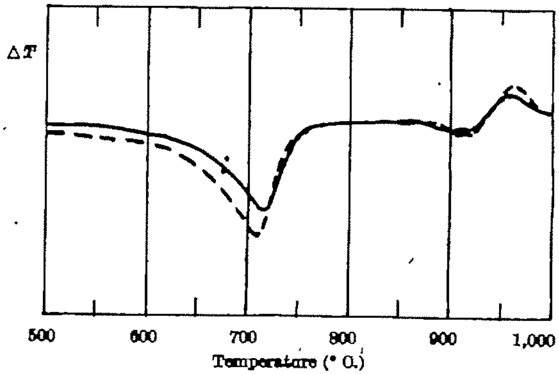

Fig. 2. Thermograms for montmorillonite (Wyoming bentonite) in a porous alumina specimen holder (– – – –) and a nickel specimen holder (———)

There currently appears to be some confusion regarding the magnitude of exothermic peaks in nickel and alumina specimen holders; Arens[5] has claimed that exothermic peaks are smaller in ceramic specimen holders than in nickel, while Gérard-Hirne and Lamy[3] report the opposite effect. The exothermic peaks for the kaolinite samples examined in the above experiments were not particularly suited for measurements of this nature, but some experiments were carried out with Wyoming bentonite (montmorillonite), which gives a much smaller exothermic peak (Fig. 2). In the nickel specimen holder (lid off) the exothermic peak is smaller than in the alumina specimen holder in about the same proportion as the endothermic peak is smaller. This finding agrees with that of Gérard-Hirne and Lamy but not with that of Arens; it does, however, appear to conform with the different characteristics of the two holders, the heat of reaction being conducted away from the surface layers more rapidly in the nickel specimen holder.

The marked difference in position of base-line in the region below 600° C. in Fig. 2 is easily explained. After the removal of the lattice hydroxyl groups the sample has different heat characteristics and the base-line appears at a higher level. As would be expected, this displacement is larger for the alumina than for the nickel specimen holder, and as the latter parts of the base-lines are superposed the earlier parts appear at separate levels. The same effect may be observed on Mr. Webb's curve 1, where the base-lines for the earlier parts of the curves are superposed and the two curves separate after the calcium carbonate peak.

That some of the above observations appear to be at variance with those of Arens may in effect be somewhat illusory. So many experimental factors are involved that each set of results can only strictly apply to the particular apparatus upon which they were obtained, and a rigorous comparison requires a critical survey of all available data, as well as a knowledge of the theoretical implications of the many factors concerned.

In spite of the various apparent advantages of the metal specimen holder, rigid standardization upon this type seems scarcely desirable. For example, while a metal holder is very suitable for dolomite determinations, we have found an alumina holder of low porosity gives reasonable results. For some investigations, indeed, the alumina type may be preferable; for example, the loss of 25 per cent in peak area may in certain circumstances be quite serious and not offset by increased sharpness of peak. The choice of holder, therefore, is logically related to the problem involved. On the other hand, the contributions of Arens[5] and Stegmüller[6], taken in conjunction with theory, may eventually make standardization of the geometry of the sample well, as suggested by Mr. Webb, possible. Uniform tightness of packing of specimens is more desirable and is relatively easy to obtain provided one operator performs all comparative tests; whether it can, however, be attained by two operators independently without use of elaborate apparatus is open to doubt.

In conclusion, I am grateful to Mr. Webb for sending me a copy of his note before publication, and should like to express my thanks to Mr. D. J. Greenland and Mr. U. Schwertmann for carrying out the actual determinations involved.

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FREE RADICALS IN BIOLOGICAL MATERIALS

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THE chemical activity of living cells is usually ascribed to compounds which are ordinary molecules, all the electrons of which occur in pairs. However, one of the striking results of efforts to analyse the reaction mechanisms of biological processes is the frequency with which it becomes necessary to depart from this rule. Investigation of a number of important biological processes leads to the conclusion that free radicals, that is, compounds with one or more unpaired electrons, occur as reaction intermediates.

Free radicals have been implicated as decisive participants in (*a*) biological oxidation-reductions[1,2], (*b*) the action of ionizing, ultra-violet and visible radiation on biological systems[3], (*c*) chemical carcinogenesis[4].

Although these inferences, if correct, are of far-reaching importance, all have been derived from indirect evidence and model experiments; free radicals have not been demonstrated in living things. From the fact that many free radicals are notoriously unstable, it has been supposed that free-radical intermediates formed during a biochemical process would be short-lived, and incapable of contributing to the more or less permanent components of the cell.

Until recently, the methods available for investigating free radicals were not suited to work with biological materials. This deficiency has in part been rectified recently by the development of paramagnetic resonance absorption techniques which are capable of detecting small amounts of free radicals in the presence of the large amounts of diamagnetic substance which occurs in living material. The present communication reports investigations based on this new technique. The results show that free radicals occur in plant and animal tissues, and provide evidence relating free radicals to metabolic activity and certain photochemical processes. Contrary to expectation, it has been found that some biological free radicals, such as melanin, are extraordinarily stable.

Paramagnetic resonance absorption is due to the unpaired electrons associated with free radicals. Experimental techniques and apparatus for detecting it have been described elsewhere[5]. Biological material is lyophilized and the resulting powder inserted into the absorption chamber of the apparatus. Typical results are illustrated in Figs. 1 and 2. The area under the absorption curve is proportional to the number of unpaired electrons in the sample, and the free-radical content of biological materials may be evaluated in this manner.

Table 1 lists the estimated free-radical content of a number of tissues. Certain significant differences are apparent. Most notable is the high free-radical content found in metabolically active tissues, such as the green leaf, liver and kidney. The extraordinarily high value of frog eggs is due to the presence of melanin, which is a free radical. The paramagnetic resonance absorption of lyophilized tissue persists for months under refrigeration.

Fractionation experiments show that the paramagnetic resonance absorption generally found in tissues is associated with protein components and

Table 1

Material	Estimated free radical content (moles × 10^{9}/gm. dry weight*)
Nicotiana tabacum, leaf	65
Nicotiana tabacum, roots	10
Coleus, leaf	180
Barley, leaf	25
Snapdragon, petals	8
Digitalis, germinating seeds	10
Carrot, root	8
Beet, root	6
Bracket fungus	35
Rabbit, whole blood	25
Rabbit, muscle	20
Rabbit, brain	25
Rabbit, liver	60
Rabbit, lung	30
Rabbit, heart	35
Rabbit, kidney	55
Mouse, liver	30
Mouse, liver hepatoma	20
Guppies, entire	2
Frog, unfertilized eggs	200
Drosophila, entire	4
Firefly, lanterns	2

* These values are based on comparison of the absorption given by approximately 0·5-gm. samples with the absorption given by 10^{-8} mole of diphenyl picryl hydrazyl free radical under identical instrumental conditions.

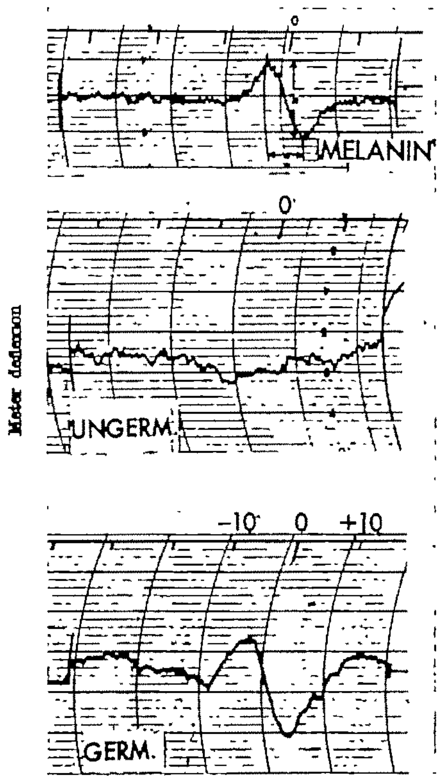

Fig. 1. Paramagnetic resonance absorption given by 1-gm. samples of lyophilized digitalis seeds before germination, and just after emergence of the primary root. Magnetic field increases towards the right along the abscissa, with point marked zero representing position of paramagnetic resonance absorption given by a standard free radical, diphenyl picryl hydrazyl. Ordinate represents the rate of change, with respect to field strength, of microwave energy (9,000 Mc./sec.) absorbed by the sample, as the field-strength is varied

For comparison, the uppermost curve shows the paramagnetic resonance absorption given by a stable free radical (melanin). The presence of unpaired electrons associated with the free radical results in absorption of incident microwave energy when the varying external magnetic field reaches about 3,000 gauss (point marked zero). The apparatus records the derivative of the absorption curve, and free radical content can be estimated from the quotient $h \times w^2$

that denaturation of the protein destroys the free radicals.

In the light of the suggestion of Michealis[1] and others that free radicals occur as intermediates in biological electron-transfer processes, it is of considerable interest to investigate the association between free radical content and metabolic activity. We find that initiation of active metabolic processes in dried yeast preparations increases the free-radical content significantly. There is similar evidence that free radicals are formed as a result of the increased metabolic activity induced by germination of seeds (Fig. 1).

Etiolated barley leaves show only about one-fifth the paramagnetic resonance absorption observed in fully green leaves. Fig. 2 shows that when etiolated leaves are exposed to 100 ft. candles of illumination from fluorescent lights, the original paramagnetic resonance absorption increases remarkably within six hours. After 24 hr. of illumination, during which time the leaves become fully green, it reaches the magnitude observed in normal light-grown leaves. Thus, the large paramagnetic resonance absorption observed in the green leaf is a result of photochemically induced formation of free radicals. This process may be associated with the synthesis of chlorophyll, for Smith[6] finds evidence that a free radical may occur as an intermediate in the photochemical conversion of protochlorophyll into chlorophyll. Preliminary investigations have been carried out to determine whether the paramagnetic resonance absorption of fully green leaves changes during illumination. The results obtained thus far show that such an effect, if it exists, must be small. The above data tend to support Michealis's proposal[1] that metabolic electron transfer induces the formation of a small steady-state concentration of free radicals.

The occurrence of paramagnetic resonance absorption in melanin suggested that similar polymeric products of biological origin be examined for free radicals. A series of natural products of this type have been studied. Paramagnetic resonance absorption has been detected in the following: gum guaiacum, liquorice (powdered root of *Glycyrrhiza*), humin (from protein hydrolysis), various plant resins, caramelized glucose, charcoals of organic origin, various types of coal and tars. The free radicals associated with these products all appear to be indefinitely stable at room temperature, and a number resist heating. The paramagnetic resonance absorption of melanin resists 24 hr. of refluxing in hydrochloric acid.

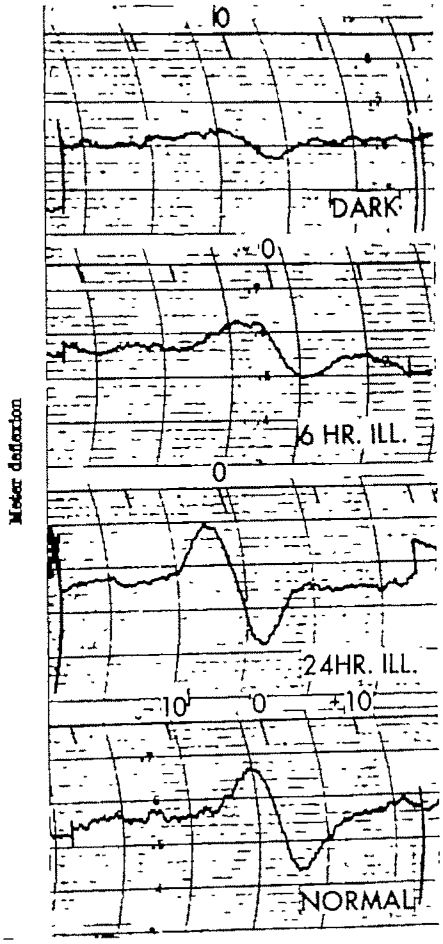

Fig. 2. Paramagnetic resonance absorption of 0 65-gm. samples of leaves from barley seedlings Uppermost curve. etiolated. Lowermost curve. leaves from comparable seedlings grown in light. Centre curves etiolated leaves after 6 and 24 hr. of illumination Ordinate and abscissa as in Fig. 1

Despite their apparent heterogeneity, the natural products containing unpaired electrons have a characteristic in common: all these materials contain polymeric condensed ring structures. The plant products listed above are all highly polymerized condensed ring structures. The same is true of melanin. Recent investigations on the structure of coal[7] show that condensed ring polymers resembling the graphite structure constitute a large portion of the material. These polymeric aggregates apparently account for the roughly spherical particles, about 0·05 μ in diameter, which are seen in electron micrographs of ethylene diamine extracts of coal[8]. We find distinct paramagnetic resonance absorption in such coal extracts. It is likely that similar aggregates also occur in tars, caramels and other organic materials which have been carbonized by heat or by other means.

It is suggested that unpaired electrons generated during reactions which lead to these condensed ring products (that is, melanin, gums, resins, coal) become trapped and stabilized in the polymer lattice. Similarly, unpaired electrons resulting from carbonization by heat, or by strong acid, may become incorporated into the graphite-like aggregates which are formed. That such polymers have a high affinity for unpaired electrons, and thereby form stable free radicals, is to be expected from recent observations that the electron affinity of a series of condensed ring substances increases considerably with the size of the molecule[9].

While these preliminary observations do not offer an explanation for these phenomena, they do show that unpaired electrons may occur in highly stable configurations in substances of considerable biological interest.

These results show that tissues contain two types of free radicals: (*a*) tissues possess free radicals apparently associated with protein moieties, which are heat-labile, occur in the concentration range of 10^{-4}–10^{-6} mole of free radical per gm. of tissue, and which appear to increase in amount during metabolic activity; (*b*) a number of polymeric condensed-ring substances, such as melanin, which are characteristic products of certain organisms, contain unpaired electrons in a highly stable configuration.

Certain broad conclusions can be derived from these observations. The properties of the labile free radicals which we have detected are consistent with Michealis's characterization of the free radicals generated by oxidative metabolism: (*a*) they appear to be associated with proteins; (*b*) they attain concentrations which vary with the level of metabolic activity; and (*c*) the range of free-radical content, 10^{-4}–10^{-6} mole/gm. of tissue, is of the order of magnitude expected from McIlwain's estimation[10] of the total electron carrier content of tissues (10^{-4}–10^{-6} mole/gm.). Furthermore, measurements of paramagnetic resonance absorption confirm the suggestion[1] that electron carriers such as riboflavin and pyocyanin are capable of forming free radicals. While these observations do not constitute proof of Michealis's proposals, they do provide both incentive and experimental opportunities for more intensive investigations of this problem.

The discovery of unpaired electrons in melanin is indirect evidence that free radicals are formed by irradiation of biological systems, for it has been shown that melanin formation in animals may be induced by ultra-violet and ionizing radiation[11]. Paramagnetic resonance absorption induced by illumination of etiolated leaves is direct evidence for such an effect.

The discovery that certain common biological products are extraordinarily stable free radicals raises a number of intriguing questions concerning the physical chemistry of substances such as melanin and resins, and also poses problems of concern to the biologist. If the unpaired electrons in such polymers are not continuously accessible to the reaction mechanisms of the cell, these substances can be thought of as dumping grounds for unpaired electrons. In this case they may influence the course of cellular metabolism by irreversibly removing unpaired electrons generated by oxidation-reduction or photochemical processes. In this connexion the induction of melanin formation by ultra-violet or ionizing radiation may be construed as a protective mechanism which, by sequestration of photon-generated unpaired electrons in an inactive configuration, forestalls more violent effects of irradiation on the cell. An alternative approach would be required if it is found that the unpaired electrons in condensed ring polymers react readily with metabolic components of the cell. This would suggest the possibility that electron transfers between metabolic intermediates may take place by a quasi-metallic conduction of electrons through the intervening condensed ring structures. From this point of view it is significant to note that the wave function of an unpaired electron associated with a condensed ring molecule appears to extend throughout a region which encompasses most of the structure[12]. The electron may therefore be considered to be highly mobile within the structure, and thereby capable of mediating conduction within it. This proposal would become especially important if it were found that enzyme proteins are capable of holding stable unpaired electrons. Such an observation would support Szent-Györgyi's suggestion[13] that cellular oxidation-reduction processes involve electron-transfer through a protein continuum.

We are indebted to Mr. James A. Warnhoff for assistance in conducting these investigations, and to Dr. S. I. Weissman for many helpful discussions of this material.

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LETTERS TO THE EDITORS

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Synthesis of Sucrose by a Partially Purified Plant Tissue Extract

It was reported previously[1] that a crude extract obtained from peas formed sucrose when incubated with a mixture of glucose-1-phosphate and fructose. Evidence was presented that the sucrose synthesis was not due to a simple reaction between glucose-1-phosphate and fructose as catalysed by bacterial sucrose phosphorylase[2]. In the present communication the results of some experiments with a partially purified pea extract are briefly described. Since this work was carried out, Leloir and Cardini have reported[3] the extraction from wheat germ of an enzyme which catalyses the reaction

$$\text{uridine diphosphate glucose} + \text{fructose} \rightleftharpoons \text{sucrose} + \text{uridine diphosphate.}$$

It is probable that this reaction is the final step in sucrose formation from glucose-1-phosphate and fructose by pea extracts.

The partially purified extract was obtained by the addition of ammonium sulphate (to 80 per cent saturation) to the crude pea extract, suspension of the precipitate in water and subsequent dialysis against 0·025 M phosphate buffer of pH 7·0 at 4° C. No sugars or phosphoric compounds (other than inorganic phosphate) were detected when trichloracetic acid extracts of the preparation were examined on paper chromatograms.

This dialysed extract, unlike the crude extract used previously, did not synthesize sucrose from glucose-1-phosphate and fructose; but this activity could be restored by the addition of the boiled crude pea extract. The dialysed extract was stable for two days at 4° C. and for seventeen days at – 15° C.

The addition of magnesium chloride to enzymic digests containing the dialysed extract, glucose-1-phosphate, fructose and boiled crude pea extract was found to increase sucrose formation. No sucrose was formed with magnesium chloride unless boiled crude pea extract was added. It was therefore concluded that the boiled crude pea extract contained a factor or factors, other than magnesium ions, essential for the synthesis of sucrose.

The boiled crude pea extract could be replaced by nucleotide fractions prepared from peas or yeast. Peas (or yeast) were extracted with hot aqueous alcohol, the nucleotides precipitated with mercuric acetate and the precipitate decomposed with hydrogen sulphide in the cold. The mercuric sulphide was filtered off and the filtrate aerated and neutralized to pH 7·0. No free sugars were detected in these nucleotide fractions when samples were examined on paper chromatograms.

The formation of sucrose from glucose-1-phosphate and fructose in the presence of the dialysed pea extract, yeast nucleotide fraction and magnesium chloride is shown graphically in Fig. 1. After 41·6 hours, fructose had decreased to nearly zero, and the loss of this sugar was approximately 4·5 times that required to account for fructose appearing in the sucrose formed. The progress of the reaction is also shown in the chromatogram in Fig. 2. It has been possible to prepare in crystalline form a sample of sucrose, which must have been synthesized since none was present in the dialysed extract or nucleotide fractions.

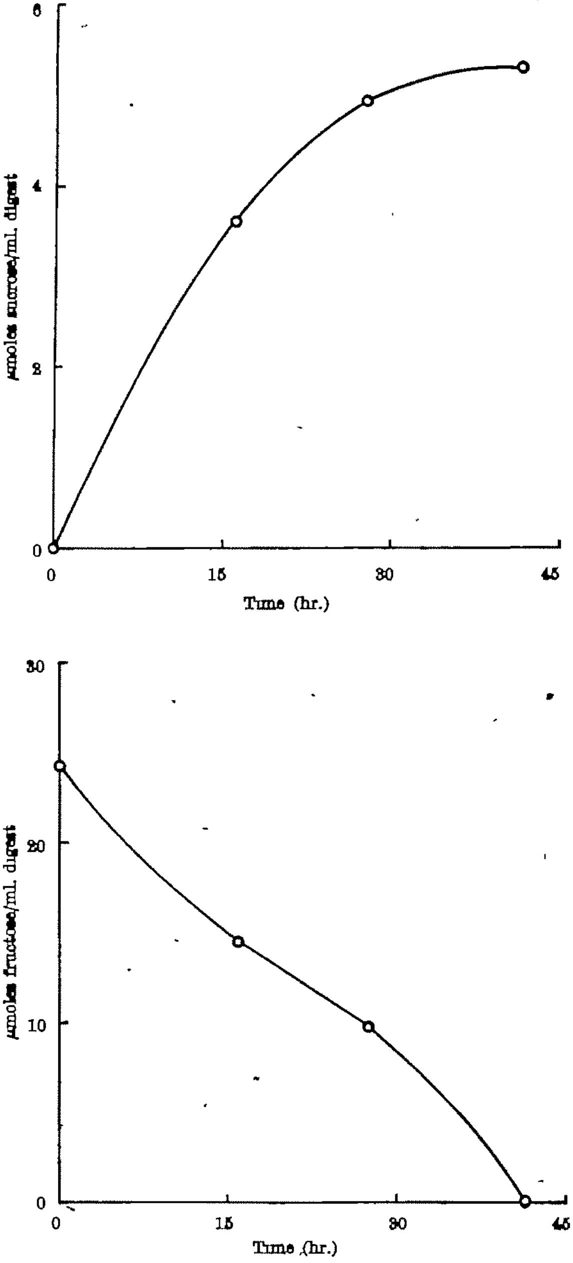

Fig. 1. The formation of sucrose and the loss of fructose in a digest containing the dialysed pea extract. Digest: glucose-1-phosphate, 0·0144 M; fructose, 0·0244 M; MgCl$_2$, 0·01 M; yeast nucleotide fraction, 0·5 ml.; dialysed pea extract, 1 ml.; total volume, 1·8 ml. pH 7·0, 25° C.

It was found that in enzymic digests containing the dialysed pea extract and the nucleotide fractions, *less* inorganic phosphate was liberated when fructose was added than with glucose-1-phosphate alone as substrate. As already reported, the addition of fructose to digests containing the crude pea extract and glucose-1-phosphate produced an increased liberation of inorganic phosphate[1].

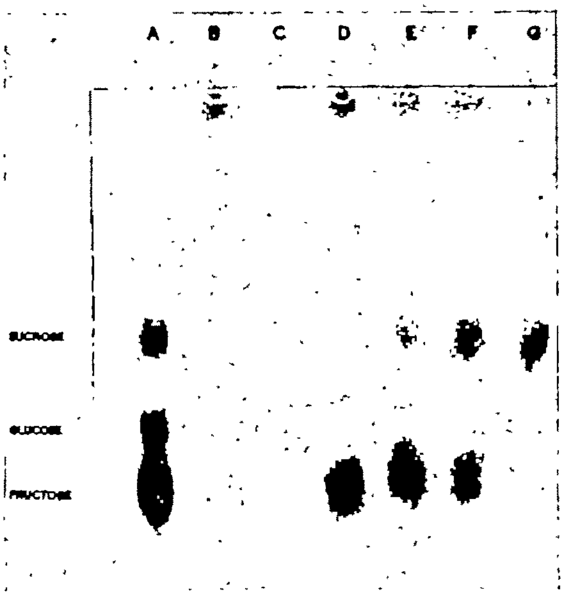

Fig 2. Chromatogram of sugars showing formation of sucrose by the dialysed pea extract. Digest as in Fig. 1. *A*, solution containing sucrose, glucose and fructose; *B*, *C*, digest without fructose after 1 min. and 41·6 hr. respectively; *D*, *E*, *F*, *G*, digest with fructose after 1 min., 16 hr., 27·6 hr. and 41·6 hr. respectively. Whatman No. 1 paper. Solvent, *n*-propyl alcohol (80 vol.)/water (15 vol.)/ammonia (5 vol.). Running time, 18 hr. $AgNO_3$–NaOH spray (ref. 4)

Sucrose synthesis was decreased when the enzymic reaction was carried out in the absence of oxygen. In an atmosphere of nitrogen, synthesis was inhibited by 81 per cent; *in vacuo* the inhibition was 86 per cent.

Glucose-1-phosphate could be replaced by glucose-6-phosphate or fructose-6-phosphate as substrate for sucrose formation. This was to be expected as the pea extract contained phosphoglucomutase and phosphohexoisomerase. As the extract also contained amylose phosphorylase, starch (plus inorganic phosphate) was able to replace glucose-1-phosphate. Fructose could not be replaced by fructose-1-phosphate, fructose-6-phosphate or fructose-1,6-diphosphate.

The coenzyme activity of the pea and yeast nucleotide fractions was acid-labile and the effect of heating with 0·1 *N* hydrochloric acid suggested that diphosphopyridine nucleotide might be involved. Factors which were more acid-stable were also present. In subsequent experiments it was found that the nucleotide fractions could be replaced by a mixture of diphosphopyridine nucleotide, uridine monophosphate and adenosine triphosphate.

Several experimental results, including the requirement of diphosphopyridine nucleotide and adenosine phosphates, the esterification of inorganic phosphate and the formation of fructose-1,6-diphosphate and carbon dioxide by the enzymic digests, are readily explained if it is assumed that a glycolytic system was operating during sucrose formation.

It has been suggested that free hexoses are not intermediates in sucrose formation in plants[5,6]. Buchanan[7] has proposed that uridine diphosphate glucose and fructose-1-phosphate react to give sucrose phosphate, which is then converted to free sucrose. The results of the present experiments with peas are consistent with the hypothesis that uridine diphosphate glucose is involved (this substance may be formed from glucose-1-phosphate and uridine triphosphate[8] and the latter compound may be produced from uridine monophosphate through the operation of a glycolytic system); but it appears that free fructose (and not a phosphoric ester of this sugar) is an intermediate in the sucrose synthesis. This is in agreement with the results obtained with extracts from wheat germ[3].

I wish to express my indebtedness to Dr. L. W. Mapson, and to Prof. C. S. Hanes and Dr. F. A. Isherwood.

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A Model System for the Olfactory Membrane

IN the course of investigations on the kinetics of lysis of red blood cells by saponin and other hæmolytic agents, we have studied the effect of the addition of small amounts of various odorants. We describe below the unusual powers such adjuvants have in accelerating the process of hæmolysis. Somewhat remarkably, the activities of the odorants in this respect are paralleled by their activities in stimulating the olfactory cell membrane. This finding lends support to a theory of olfactory stimulation[1] which envisages 'puncturing' of the olfactory cell membrane by the odorant molecules.

Although little is known about the structure and composition of the olfactory cell membrane, there is reason to believe that it consists of orientated layers of cholesterol, phospholipids and proteins[2]. The layer may possibly only be bimolecular and yet remain impermeable to ions. In certain nerve cells it has been shown that there is an excess concentration of potassium ion inside, and an excess of sodium outside the cell. The cell membrane maintains its continuity by being partly liquid, some rigidity being provided, however, by cholesterol molecules and protein. The state of affairs is probably similar for the olfactory nerve cells. As a model, the red cell possesses the experimental advantage that, on penetration of the cell wall (and here again the lipids may form a bimolecular envelope[3]), the hæmoglobin is released.

It is found that, in the concentration-range studied, odorous substances act as weak hæmolysants. Thus a 0·005 *M* solution of skatol in isotonic buffered

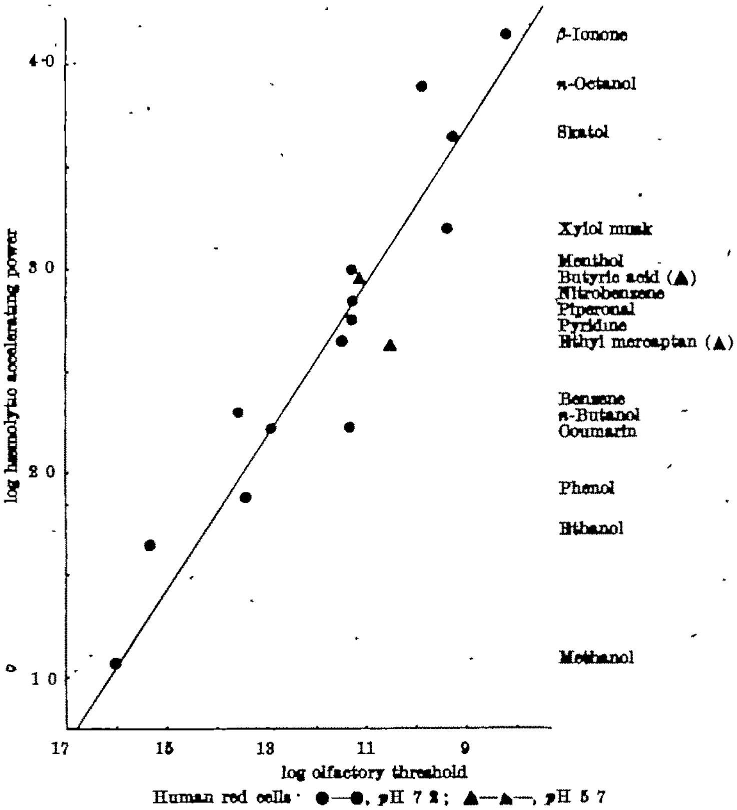

Fig. 1. Logarithm of the accelerating power of various odorants against the logarithm of the olfactory threshold. Values of the latter are recalculated from those given in the experimental literature. Experiments were carried out at 25° C.

saline at pH 7·2 and 35° C. took 60 min. to hæmolyse a dilute suspension of human red blood cells. Ponder[4] has reported that an indole solution containing 1 mM/l. completely hæmolyses a suspension of rabbit red cells in 30 min. at pH 6·3 and 25° C. A similar concentration of a strong hæmolysant such as saponin is effective in a few seconds.

We have found, however, that all the odorants tested acted as accelerators for hæmolysis by saponin. The exact mechanism by which these accelerators act is still under investigation; but the evidence indicates that the accelerant molecules interact with some component of the erythrocyte membrane, weakening it and facilitating the process of penetration by the saponin. This is in accordance with the findings of Ponder[4].

As a measure of the accelerating power of the odorant, the quantity

$$A = \frac{\left(\dfrac{1/T}{1/T_0} - 1\right)}{c}$$

was taken, where A is accelerating power, c is molar concentration of odorant, and T and T_0 are the times for the sample to undergo hæmolysis with and without odorant respectively.

The accelerating power is a measure of the extent to which the cell wall is weakened by the odorant. If the model is a good one, and if it is true that the odorant molecule is adsorbed on to and penetrates the olfactory cell wall, then we may expect a relation between the olfactory threshold and the accelerating power for hæmolysis. That this correlation does indeed exist is shown in Fig. 1, in which log A is plotted against the logarithm of the olfactory threshold (in molecules/c.c.). Substances such as β-ionone or skatol, which are powerful odorants (low olfactory thresholds), are also powerful accelerants; phenol and ethanol, having large olfactory thresholds (weakly odorant), are weak accelerators.

Little difference is found between the accelerating powers of *dl*- and *l*-menthol. Between n-butanol and perfluorobutanol, however, large differences are found; perfluorobutanol has a fairly powerful camphor-like odour; n-butanol is a comparatively weak odorant (O.T. = $8 \cdot 2 \times 10^{11}$ mol./c.c.) and is only half as effective as an accelerant.

At pH 7·2 the points for two compounds, both weak acids, lie well below the line; they appear less powerful accelerators than might be expected. This anomaly has been resolved by repeating these experiments at pH 5·7, when both additives exist entirely in the non-ionized form.

A series of isomeric methyl coumarins (kindly provided by Prof. Passerini) has also been investigated. It is found that 4-methyl coumarin, which is almost odourless, has less accelerating power than the other, and more strongly odorous, methyl coumarins.

Experiments with sodium decyl sulphate in place of saponin show that the odorants have similar accelerating effects on the hæmolysis.

We conclude that the structure and composition of the red cell membrane are such as to make it a good model for the surface of the olfactory cell. In view of the correlation shown in Fig. 1, and since hæmolytic acceleration is believed to entail penetration into the cell membrane with consequent weakening of the cell wall, we consider that our results lend support to the theory of olfaction which interprets the initiation of the olfactory stimulus in terms of such a process[1].

A full account of our findings will be published elsewhere.

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Detection of Carbohydrase in Paper Electrophoresis

The task of testing and localizing enzymes in a protein mixture subjected to paper electrophoresis is a tedious one. This is particularly true in a fractionation study where the number of tests may be numerous. During the course of such an investigation of the various carbohydrases in an *Aspergillus niger* fermentation, it became necessary to employ a rapid qualitative test for the detection of these enzymes. Keilin and Hartree[1] have reported that glucose oxidase (notatin) can be successfully used for the quantitative assay of various carbohydrases. Monod and Torriani[2] employed notatin to determine glucose in their studies of amylomaltase. Recently, Whistler *et al.*[3] showed that D-glucose in corn syrups can also be quantitatively estimated by using notatin. The latter enzyme oxidizes glucose to yield two products—gluconic acid and hydrogen peroxide.

We were interested in detecting qualitatively two enzymes, maltase and invertase, and if possible limit dextrinase. The hydrolysis of maltose and sucrose (and possibly limit dextrin) liberates glucose. The latter is oxidized by notatin, and the resulting gluconic acid can be detected by spraying with an alcoholic solution of bromcresol purple or any suitable indicator dye. Control experiments showed that five gammas of gluconic acid or glucose could be easily detected on filter paper. The enzymatic activity of fifty gammas (equivalent to twenty gammas of protein) of crude material could be detected with ease. Appropriate blanks indicated that notatin in the presence of various substrates gave negative results.

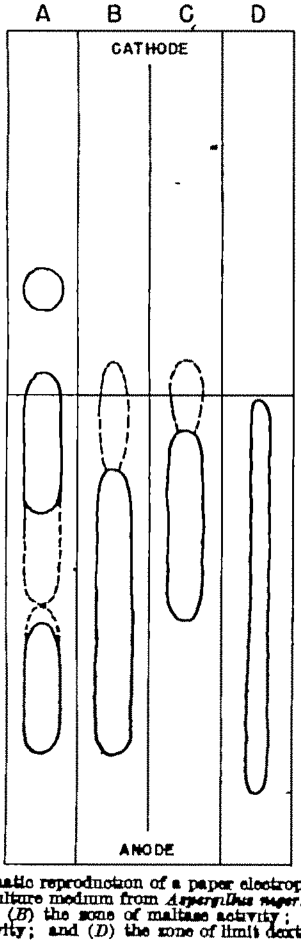

Fig. 1. Schematic reproduction of a paper electrophoresis experiment of the culture medium from *Aspergillus niger*. (*A*) The protein pattern; (*B*) the zone of maltase activity; (*C*) the zone of invertase activity; and (*D*) the zone of limit dextrinase activity

The method finally used was as follows. A freeze-dried preparation of the fermentation medium was subjected to filter-paper electrophoresis, as described by Kunkel and Tiselius[4], using a phosphate buffer, ionic strength 0·1 and *p*H 6·9. Four spots of the enzyme solution were applied to the middle of the paper (Whatman 3 *MM*) at 2·5-cm. intervals. After the completion of the run, the paper was cut longitudinally into four strips. One strip was stained with bromophenol blue[4] in order to ascertain the protein areas. While still damp (the strips were not allowed to dry out), the three remaining strips were sprayed with the following solutions: (1) a mixture of equal volumes of 2 per cent maltose and 0·5 notatin ('Dee O', obtained from Takamine Laboratory, Inc., Clifton, New Jersey, U.S.A.) for maltase activity, (2) a solution of equal portions of 2 per cent sucrose and 0·5 per cent notatin for invertase activity, and (3) for limit dextrinase activity a mixture containing 2 per cent limit dextrin and 0·5 per cent notatin was used. Each strip was covered with an eighth-inch wide mask while applying the above solutions in order to decrease excessive diffusion of the aqueous reagents. The strips were then clamped between two glass plates and incubated at 30° C. for half an hour, after which they were removed and dried at 110° C. Finally, the papers were sprayed with a solution of bromcresol purple (0·06 per cent in 95 per cent ethanol). The areas of enzymatic activity appeared as bright yellow spots on a bluish-grey background (Fig. 1).

This test should prove useful in detecting the presence of any carbohydrase which yields glucose as one of the end-products, and for this reason its application could be widely used.

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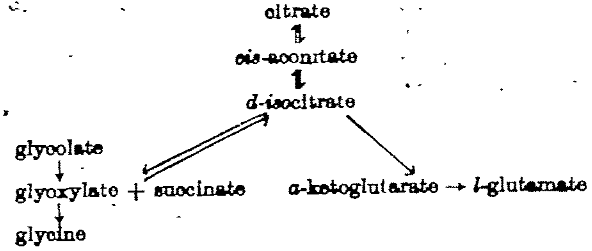
The *d-Iso*Citric Lyase System: the Formation of Glyoxylic and Succinic Acids from *d-Iso*Citric Acid

During studies on the acetate metabolism of *Penicillium chrysogenum* in this Department, it was found that alcoholic extracts of acetate-grown mycelium contained considerable quantities of glutamic acid and glycine, as well as a number of other metabolites[1].

In the course of this work, it was noted that citric acid disappeared rapidly on incubation with cell-free extracts of *P. chrysogenum* in the presence of arsenite, and that glutamate, α-ketoglutarate, glycine, glyoxylate and succinate formed. By varying the experimental conditions, it could be shown that citrate underwent cleavage along at least two pathways: (1) a complete breakdown to glutamate and α-ketoglutarate in fresh extracts fortified with magnesium chloride, arsenite, and a catalytic amount of TPN (not DPN); (2) a quantitative conversion to glyoxylate and succinate in aged (4 hr., 0° C.) or dialysed extracts in the presence of semicarbazide. If arsenite was used in place of semicarbazide, less glyoxylate accumulated and a large amount of glycine formed. Although the extracts were incubated aerobically, no oxygen was consumed.

The conversion of citrate to glyoxylate and succinate was found to be reversible. While the extracts to a limited extent were capable of oxidizing glycolate to glyoxylate, no citrate was formed in their presence from glycolate and malate. Furthermore, no detectable *d-iso*citric dehydrogenase activity was observed under conditions which were optimal for glyoxylate formation. On the basis of extensive inhibition experiments with α,α′-dipyridyl, trans-aconitate, ethylene diamine tetra-acetate, and potassium cyanide, it is considered probable that *d-iso*citrate is the immediate precursor of the cleavage products.

These reactions might be summarized as follows:



In the above scheme the direction of the arrows indicates the reactions identified, and does not necessarily relate to the reversibility of any individual reaction.

The enzyme system involved in the formation of glyoxylate and succinate from *d-iso*citric acid has been termed the *d-iso*citric lyase system. It has been found as well in extracts of baker's yeast, *Aspergillus niger* and *Rhizopus* sp. Further study on the characterization of the reaction system and on the isolation of its enzymic components is being carried out at the present time.

Glyoxylate has been known as a mould metabolite for many years[2], but the mechanism of its biosynthesis has remained obscure. The above-described reactions, demonstrating its facile formation from citrate by a cell-free enzyme extract of *P. chrysogenum*, indicate one possible pathway of its biosynthesis. In view of the fact that glyoxylic acid can be readily converted to glycine enzymatically[3], this reaction sequence may also account for the accumulation of glycine in the intact mould mycelium after incubation with acetate. The formation of glyoxylate from acetate has been suggested by Challenger[4], who found that glyoxylate and oxalate accumulated in the medium when *A. niger* was grown on calcium acetate. Whether or not glyoxylate has any function in the formation of oxalate remains to be seen.

Recently, while this work was in progress, Campbell[5] demonstrated the occurrence of an enzyme system in sonic extracts of *Pseudomonas aeruginosa* similar to that described above. This enzyme system converted citrate and *cis*-aconitate to glyoxylate and succinate, but *iso*citrate did not appear to be an intermediate.

Enzyme extracts were prepared at – 10° C. by means of Hughes' press[6] from frozen washed mycelium of *P. chrysogenum* Q176 grown in stirred aerated stainless steel fermenters[15] on an acetate salt medium and harvested in the late logarithmic phase. The crushed mycelial mass was centrifuged at 15,000 *g* for 20 minutes at + 2° C. The supernatant was frozen and stored at – 20° C., in which condition the enzyme system was stable for at least a month.

Glyoxylic acid was identified by the chromatographic behaviour, alkali instability, and characteristic spectrum of its 2 : 4-dinitrophenylhydrazone[7,8], and was crystallized from the reaction medium as its 2 : 4-dinitrophenylhydrazone, m.p. 189–192°, mixed m.p. 190–192°. Succinic acid was identified by its R_F values in several solvent systems and was estimated with a succinoxidase preparation[9]. Citrate was determined by the method of Taylor[10], *l*-glutamic acid with a carrot decarboxylase preparation[11], and total hydrazones by the general extraction procedure of Friedman and Haugen[12].

I am greatly indebted to Dr. D. Cavallini for a sample of the 2 : 4-dinitrophenylhydrazone of glyoxylic acid, and to Dr. C. B. Anfinsen for generous gifts of *cis*-aconitic anhydride and crystalline dimethyl *d-iso*citric lactone, observed m.p. 102–104°, reported m.p. 104–106° [13]. After mild alkaline hydrolysis of the lactone, the specific rotation of the molybdate complex of free *d-iso*citric acid was – 760° $[\alpha]_D =$ – 745° [14]. All other reagents were analytical grade commercial products.

A detailed account of these experiments is to be published elsewhere. I wish to express my sincere appreciation to Prof. E. B. Chain for his continued interest and helpful advice and for the hospitality of his laboratory, and to Prof. Domenico Marotta, director of the Istituto Superiore di Sanità, for his co-operation and support during the course of this work.

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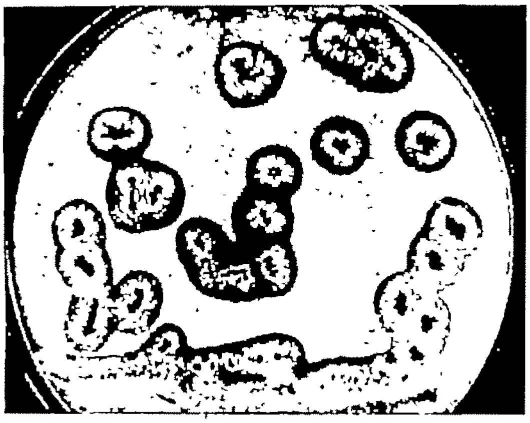
Decomposition of Oxalate by *Streptomyces*

THE microbial degradation of oxalate is relatively a rare phenomenon. During the last decade, however, some valuable information on the isolation and study of some more oxalate-decomposing organisms, mostly bacteria, has been reported. The work of Bhat and Barker[1], Janota[2], Muller[3], Khambata and Bhat[4,5] and Jayasuriya[6,7] has contributed substantially in this direction. Nevertheless, there seems to be no published data available on the decomposition of



Two-day culture of a *Streptomyces* sp. (isolated from cellulose enrichment medium) growing on oxalate agar. Decomposition of oxalate is indicated by the clearing of calcium oxalate (haloes) around the colonies. ½ nat. size

oxalate by *Streptomyces* and, so far as we are aware, this is the first report on this subject.

During the course of investigations on the micro-organisms associated with the intestine of the Indian earthworm[8], we encountered many *Streptomyces*. They were isolated from various enrichment media which were inoculated with suspensions of the intestinal contents of the worms. Details of the method of extracting the contents of the earthworm gut are obtainable elsewhere[4,5]. Three of these *Streptomyces* were isolated from oxalate enrichment media and exhibited oxalate-decomposing ability as evidenced by halo formation around the colonies when grown on a slightly modified Bhat and Barker's oxalate agar medium containing either yeast autolysate or yeast extract[4,6].

Stimulated by this interesting observation, we experimented further by streaking on oxalate agar twenty more *Streptomyces* isolated from the other enrichments also, namely, cellulose, asparagine and nitrogen-free enrichments. All, except one, displayed the characteristic clear-cut halo formation, strongly suggesting oxalate decomposition. The accompanying photograph strikingly illustrates the oxalate-decomposing ability of a *Streptomyces* species. Subsequent permanganate titrations carried out on eight-day old cultures of all the twenty-three *Streptomyces* grown in Bhat and Barker's liquid oxalate medium containing 0·1 per cent yeast extract confirmed our belief that oxalate was decomposed by these *Streptomyces*. Even the single isolate which did not exhibit halo formation on oxalate agar, on titration did show a negligible (0·2 per cent) decomposition of oxalate. The amount of oxalate decomposed by the other isolates varied from 6·3 per cent to as high as 83·4 per cent, but many decomposed more than 70 per cent of oxalate. It is, however, very necessary to emphasize the fact that our streptomycetes decomposed oxalate only in the presence of yeast extract. In oxalate media without yeast extract the *Streptomyces* gave scant or no growth. It may also be mentioned that three of these were identified as species closely related to *Streptomyces cellulosae*. The others could not be identified specifically but have been described in a doctoral dissertation submitted by one of us (S. R. K.)[8].

From these observations, it is felt that the oxalate-decomposing ability of *Streptomyces* is worth further exploration.

We are indebted to Mr. P. R. Gupta for taking the photograph.

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Invasiveness of Sarcoma Cells

IT has recently been shown[1] that chick-heart fibroblasts in tissue culture influence each other's movement through their mutual contacts. In particular, it appears that when two fibroblasts touch, their further movement in the direction of their point of contact tends to be stopped. This phenomenon, which we called 'contact inhibition', is in principle capable of explaining many features of the behaviour of fibroblasts both in tissue culture and in the organism. Among other things, it implies a relative immobility within a group of fibroblasts, provided the group is enclosed by an external barrier of some sort, since the cells inhibit each other. Contact inhibition would therefore be expected to play a part in keeping the fibroblasts within an organism largely immobilized under normal conditions.

We have recently obtained evidence that contact inhibition occurs not only between fibroblasts from the same source, but between those coming from different organs and even from different species. A variety of cells are probably capable of immobilizing each other. The immobilization of cells within an organism breaks down, however, in the case of a malignant tumour. This suggests that sarcoma cells should be tested for contact inhibition against normal fibroblasts in tissue culture. The invasion of normal tissues by cancerous ones has previously been demonstrated to occur *in vitro*[2-4]. The observation that such invasion has occurred does not, however, necessarily mean that contact-inhibition has been absent. More direct tests are necessary.

We have made such tests, explanting two fragments of tissue close together in a liquid medium, and observing the two outgrowths of cells as they move towards each other on the solid surface and meet in the space between the explants. If contact inhibition operates between the cells of two such explants, there occurs a fundamental change of behaviour when junction between the two outgrowths is established: if they cannot turn aside, the cells almost stop moving. The result is that the space between the explants is filled by a continuous sheet of cells substantially one cell thick. This is what happens when the two explants are of neonatal mouse skeletal muscle, heart, bone or liver. When, however, one of the explants is from a mouse sarcoma (*S37* or Crocker, kindly supplied by the Chester Beatty Research Institute) and the other from one of these neonatal organs, the result is strikingly different. We have not been able to detect any change of behaviour in the sarcoma cells when they meet the fibroblasts. Both advancing outgrowths of cells continue moving after they have met, and become superimposed. We conclude that contact inhibition must be very slight or absent between these sarcoma cells and normal fibroblasts.

It would obviously be premature to assert that all malignant cells are characterized by reduction or absence of contact inhibition. A very large range of sarcomata and carcinomata, as well as of benign tumours and normal tissues, needs to be tested. Nevertheless, the hypothesis seems to be sufficiently plausible, in relating the invasiveness of malignant cells to a property of normal cells, to be perhaps worth following up by those who have access to a large range of tumours.

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Intracellular Distribution of Histamine

ALTHOUGH histamine is widely distributed in the tissues, very little has been reported on its intracellular distribution. Recently, Copenhaver *et al.*[1] and Hagen[2], studying the histamine content of different cell fractions of dog liver, verified that the major amount of this substance was present in the mitochondrial fraction.

However, dog liver is exceptionally rich in mast cells[3], and the contamination of the mitochondrial fraction with mast cell granules during the differential centrifugation must be considered in the interpretation of these papers. We report here experiments performed in order to observe the distribution of mast cell granules in the different fractions of dog liver homogenate.

Samples of dog liver were obtained under pentobarbital anaesthesia and fractionated in 0·25 *M* sucrose as described by Schneider[4]. The nuclear, mitochondrial and microsome plus supernatant fractions were studied. Smears were made from these three fractions, fixed in 1 per cent lead sub-acetate in 50 per cent alcohol, stained with acidified Ehrlich's thionin and observed by normal and phase-contrast microscopy. Microscopic observation showed that the mitochondrial fraction was highly contaminated with mast cell granules which appeared as very small round metachromatic particles.

Many recent observations support the striking positive correlation between mast cell content of a tissue and its concentration of histamine[5]. Furthermore, the alterations of mast cells in conditions in which liberation of histamine occurs, both *in vivo* and *in vitro*[6], suggest that tissue histamine is present mainly in mast cells. By differential centrifugation of rat subcutaneous tissue a relatively pure fraction of mast cell granules could be obtained, and it was verified that the major amount of histamine was present in these granules, from which it could be released by heating in an acid medium or by the action of compound 48/80, a very potent histamine releaser. It is therefore probable that the higher histamine concentration of the mitochondrial fraction of dog liver might be due, at least in part, to its contamination with mast cell granules. A reconsideration of this problem seems to be necessary.

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Destruction of Tumour Cells by Rift Valley Fever Virus

IN the course of work on the effects of infection with several viruses upon different kinds of tissue cells from several animal species *in vitro*, it was found unexpectedly that Rift Valley fever virus has a marked destructive action upon rat sarcoma cells grown in tissue culture. A number of papers have appeared on the effects of infection with viruses upon various tumours in several animal species[1]. A destructive effect of the viruses of eastern equine encephalomyelitis and poliomyelitis on the tumour cells grown in tissue culture has been demonstrated by Bang and Gey[2] and by Scherer, Syverton and Gey[3] respectively; but no report of an effect of infection with Rift Valley fever virus upon tumour cells either *in vivo* or *in vitro* came to our attention. It is felt, therefore, that the results so far obtained by us are sufficiently interesting to merit publication at this stage.

Rhodamine *B* rat sarcoma[4] and fructose mouse sarcoma[5] were used for tissue culture experiments. The roller tube technique was used and the cover-slip technique in Porter flasks was employed for staining cells grown in tissue culture. Suitable pieces of tumour tissues were grown directly on the glass wall of the roller tube without clot or upon the cover-slip in a Porter flask with or without plasma clot. Nutrient medium (1·0 ml. per tube) consisted of 45 per cent Hanks's solution, 45 per cent horse serum (or human ascitic fluid) and 10 per cent swine (or chick) embryo extract (1 : 1 in Hanks's solution). 100 μgm. of

Table 1. CYTOPATHOGENIC EFFECT OF THE PANTROPIC STRAIN OF RIFT VALLEY FEVER VIRUS IN ROLLER TUBE CULTURES OF RAT SARCOMA CELLS

No. of tube	Dilution of inoculum (0·1 ml. per tube)	Extent of sarcoma cell degeneration* (days after inoculation)											Effect of inoculum in mice†
		1	2	3	4	5	6	7	8	9	10	11	
1	10^{-2}	–	+	++	+++								
2	"	–	+	++	+++								
3	10^{-3}	–	+	++	+++								
4	"	–	+	++	+++								
5	10^{-4}	–	–	++	+++								
6	"	–	–	++	+++	+++							
7	10^{-5}	–	–	–	+++	+++							
8	"	–	–	–	+++	+++							4/4
9	10^{-6}	–	–	–	+++	+++							
10	"	–	–	–	+++	+++							4/4
11	10^{-7}	–	–	–	–	+++	+++						
12	"	–	–	–	–	+++	+++						4/4
13	10^{-8}	–	–	–	–	–	–	++	+++	+++	+++		
14	"	–	–	–	–	–	–	–	–	–	–	–	2/4
15	10^{-9}	–	–	–	–	–	–	–	–	–	–	–	
16	"	–	–	–	–	–	–	–	–	–	–	–	0/4
17	No virus	–	–	–	–	–	–	–	–	–	–	–	
18	" "	–	–	–	–	–	–	–	–	–	–	–	

* Extent of cell degeneration: –, none; +, slight; ++, marked; +++, complete.
† Mice inoculated subcutaneously with 0·1 ml. of the inoculum. Numerator = mice that died; denominator = mice inoculated.

streptomycin and 100 units of penicillin per ml. were added to the medium. Cultures were re-fed at intervals of three to five days. After the cells had grown for a few days, 0·1 ml. of a dilution of virus suspension was added, and the condition of the cultures was followed for more than ten days.

The virus of Rift Valley fever was obtained through the courtesy of Prof. T. Nagano, of the Institute for Infectious Diseases, Tokyo. The pantropic strain of the virus was originally isolated in East Africa by Daubney, Hudson and Garnham[6], and Endo[7] succeeded in producing the neurotropic strain by serial passages of the pantropic strain in Maitland tissue culture with embryonic mouse brain. The strain is essentially similar in its properties to that produced by previous investigators[8]. The strains of the virus were used in the form of suspensions of infected mouse liver and mouse brain respectively.

The results of one experiment with the pantropic strain of the virus are presented in Table 1. It was observed that the more concentrated viral inocula destroyed the rat sarcoma cells grown in tissue culture within two to three days, whereas cultures inoculated with higher dilutions of virus showed destruction only after four to six days (see Fig. 1). Considerable multiplication of the virus was confirmed by subcutaneous mouse titrations of the supernatant fluids of cultures inoculated with smaller viral inocula. The titre of virus in the culture fluids rose rapidly to a maximum of 10^{-6} to 10^{-7} in a few days before the appearance of marked cell degeneration.

Similar results were obtained with the neurotropic strain of the virus, and comparable results were also obtained in the tissue cultures of fructose mouse sarcoma with both strains of the virus. Destruction of these tumour cell cultures with both strains of the virus could be completely prevented by pretreatment of the virus with immune rabbit serum prepared against the pantropic strain of the virus. The destructive effect of the virus upon tumour cell cultures is comparable to that of the virus of eastern equine encephalomyelitis upon one culture of a malignant-cell line of rat cells (*T*-333) reported by Bang and Gey[9].

It may be noted here that both strains have also marked destructive effect upon normal tissue cells, namely, embryonic human, rat, mouse and swine fibroblasts. Since none of several neurotropic viruses so far tested for destructive effect upon the rat and mouse sarcoma cells grown in tissue culture showed an effect comparable to that of both strains of the Rift Valley fever virus, it seems probable that the marked cytopathogenic effect is an inherent property of this virus which is not dependent on its neurotropism.

The finding that Rift Valley fever virus multiplied readily in tumour cell cultures with destruction of tumour cells led to a preliminary study demonstrating a marked oncolytic action of the neurotropic strain of the virus, which is non-lethal for mice when inoculated either subcutaneously or intraperitoneally, on the Ehrlich ascites tumour. When the mixture of a dilution of the virus and the undiluted ascitic fluid, previously incubated at 37° C. for 1 hr., was injected subcutaneously into mice, the growth of subcutaneous tumour was completely inhibited, even when the higher dilutions of the virus were used.

In another experiment, 0·2 ml. of 1 : 10 dilution of the neurotropic virus ($LD_{50}\,10^{-7 \cdot 5}$) was inoculated intraperitoneally into mice, injected four days previously with 0·2 ml. of undiluted ascitic fluid.

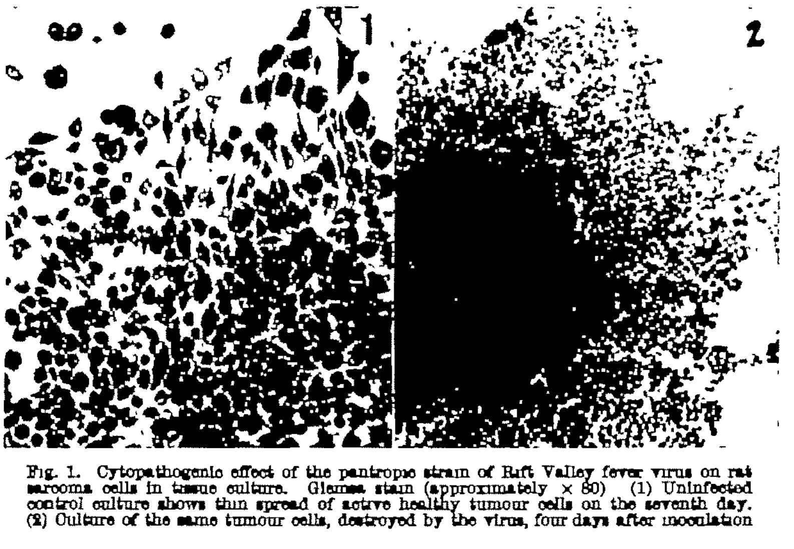

Fig. 1. Cytopathogenic effect of the pantropic strain of Rift Valley fever virus on rat sarcoma cells in tissue culture. Giemsa stain (approximately × 80). (1) Uninfected control culture shows thin spread of active healthy tumour cells on the seventh day. (2) Culture of the same tumour cells, destroyed by the virus, four days after inoculation

Marked destruction of tumour cells was observed, and in a few days no ascitic fluid could be obtained from mice infected with the virus. All the mice thus treated survived thirty days of observation, while the control ones died from ascites tumour. Mice receiving higher dilutions (10^{-2}, 10^{-3}, 10^{-4}) of the virus did not survive, although the amount of ascitic fluid was less than that of the control mice. The intracerebral mouse titrations of the supernatants of ascitic fluids showed that considerable multiplication of virus occurred. The oncolytic action was completely neutralized by pretreatment of the 1 : 10 dilution of the virus with immune serum. Koprowska and Koprowski[9] have already reported on a similar powerful inhibitory effect of Bunyamwera virus upon the Ehrlich ascites tumour.

Details of these and further experiments will appear elsewhere.

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Glycogen Secretion in the Epididymis

Very little information is available on the function of the epididymis and especially of the nature of its secretion products. During a study of the histochemistry of this organ in domestic and laboratory animals pictures were obtained which indicated the presence of glycogen in the epididymal secretion products.

Small pieces from various parts of the epididymis were fixed in Carnoy's fluid or in Serra's[1] acetic acid–formol alcohol and embedded in paraffin according to routine methods. Sections were cut at 5 microns, attached dry to slides, deparaffinized in benzene, coated with a very thin film of 'Celloidine' and treated with periodic acid and Schiff's reagent. Control sections without 'Celloidine' coating were immersed in a buffered solution of malt diastase at 37° C. for one hour and then treated as above. Other controls were placed in the buffer solution only before the staining procedure. As chemical fixation often produces diffusion of glycogen with subsequent unreliable localization of the reaction product the freeze-drying technique was used in order to avoid this possible source of artefacts. The apparatus of Glick and Malmström[2] as modified by Moberger *et al.*[3] was used. Paraffin sections were cut at 5 microns, fixed dry to the slides, deparaffinized, dried in the air, and then immersed in a 0·2 per cent solution of 'Celloidine' in

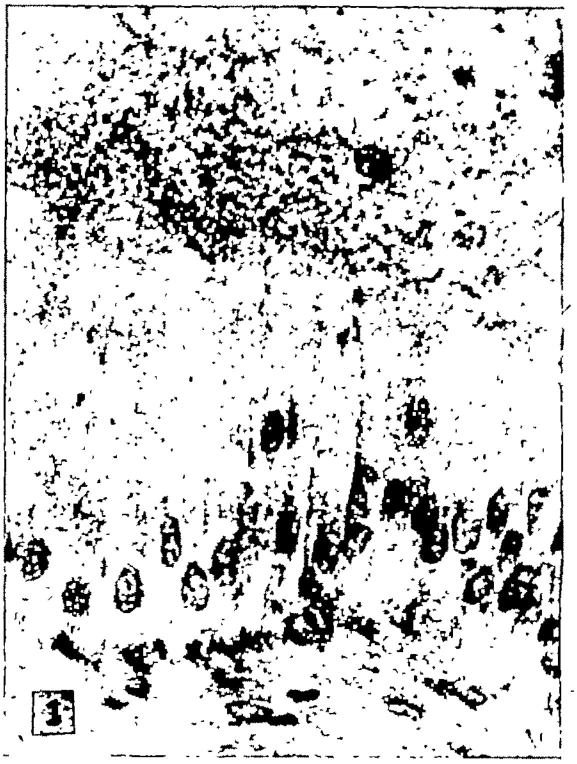

Fig. 1. Epithelium from the *corpus epididymidis* of rabbit. Large amounts of glycogen granules in the secretion. Fixation in Serra's fluid

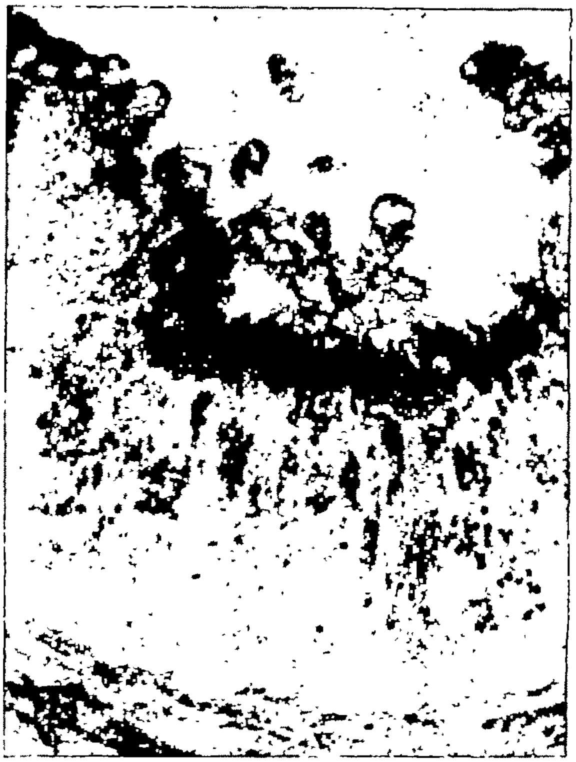

Fig. 2. Epithelium from the *cauda epididymidis* of dog. Moderate amounts of diffusely distributed glycogen in all secretion globules. The positive reaction in the stereocilia and intracellular granules is not due to glycogen. Frozen-dried specimen

ether and absolute alcohol. After drying in the air, the sections were treated with periodic acid and Schiff's reagent. Controls were prepared as described above.

Glycogen was demonstrated by both methods in the epididymal epithelium of several species, though in different amounts and different regions of the organ. In some regions moderate amounts were present in the secretion products. In globules lying free in the lumen, the glycogen was often less prominent or absent, especially in those intermingled with the spermatozoa. In frozen-dried material the reaction was diffusely distributed within the secretion globules, and stronger in their periphery. After chemical fixation small, heavily coloured granules were seen.

In the control sections a faint red colour persisted, and the stereocilia were generally still dark red.

McLeod[4] has shown that glycolysis and motility of human spermatozoa are produced by glycogen as well as by glucose and fructose under anaerobic conditions. The glycogen secretion reported here may therefore represent a mode of 'nutrition' of epididymal spermatozoa during the long time required for their passage through the organ.

A detailed description of the pictures observed in the different species will be published elsewhere.

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Use of *p*-Chloromercuribenzoic Acid in the Determination of Ascorbic Acid in the Presence of Sulphydryl Compounds

In certain circumstances hydrogen sulphide, cysteine and related sulphydryl compounds react with 2 : 6-dichlorophenol-indophenol (indophenol) and thus may interfere with the determination of ascorbic acid using this reagent. In view of the known ability of *p*-chloromercuribenzoic acid to combine with sulphydryl compounds[1], the possibility of using this reagent to suppress such interference has been examined.

Results indicate that this reagent does not itself react with indophenol nor does it affect the determination of ascorbic acid in pure solution, using a colorimetric procedure based on the decolorization of excess indophenol. Under similar conditions the addition of *p*-chloromercuribenzoic acid has been found to suppress completely the decolorization of indophenol by hydrogen sulphide, cysteine and glutathione respectively.

The reagent has been used in the following manner: 1 ml. of *p*-chloromercuribenzoic acid solution (200 mgm./100 ml. in 0·05 *N* sodium hydroxide) was added to 3 ml. of standard ascorbic acid solution (0·0–2·0 mgm./100 ml.), or test solution, in 1·8 per cent (w/v) metaphosphoric acid solution. Because of the low solubility of *p*-chloromercuribenzoic acid at this *p*H (about 1·5) most of the excess reagent was precipitated. The solution containing the precipitate was allowed to stand for 5 min. and then centrifuged. To 2 ml. of the supernatant fluid was added 0·5 ml. sodium citrate solution followed by 1 ml. indophenol solution (4 mgm./100 ml.) and the optical density of the resulting colour determined 30 sec. after the addition of the dye using a Unicam spectrophotometer *S.P.* 600 at a wave-length of 520 mμ. The concentration of the sodium citrate used was such as to bring the final *p*H to 3·5. With solutions of ascorbic acid in 1·8 per cent (w/v) metaphosphoric acid a concentration of 7 per cent (w/v) was required.

It is suggested that *p*-chloromercuribenzoic acid may be of value in increasing the specificity of the indophenol reaction applied to the determination of ascorbic acid in biological material containing sulphydryl compounds. It offers advantages over mercuric acetate[2] for the removal of cysteine and certain other sulphydryl compounds in that subsequent treatment with hydrogen sulphide, to remove the excess mercuric ions and to convert the dehydroascorbic acid formed to ascorbic acid, is not required. It thus avoids a procedure which itself introduces several sources of error[3,4] and does not permit the determination of ascorbic acid in the presence of dehydroascorbic acid.

The effect of *p*-chloromercuribenzoic acid on the determination of the 'ascorbic acid' content of human plasma is being studied and it is hoped to publish results shortly.

We are indebted to Dr. A. B. Roy for the gift of the *p*-chloromercuribenzoic acid and for suggestions which led to its use described here.

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A New Mixed Disulphide: Penicillamine–Cysteine

As part of a study of skin sensitization to penicillin and its derivatives, we have been investigating the behaviour of penicillamine (β,β′-dimethylcysteine). Since D-penicillamine proved capable of eliciting allergic skin responses[1], it was expected that it would react with epidermal proteins[2], possibly through cystine or cysteine residues. Accordingly, it was of interest to determine whether this sulphydryl compound reacts with cystine or cysteine. It was found that a reaction occurs readily with cystine with the formation of a mixed disulphide which is here designated penicillamine–cysteine.

A typical experiment consisted of mixing 1 mgm. of D-penicillamine and 2 mgm. of L-cystine in 0·4 ml. of 0·5 *M* ammonium chloride at *p*H 7·4. Aliquots were analysed by ascending chromatography on paper with phenol–water as solvent. A new ninhydrin-positive compound was found, $R_F = 0{\cdot}41$, about midway between cystine, $R_F = 0{\cdot}2$, and penicillamine, $R_F \simeq 0{\cdot}7$. The new compound gave a positive nitroprusside reaction only after reduction with alkaline cyanide solution. It yielded cysteic acid and penicillamine sulphonic acid after oxidation with aqueous bromine. Reduction of the compound with sodium sulphite solution at pH 7 yielded two distinct spots on paper: the more rapidly moving spot was indistinguishable from penicillamine and the slower ($R_F = 0 \cdot 1$) had the same R_F as material prepared by sulphite reduction of cystine[3]. Oxidation of these reduction products with bromine water yielded penicillamine sulphonic acid and cysteic acid respectively.

The mixed disulphide was prepared on a larger scale in the following way: 200 mgm. of D-penicillamine and 400 mgm. of L-cystine were mixed in 8 ml. of water which was adjusted to pH 9 with 5 *N* ammonium hydroxide. (Some of the D-penicillamine used was kindly furnished by Bristol Laboratories, Syracuse, N.Y., and by Charles Pfizer and Co., Brooklyn, N.Y.) The mixture was shaken intermittently at room temperature for eight days. The soluble fraction was evaporated to dryness, then dissolved in 2 ml. of 2 *N* hydrochloric acid and run on a 70 × 1·2 cm. 'Dowex 50' column in the hydrogen ion form (200–400 mesh, 8 per cent cross-linking). The chromatogram was developed with 2·5 *N* hydrochloric acid at a rate of flow of 5 ml. per hour. The fractions containing the mixed disulphide (430–545 ml.) were combined and evaporated to dryness *in vacuo* at 40°. The residue was dissolved in 1·5 ml. of 30 per cent ethanol–water (v/v). This solution was neutralized with 2 *N* ammonium hydroxide, and long, colourless, needle-like crystals formed immediately. After standing overnight at 4° the crystalline product was washed in the cold with water, 30 per cent ethanol–water and absolute ethanol. Yield: 50 mgm., m.p. 195° (dec.). Elemental analysis (Schwarzkopf Microanalytical Laboratory, Woodside 77, N.Y.). Calc. for $C_8H_{16}N_2S_2O_4$: C, 35·8; H, 6·00; N, 10·4; S, 23·9. Found: C, 35·8; H, 5·48; N, 10·1; S, 23·3. The compound is hygroscopic and the elemental analysis has been corrected for a water content of 8 per cent.

A rapid formation of the mixed disulphide of D-penicillamine and glutathione was also observed when penicillamine and oxidized glutathione reacted in *M* ammonium chloride solution at pH 7·4.

Studies on the reaction of penicillamine with various proteins are now in progress.

The support of this work by grants from the Standard Oil Company (New Jersey), New York City, and the National Microbiological Institute of the National Institutes of Health, United States Public Health Service, is gratefully acknowledged. We wish to thank Dr. Norton Nelson for his helpful interest in this study.

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A New Glass Cell for Preparative Counter-Current Distribution

We make a distinction between preparative and the usual counter-current distribution. By the latter we mean, of course, the very efficient method of separation based on extraction, devised chiefly by L. C. Craig[1]. With this method only a single addition of mixture to the apparatus is possible. This fact, although the amount added can sometimes be fairly large, limits the preparative value of the method. Several columns, working on a continuous basis (repeated or continuous addition of the mixture being possible) have been designed. These columns, however, lack the advantages of counter-current distribution where each cell is completely separated from the others. The principal advantages in this connexion are the easy mathematical interpretation and the possibility of stopping the operation at any time.

By preparative counter-current distribution we mean a technique based on separate cells and allowing repeated additions of the mixture to be separated. Such a technique has been described by Verzele[2]. The method differs essentially from the usual counter-current distribution in two ways: (*a*) the repeated additions must be made somewhere in the middle of the extraction train; this presents no difficulty; (*b*) the lower phase must be transferred also, and in a direction opposite to the displacement of the upper phase.

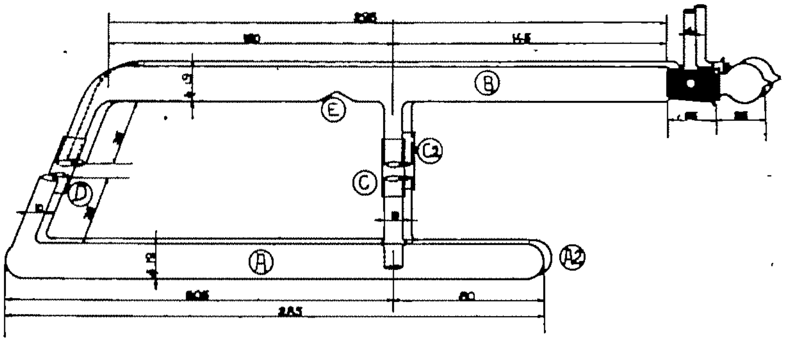

Fig 1

A new glass cell permitting the transfer of the lower phase is illustrated in Fig. 1. This new cell is a real improvement on the first model[2]. The lower half of the cell (*A*) is the agitation chamber. The stopcock permits easy removal of the solvents. *B* is the decantation chamber. *E* prevents the solvents flowing in the wrong direction. The cells can be joined together with plastic tubing or fused on to one another, depending on the ultimate use of the apparatus. Plastic tubing can sometimes be a nuisance when concentrations are determined spectrophotometrically.

Transfer of the upper phase. (1) Turn the cell 90° in a clockwise direction. The upper phase flows from *A* through *C* into the decantation chamber *B*. (2) Turn the cell farther in the clockwise direction to 200° from the original state. The lower phase of *A2*, withheld in *A2* by the extension of *C2*, flows through *D* into the decantation chamber *B*. The lower phase of *A* flows into the preceding decantation chamber, not shown on Fig. 1. (3) Turn farther clockwise to make a full turn (360° from the original position). The two phases flow together through *D* into the agitation chamber *A2*. Whereas the lower phase returns to the agitation chamber from which it came, the upper phase has been transferred from *A* to *A2*. Although the operation has been described stepwise, it is clear that a transfer of the upper phase is obtained by one uninterrupted full turn in the clockwise direction.

Transfer of the lower phase. Steps (1) and (2) of the upper-phase transfer remain unchanged. (3) The horizontal agitation state is attained by turning anti-clockwise for 200°. The two phases flow together through *C* into the agitation chamber *A*. The upper phase returns whence it came; the lower phase has been transferred into a direction opposite to the direction of transfer of the upper phase (from *A2* to *A*).

Transfer of the lower phase is obtained by turning 200° in a clockwise direction and back again.

It is obvious that the usual counter-current distribution can also be carried out with this cell.

A train of 216 such cells has been constructed in this laboratory.

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Hydrogen Reduction of Tungsten Oxides

PREVIOUS work[1] has shown that hydrogen reduction of tungsten trioxide gave the β-oxide ($W_{20}O_{58}$)[2], which was then apparently reduced both to β-tungsten (*a* = 5·04 A.) and to tungsten dioxide or the γ-oxide.

Further work has been done on the reduction of the trioxide, dioxide and γ-oxide. The latter had the composition $W_{18}O_{48 \cdot 2}$, compared with the stoichiometric composition $W_{18}O_{49}$[3]. 25 mgm. and 50 mgm. samples and a hydrogen flow-rate of 600 c.c./min. were used instead of the 500 mgm. samples and 100 c.c./min. used previously. Reaction products were identified by X-ray diffraction analysis.

The first stage in the reduction of tungsten trioxide was always the formation of β-oxide. The final product was pure β-tungsten at 465°–584° C., but at 645° C. it consisted of α-tungsten and a small amount of the β-form. Samples partially reduced at 465°–645° C. contained only β-oxide and tungsten metal, but the dioxide also was formed at 677° C. and by reduction in moist hydrogen at 645° C.

The final products of reduction of γ-oxide at 470°–584° C. were α- and β-tungsten mixtures, the α-tungsten content increasing with increasing temperature. At 658° C. no β-tungsten was in the final product; but it was present in partially reduced samples. In two samples partially reduced at 470° C. and 540° C. β-tungsten was found unaccompanied by α-tungsten.

The sole product of reduction of the dioxide at 547°–587° C. was α-tungsten.

The following conclusions are reached from this and previous work. The primary product of reduction of tungsten trioxide is β-oxide. β-Oxide is reduced directly to β-tungsten, γ-oxide to both α- and β-tungsten, and the dioxide to α-tungsten. β-Tungsten is formed from the β- and γ-oxides even at temperatures where it is rapidly converted to α-tungsten. Formation of the γ-oxide and dioxide during reduction of tungsten trioxide is not, as was hitherto thought, a necessary stage in the reaction, but is due to insufficiently rapid removal of water vapour from the reaction zone. The γ-oxide and dioxide may be formed by oxidation of the β-tungsten, or by growth of γ-oxide and dioxide nuclei, formed by oxidation of the primary β-tungsten nuclei.

Only the dioxide was completely reduced to metal. The sigmoid time-course curves for the trioxide flattened out at compositions in the range $WO_{0 \cdot 2-0 \cdot 4}$ and at about $WO_{0 \cdot 08}$ for the γ-oxide. Thus, removal of the oxygen was not quite complete in those cases where β-tungsten was formed. This supports the suggestion of Hägg and Schönberg[4] that β-tungsten is a metallic oxide, with a maximum oxygen content corresponding to the composition W_3O.

I wish to thank Mr. M. G. Harwood, who was responsible for the X-ray crystallography, and Dr. J. A. M. van Moll and the Directors of Philips Electrical, Ltd., for permission to publish these results.

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Quantitative Infra-Red Analysis of Mixtures

DIFFERENTIAL analysis of mixtures is an accepted technique in ultra-violet spectrophotometry[1], and it is the purpose of this communication to describe the successful application of this technique to infra-red solution analysis, where a double-beam instrument is used. Double-beam infra-red spectrophotometers enable complex mixtures of isomeric or closely related substances to be analysed; but it is usually necessary to detect a major peak peculiar to a particular component of the mixture. This is not always possible, and minor peaks, or peaks where interference is present, have been used. In the latter case corrections are applied for the interfering substance, which is separately estimated. Interference can also affect the shoulders adjacent to an analytical peak, so, while the actual peak is unaffected, the resultant extinction coefficient is questionable, because the true base line (I_0 value) is in doubt.

This interference was eliminated by adding to the compensating cell (usually containing solvent only) the interfering substance in a concentration equivalent to that present in the mixture, and dissolved in the solvent used in the sample cell. Alternatively, a different substance having an absorption peak at the same frequency may be used. The resulting trace shows the absorption of the mixture, less that of the interfering substance. Solvent absorption is eliminated by having low concentrations (which may involve thick cells) and using either matched cells or a variable-space cell of thickness similar to that of a fixed-thickness cell. This technique has been used for measuring the percentage of *trans* unsaturated fatty acids (expressed as elaidic acid) in the presence of *cis* unsaturated fatty acids and saturated fatty acids. Such an analysis is complicated by the fact that the *trans* double-bond peak at 965 *K** lies on the side of a major carboxyl peak at 933 *K*. It is therefore masked by this peak; but when a solution of mixed C_{18} fatty acids in carbon disulphide in the sample cell is measured against a similar concentration of stearic acid in carbon disulphide in a compensating cell of the same thickness, the carboxyl peak can be completely compensated and the resultant graph is that due to the *trans* double-bond alone. By this method 0·5 per cent *trans* unsaturated acids in the presence of *cis* unsaturated acids and saturated acids was accurately determined. Similarly, a mixture of DDT *pp′* and *op′* isomers and BHC γ-isomer was analysed by first compensating for total DDT at 1,015 *K* and measuring γ-isomer BHC at 686 *K* and 910 *K*, and secondly compensating for γ-isomer BHC at 910 *K* and measuring total DDT at 1,015 *K* and *pp′* to *op′* ratio at 806 *K*.

The method is also recommended as a criterion of purity. Similar weights of pure compound and sample are separately dissolved in equal volumes of an appropriate solvent and placed in matched sample cells. If the pure compound and sample are identical, the resultant trace is a line at 100 per cent transmittance and any impurity is readily detected.

Compensation by the above techniques may lead to low-energy transmission by each beam, and precautions may be needed to maintain instrument performance under the conditions of low energy and low signal-to-noise ratio. Such precautions include increasing energy from source, increasing slit widths, increasing electronic gain, and reducing consequent noise by the use of appropriate filters and slow scanning speeds.

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* Following the recommendation of the Joint Commission of Spectroscopy, the symbol *K* is used for denoting the unit of wave number previously designated as $cm.^{-1}$.

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A New Circuit for balancing the Characteristics of Pairs of Valves

In circuits containing balanced valves, as used in such applications as push-pull output stages or in d.c. amplifiers, it is customary to balance the valves by means of external circuit adjustments so that errors caused by differences in their characteristics are reduced. There are various methods of doing this[1]; but none of these gives compensation for all characteristics simultaneously, as it is possible to make adjustments to only one of the three properties, namely, zero balance (equality of static plate currents), stage gain and effect of changes of cathode-supply voltage.

Two valves of the same type rarely have identical characteristics, the variations being greater than can be accounted for by variations in electrode geometry. This is due to the well-known variations in the emission characteristics of the oxide cathode.

At a given operating point, differences in the characteristics of two valves caused by variation of the work function can be compensated by an appropriate adjustment of the cathode temperature and hence of the heater supply voltage.

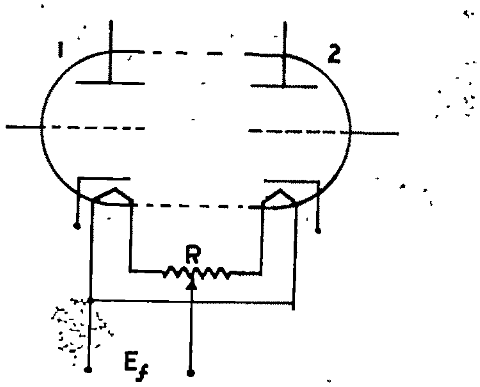

Fig. 1. A new circuit for balancing both static and dynamic properties of a pair of triodes by adjustment of the heater voltages

This approach leads to the very simple circuit of Fig. 1 for the balancing of a pair of triodes (or pentodes at fixed screen voltage). A small difference in the heater supply voltages is introduced by the potentiometer *R*, of a few ohms resistance, in series with the heater supply circuit. A suitable method of balancing is to adjust *R* until the static plate currents are equal. Experimental measurements on a number of valves of different types have shown that, when this is done, the other parameters of the valves are also brought into balance. That is, the mutual conductances of the two valves are almost equal (to within 2 per cent), and the compensation for heater supply voltage changes is also balanced. This result would presumably apply only to valves in which the differences in geometry are negligible.

It is found experimentally that it is necessary to provide for a difference of 10 per cent in the heater supply voltages, and that approximately 50 per cent of valves of the same type can be balanced with differences of only 5 per cent. In many cases (that is, d.c. amplifiers) it is desirable to operate the heaters at a reduced voltage, and the voltage drop in *R* is then unimportant.

Full experimental details will be published elsewhere.

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Cytological Polymorphism in the Nematode *Haemonchus contortus* (Rudolphi 1803) Cobb 1898

Recent observations by Roberts, Turner and McKevett[1] have indicated that the so-called ovine and bovine 'strains' of *Haemonchus contortus* (Rud. 1803) are distinct species. This conclusion is based mainly on differences in the morphology of the infective larvæ and in the type of cuticular vulval process dominant in adult females in natural populations in each host. Supporting evidence was also found in heritability tests involving these differences. The measurements of the infective larvæ presented

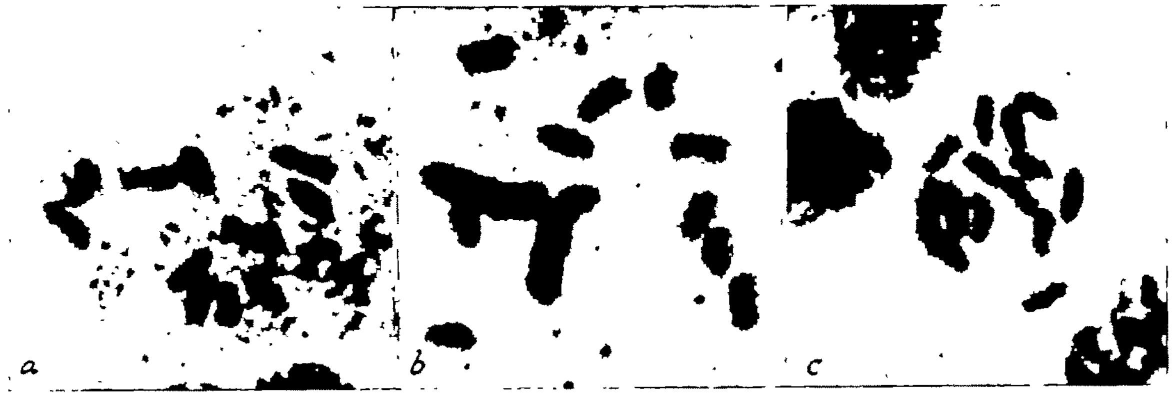

Fig. 1. Oogonial metaphase chromosomes of (a) *H. contortus* from a sheep; (b) *H. contortus* from a calf; (c) a hybrid *H. contortus*

by these authors, however, show some overlapping, and their heritability observations were carried only to the F_1 generation. For these reasons a cytological examination was undertaken and studies of the chromosomes were made on aceto-orcein squashes of the gonads.

In natural infestations the chromosome number for both forms is $2n = 11$ (♂), 12 (♀). Whereas gonial metaphase chromosomes of the worms from sheep are all of similar size (Fig. 1,*a*), those of the worms from cattle include one very large chromosome in the male and two in the female which are almost three times as long and twice as thick as any of the ten equal-sized autosomes (Fig. 1,*b*). These very large chromosomes are undoubtedly sex chromosomes, their increased size being due to the presence of heterochromatin, since they exhibit positive heteropycnosis along their complete length during prophase of gonial mitosis.

Examination of a pure infestation of cattle origin established in a worm-free calf showed the possession of large sex chromosomes to be a constant attribute of the form infesting cattle. It was also demonstrated that the presence of the large chromosomes does not influence in any way the type of vulval process in the female. A similar finding in respect of the chromosome picture was also obtained in naturally occurring infestations in sheep.

In an experiment designed to ascertain whether interbreeding occurs between the two forms, the large sex chromosomes were used as 'markers' and a worm-free sheep was given equal numbers of infective larvæ from cattle and from sheep. Infective larvæ from this lamb constituted the F_1 generation and were fed to a second worm-free lamb, which was slaughtered when the worms had reached maturity. Seventy-seven female worms from the second lamb were examined cytologically; of these, fifty possessed sheep-type chromosome complements, twenty-four the cattle type and three displayed a hybrid make-up, in which only one outsize chromosome was present (Fig. 1,*c*). The eggs from each of the seventy-seven females were cultured and those from all females, including the three hybrids, developed and hatched normally.

Another factor of interest was the finding of a triploid female among the parent generation in which the eighteen metaphase chromosomes were of equal length.

Although this experiment demonstrated the existence of a low percentage of a fertile hybrid form in an artificial population, it is highly significant that, to date, no hybrids have been found in examinations of natural populations.

Further work will be carried out on natural populations in which it is known that interbreeding has had every opportunity to occur over a number of years. The results of these observations will assist in deciding the question of specific distinctness.

Details of this work will be published elsewhere.

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May 24.

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[1] Roberts, F. H. S., Turner, H. N., and McKevett, M., *Aust. J. Zool.* (In the press).

Photoperiodic Control of Germination in Seed of Birch (*Betula pubescens* Ehrh.)

It is well known that the flowering response of both short-day and long-day herbaceous species is governed by the day-length conditions to which the mature leaves are exposed, and that the meristematic tissue of the shoot apex is insensitive. It has been shown for certain woody species, however, that direct photoperiodic perception may occur in the meristematic tissue of both dormant resting-buds and actively growing apices, in relation to dormancy phenomena. Thus, the unchilled resting-buds of dormant leafless seedlings of *Fagus sylvatica* and *Betula pubescens*[1,2] may be induced to expand by exposure to long-day conditions. Similarly, actively growing, leafy seedlings of *Betula pubescens* may be induced to form resting-buds by direct exposure of the apical region of the shoot to short-day conditions, regardless of the conditions of day-length under which the mature leaves are maintained. It is of interest, therefore, to investigate whether the embryos of such woody species also show photoperiodic effects in relation to dormancy, and experiments have been carried out with seeds of birch for this purpose.

Preliminary tests showed that the *unstratified* (that is, unchilled) seeds will not germinate on moist filter paper in complete darkness at room temperature but will do so if exposed to light, and hence are light-requiring seeds. Experiments were carried out to determine the effect on germination of exposing the

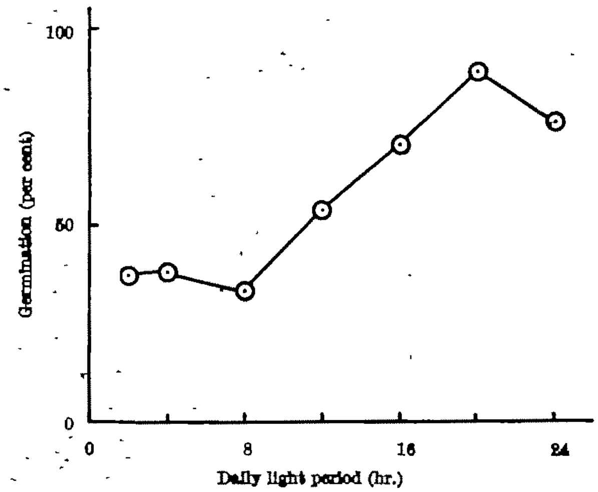

Fig. 1. Effect of day-length upon germination of unchilled birch seed. (Illumination with red light at 1,000 ergs/cm.²/sec. Temperature during both light and dark periods, 15° C.)

seeds to various lengths of photoperiod. For this purpose red light (falling within the range 5800–7000 A.) derived from red fluorescent tubes in conjunction with red 'Perspex' (*R*.400) was used, the intensity at the level of the seeds being approximately 1,000 ergs/cm.²/sec. It was found that the germination is markedly affected by the conditions of day-length, but that this photoperiodic response is profoundly modified by the prevailing temperature conditions.

Fig. 1 illustrates the effect of varying lengths of photoperiod, within 24-hr. cycles, at 15° C. The number of germinated seeds in each treatment was counted daily and the treatments continued until there was no further increase in germination, that is, for 12–14 days. (A considerable proportion of the seeds were found to lack embryos and these were excluded from the germination percentage.) It is seen that a high percentage germination is obtained with photoperiods of 16 hr. or longer, but under short-day conditions the maximum germination is only of the order of 30 per cent. A number of further experiments have been carried out which confirm that this is a true photoperiodic effect and that the final germination percentage is not governed by the total quantity of light received. For example, the percentage germination following exposure to seven cycles consisting of 8 hr. light/8 hr. dark was 60 per cent compared with 30 per cent following the same number of cycles consisting of 8 hr. light/16 hr. dark, although the total period of illumination (56 hr.) was the same for both treatments.

With higher temperature conditions (20°, 25° C.) the final germination was 93 per cent under both 8-hr. and 20-hr. photoperiods (with 24-hr. cycle) and the photoperiodic nature of the response is thus not apparent. At these higher temperatures even a single light-exposure followed by storage in the dark resulted in considerable germination (Table 1), whereas at 15° C., with corresponding periods c illumination, only a very low percentage germinatio was obtained.

Table 1. EFFECT OF SINGLE LIGHT-EXPOSURE ON PERCENTAGE GERMINATION AT 20° C.

Duration of light period (hr.)	0	0·25	1·0	4 0	8·0	20·0	24 0
Percentage germination	0	37·5	42·3	47·2	54·0	66·6	68 9

The effect of a single 4-hr. period of illuminatio with red light at 20° C. may be nullified if followe by illumination for 30 min. with infra-red radiatio (intensity 3,000 ergs/cm.²/sec.) within the rang 7200–10,000 A., and in this respect the responses c birch seeds resemble those of lettuce seeds[3].

Seed which had been soaked and stored in the dar at 5° C. for six weeks was found to germinate rapidl in darkness on transfer to a temperature of 15° C Chilled birch seed has apparently, therefore, no ligh requirement. There is thus a close parallel betwee the responses of both resting-buds and embryos o birch, for both structures show a requirement fo long photoperiods to overcome dormancy whe unchilled, but show no light-requirement afte chilling[2].

These effects in birch provide direct evidence i support of the hypothesis, put forward by Borthwick[4] and his co-workers, that the same photo-reactio is involved in both light-sensitive seeds and in photoperiodic effects observed in the later stages o development.

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P. F. WAREING

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Aug. 3.

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[1] Wareing, P. F., *Physiol. Plant.*, 6, 692 (1953).

[2] Wareing, P. F., *Physiol. Plant.*, 7, 261 (1954).

[3] Borthwick, H. A., Hendricks, S. B., Parker, M. W., Toole, E. H. and Toole, V. K., *Proc. U.S. Nat. Acad. Sci.*, 38, 662 (1952).

[4] Borthwick, H. A., Hendricks, S. B., and Parker, M. W., *Proc. U.S Nat. Acad. Sci.*, 38, 929 (1952).

Magnetic Observations at Quetta during the Total Solar Eclipse of June 30

WITH the view of studying the effects of the total solar eclipse of June 30, 1954, on the magnetogram at Quetta, the Ruska magnetograph was set to run at 80 mm./hr., instead of the normal speed of 20 mm./hr. The Quetta Magnetic Observatory wa approximately three miles south of the northern ri of the shadow belt. The beginning of totality was 13h. 58·8m. G.M.T. and hence the corpuscular eclipse wa to be expected at approximately 11h. 59m. G.M.T.

The day was magnetically almost quiet. The horizontal force curve (*H*-trace) is entirely smooth a few hours before and after the eclipse period. At 12h. 1·6m. G.M.T. (2·6 min. after the expected corpuscula eclipse time), a full oscillation of a period of 1·3 min. and an amplitude of 0·8 γ appears in the *H*-trace. The onset is towards the positive side. The trac remained slightly disturbed until 12h. 47m. G.M.T. At the same time a slight increase of declination (*D*) by 0·1′ (1·0 γ) also occurred.

At 13h. 57·2 m. a very minute onset towards the positive side of *H* occurred. The amplitude of the onset is approximately 0·4 γ and consists of a sequence of irregular oscillations which last for 0·8 min. only.

S. A. A. KAZMI

Pakistan Meteorological Department,
Magnetic Observatory,
Quetta.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 11

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Mr. L. L. Whyte: "One-way Processes in Physics and Biology" (Chairman's Address).

Society of Chemical Industry, Fine Chemicals Group (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Dr. G. M. Dyson: "The Economics of Research in the Fine Chemicals and Pharmaceutical Industries".

Tuesday, October 12

British Psychological Society, Industrial Section (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1), at 1 p.m.—Dr. Alastair Heron: "Scientific and Professional Problems for the Psychologist in Industry".

Zoological Society of London (at the Zoological Gardens, Regent's Park London, N.W.1), at 5 p.m.—Scientific Papers.

Institution of Civil Engineers (at Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. L. Wilson: "The Design and Construction of the Handling and Treatment System for Liquid Radioactive Wastes"; Mr. R. H. Burns: "Operational Experiences with a Handling and Treatment System for Liquid Radioactive Wastes".

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. W. van Krevelen (Holland). "Heterogeneous Reaction Processes. 1. Gas-Liquid Reaction Processes".* (Further Lecture on October 22.)

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. I. Prigogine (University of Brussels): "Irreversible Processes". Lecture 1: "Thermodynamics of Irreversible Phenomena".* (Further Lectures on October 14 and 15.)

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of the Subject of Electro-magnetism".

Society for Visiting Scientists, Ltd. (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion meeting on "Nuclear Energy in Industry and Medicine". Chairman—Prof. Sir Francis Simon, F.R.S. Speakers—Dr. J. V. Dunworth, Prof. J. Rotblat and Mr. F. H. S. Brown.

Tuesday, October 12—Wednesday, October 13

Iron and Steel Institute (joint meeting with the National Forgemasters' Association and the Chambre Syndicale de la Grosse Forge Française, at 4 Grosvenor Gardens, London, S.W.1), at 9.45 a.m. daily—Discussion of Technical Papers.

Wednesday, October 13

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. A. Neuberger, F.R.S.: "Porphyrin Metabolism".*

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. O. T. Jones, F.R.S.: "The Geological Evolution of Wales and the Adjoining Regions" (Tenth William Smith Lecture).

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. W. Oatley: Chairman's Address.

Society of Chemical Industry, Food Group—Nutrition Panel (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. Magnus Pyke. "Food, Chemistry and Nutrition".

British Psychological Society, Social Psychology Section (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 8.15 p.m.—Prof. C. A. Mace: "'Thinking' as a Psychological Function of Social Groups".

Thursday, October 14

British Society for the History of Science, Northern Branch of the Philosophy of Science Group (at the University, Sheffield), at 5.30 p.m.—Annual General Meeting. At 7.30 p.m. (in conjunction with the Sheffield University Extra-Mural Department)—Mr. L. L. Whyte. "The Growth and Implications of Modern Physics—a Philosophical View".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Prof. R. J. Sarjant and Dr. D. Smith: "Heat Transfer in a Continuous Reheating Furnace"; Dr. N. P. Bacon and Prof. R. J. Sarjant: "The Significance of Sectional Heat Balances and Burner Performances in Furnaces".*

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. A. Morris Cassie: "The Operation of a High-Voltage D.C. System". (From a series of five lectures on "Electrical Power Transmission by High Voltage D.C.")*

Scientific Film Association, Sciences Committee (in the Theatre of the Shell Film Unit, Room 106, Shell-Mex House, Strand, London, W.C.2), at 6.30 p.m.—Meeting on "The Use of Film in Chemical Investigations".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, October 15

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. W. R. Bailey, F.R.S.: Presidential Address.

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle upon Tyne), at 6.15 p.m.—Opening General Meeting.

Quaker Scientists' Fellowship (in the Small Meeting House, Friends House, Euston Road, London, N.W.1), at 6.30 p.m.—Sir Russell Brain: "Science and Religion".*

Friday, October 15—Saturday, October 16

Biochemical Society (at the National Institute of Medical Research, The Ridgeway, Mill Hill, London, N.W.7), at 2.30 p.m. on Friday and 11.30 a.m. on Saturday—Scientific Papers.

Saturday, October 16

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—The Reverend A. M. Jones: "African Music" (Illustrated by gramophone records).*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer, Grade B (with a degree and some teaching experience) in Biology—The Principal, North Staffordshire Technical College, Stoke-on-Trent (October 12).

Head (with experience of university scholarship work with sixth form) of the Geography Department—The Headmaster, Solihull School, Warwickshire (October 13)

Assistant Lecturer (professionally qualified and with adequate industrial experience) in Electrical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (October 14).

Assistant Lecturer (with a degree in engineering and/or in agriculture, and practical experience of farm implements and machinery) in Agricultural Engineering—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (October 14).

Senior Scientific Officer (with a university degree of high standard in electrical engineering or physics, with mathematics or mathematical physics to final honours standard or equivalent qualifications) in the Aeronautical Research Laboratories, Department of Supply, Fishermen's Bend, Victoria, Australia, to be responsible for the investigation of instrumentation schemes in the field of aeronautical research, and detailed investigation of resultant problems and the subsequent development of necessary apparatus—The Senior Representative (A.P.22), Department of Supply, Australia House, Strand, London, W.C.2 (October 14).

Assistant Lecturer (Grade A) in Biology—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (October 16).

Laboratory Technician (with experience in general laboratory practice, the construction of experimental physical apparatus and instrument repair, and preferably with a knowledge of glass blowing)—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (October 16).

Principal (graduate in agriculture or appropriate sciences and with experience in teaching, practical farming and administration) of the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (October 16).

Research Assistants (2) at the Cavendish Laboratory to help with the work in radio astronomy—The Secretary of the Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (October 16).

Guide Lecturer (with a university honours degree, and experience in lecturing or teaching, and preferably with a knowledge of a foreign language) at the Victoria and Albert Museum, London—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4880/54 (October 19).

Assistant in the Department of Geography—The Secretary, The University, Edinburgh (October 20).

Soil Conservation Officers (graduates in agriculture or agricultural engineering) in the Federal Department of Conservation and Extension, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (October 20).

Assistant (with a degree in physics, together with some research experience and an actual or prospective interest in archæology) in the Archæological Research Laboratory—The Registrar, University Registry, Oxford (October 23)

Assistant Lecturer in Applied Mathematics—The Registrar, The University, Hull (October 24).

Lecturer in Agricultural Economics and Farm Management at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

Senior Experimental Officer (with a pass degree in mechanical engineering or chemical engineering or H.N.C. in either of these subjects, and experience in the design, manufacture, development, installation and operation of process and chemical plant incorporating modern heat and mass transfer principles, or of heat exchange equipment used in power stations) in the Mechanical Engineering Research Laboratory, Department of Scientific and Industrial Research, East Kilbride, near Glasgow, for duties which involve the design (or selection) and development of heat transfer equipment—The Secretary, Civil Service Commission, 30 Old Burlington Street, London, W.1, quoting 84382/54 (October 26).

LIBRARIAN, Grade 3 (Fellow or Associate of the Library Association or with the Diploma of the London University School of Librarianship, and considerable experience (preferably technical) of library work, and preferably with a degree in a science subject, and a knowledge of languages) in the Ministry of Agriculture and Fisheries Veterinary Laboratory, Weybridge, Surrey—The Civil Service Commission, Burlington Gardens, London, W.1, quoting 4379/54 (October 28).

LIBRARIAN (with experience in a scientific library)—The General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1 (October 29).

RESEARCH ASSISTANT (with some research experience in a branch of applied mathematics or numerical analysis, and preferably with previous experience of automatic computing) IN THE COMPUTING MACHINE LABORATORY—The Registrar, The University, Manchester 13 (October 30)

SENIOR LECTURER IN ANTHROPOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, October 30).

CHAIR OF APPLIED MATHEMATICS at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, October 31).

CHEMIST (graduate of a recognized university, and preferably with some postgraduate experience and training), with the Tobacco Research Board of Southern Rhodesia, for duties which cover the analyses of soils and tobacco leaf from experimental plots—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (October 31).

LECTURER IN VETERINARY SURGERY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURER and a LECTURER IN THE DEPARTMENT OF ZOOLOGY at the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, October 31).

SENIOR EXPERIMENTAL OFFICER (with a pass degree in an appropriate subject, or technical qualification, and preferably with experience in research work and electronics, and prepared to undertake and supervise development of electronic apparatus) IN THE CENTRIFUGE UNIT of the Royal Air Force Institute of Aviation Medicine, Farnborough, Hants, to work in a small scientific unit concerned with effects of acceleration on man and animals—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4383/54 (November 9).

LECTURER (Grade I) IN CHEMICAL ENGINEERING at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 15).

SENIOR LECTURER or LECTURER IN PHILOSOPHY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, November 15).

DEPARTMENTAL ASSISTANT (preferably with a degree in dairying) IN DAIRYING, at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

ENGINEERS and PHYSICISTS (Experimental Officer and Assistant Experimental Officer grades, with at least H.S.C. (pass degree, H.N.C. or near equivalent an advantage)), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.247/52A.

RESEARCH ASSISTANT IN THE PHYSICS DEPARTMENT, for problems concerned with the design of a high pressure Wilson Cloud Chamber—The Registrar, Imperial College, London, S.W.7.

RESEARCH ASSISTANT (man or woman) in the field of physical chemistry (reaction kinetics)—The Secretary, University College, Exeter.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry, and preferably with experience in thermochemistry, reaction kinetics and/or optical techniques), with the United Kingdom Atomic Energy Authority, Fort Halstead, Kent, for research on some of the physical and physico-chemical aspects of detonation and associated phenomena—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 225/WG/54.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Oxford System of Decimal Classification for Forestry. (Being the definitive English version as authorized by the Rome Congress of the International Union of Forest Research Organizations, Sept. 1953, and published on their behalf by the Commonwealth Agricultural Bureaux.) Pp. 115. (Farnham Royal: Commonwealth Agricultural Bureaux, 1954.) 10s. [207

Department of Agriculture for Scotland. Memoirs of the Soil Survey of Great Britain–Scotland. The Soils of the Country Round Banff, Huntly and Turriff (Lower Banffshire and North-West Aberdeenshire). By Dr. R. Glentworth. (Sheets 86 and 96.) Pp. x+169+24 plates. (Edinburgh: H.M. Stationery Office, 1954.) 17s. 6d. net. [207

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research for the year 1953. Pp. vi+66+16 plates. (London: H.M. Stationery Office, 1954.) 3s. 6d. net. [207

Brown's Coppice: a Survey. By the Natural History Society of King Edward VI Grammar School, Camp Hill, Birmingham. Pp. vi+79+11 plates. (Camp Hill, Birmingham: Natural History Society of King Edward VI Grammar School, 1954.) 5s. [207

Ministry of Health; Department of Health for Scotland. Poliomyelitis—Medical Memorandum. Pp. 13 (London: Ministry of Health, 1954.) [207

Air Ministry: Meteorological Office. Meteorological Reports. No. 14: Sea-Breezes at North Front, Gibraltar. By A. Ward. Pp. ii+8+5 plates. (M.O. 555i) (London: H.M. Stationery Office, 1954.) 1s 6d. net [207

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 3: Some Recent Advances in Physical Chemistry. By Dr. A. R. J. P. Ubbelohde, F.R.S. Pp. ii+20 (London: Royal Institute of Chemistry, 1954.) [237

Is Management a Profession? By L. Urwick. Pp. 27. (London: Urwick, Orr and Partners, Ltd., 1954.) [237

Boundaries of Physics. By Prof. G. O. Jones. (An Inaugural Lecture delivered on 2nd March, 1954, Queen Mary College, University of London.) Pp. 22+2 plates. (London: Queen Mary College (University of London), 1954.) [237

Department of Scientific and Industrial Research. Forest Products Research. Bulletin No. 31: Prevention of Decay of Wood in Boats. By J. G. Savory. With a contribution on Electrochemical Attack by D. F. Packman. Pp. iv+18+8 plates. (London: H.M. Stationery Office, 1954.) 2s. net. [237

National Institute of Agricultural Botany. Thirty-Fourth Report and Accounts, 1953. Pp. 48. (Cambridge: National Institute of Agricultural Botany, 1954.) [237

Other Countries

Smithsonian Institution: United States National Museum. Proceedings of the United States National Museum. Vol. 103, No. 3325: The Relationships of Old and New World Melanians. By J. P. E. Morrison. Pp. 357–394+plate 11. Vol. 103, No. 3326: Preliminary Analysis of the Fossil Vertebrates of the Canyon Ferry Reservoir Area. By Theodore E. White. Pp. 395–438. Vol. 103, No. 3327: A Review of the Labrid Fish Genus Wetmorella, with descriptions of New Forms from the Tropical Indo-Pacific. By Leonard P. Schultz and N. B. Marshall. Pp. 439–448+plate 12. Vol. 103, No. 3328: Review of the Atlantic Periwinkles, Nodilittorina, Echininus, and Tectarius. By R. Tucker Abbott. Pp. 449–464. Vol. 103, No. 3329: Mammals of Northern Columbia, Preliminary Report No. 7: (Genus *Tapirus*), with a systematic review of American Species. By Philip Hershkovitz. Pp. 465–496. Vol. 103, No. 3330: A Revision of the Goatfish Genus Upeneus, with descriptions of Two New Species. By Ernest A. Lachner. Pp. 497–532. (Washington, D.C.: Government Printing Office, 1954.) [207

Dendron. (News Bulletin of the International Dendrology Union.) Vol. 1, No. 1, July, 1954. Pp. 24. (Oisterwijk, Netherlands: J. Bergmans, International Dendrology Union, 1954.) [207

Notulae Naturae of the Academy of Natural Sciences of Philadelphia. No. 247 (June 5, 1953): New and Interesting Species of Foraminifera from the Vincentown Formation. Part 2: Forms Previously Described. By James D. McLean, Jr. Pp. 16 (4 plates). No. 248 (June 5, 1953): Notes on Peruvian Dendrocolaptidae, Conopophagidae and Rhinocryptidae. By James Bond. Pp. 7. No. 249 (July 20, 1953): A New Slender Cone from the Gulf of Mexico. By Thomas L. McGinty. Pp. 2. No. 250 (October 7, 1953): Three Undescribed North American Leeches (Hirudinea). By J. Percy Moore. Pp. 13 (1 plate). No. 251 (October 21, 1953): New Records of Symbiocladius Equitans (Claassen), with some notes on the Genus (Diptera: Tendipedidae). By Selwyn S. Roback. Pp. 2. No. 252 (October 21, 1953): Results of the Catherwood–Chaplin West Indies Expedition. Part 7: The Lichens. By William L. Dix. Pp. 3. No. 253 (October 21, 1953): Tendipedid Larvae from the St. Lawrence River (Diptera: Tendipedidae). By Selwyn S. Roback. Pp. 4. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1953.) [207

Notulae Naturae of the Academy of Natural Sciences of Philadelphia. No. 254 (November 24, 1953): Euphrasia in China (Scrophulariaceae). By Hui-Lin Li. Pp. 6. No. 255 (December 9, 1953): Notes on the Peruvian Icteridae, Vireonidae and Parulidae. By James Bond. Pp. 15. (Philadelphia: Academy of Natural Sciences of Philadelphia, 1953.) [207

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MASS COMMUNICATION, POWER AND INFLUENCE

NOW that the Television Act is on the statute book and the chairman and director-general of the Independent Television Authority have been appointed, it should be possible to continue the public discussion of the real issues free from the heat engendered by the decision to make commercial television a party political matter. The composition of the governing body of the Independent Television Authority encourages confidence that every effort will be made to see that the development of television is fostered with due regard to the public interest, though it has yet to be seen whether in practice the high standards of public service established by the British Broadcasting Corporation can be maintained. Meanwhile, it should be apparent that the misgivings which are entertained on that score are due not to poor opinions of business interests or of advertisers, but rather to doubts whether the Authority possesses sufficient powers and independence to make the public interest prevail if a clash with commercial interests should arise. To insist that the public interest must prevail, or that the question of what is the public interest is not to be determined by those whose interests are immediately concerned, is no more to impute bad faith to such persons than to maintain that government departments should not be left to judge the public interest in matters in which they are immediately concerned is to impeach the integrity of the Civil Service.

It is only too easy to attack the motives of those whose belief that broadcasting and television represent instruments of immense power over the minds of men, the social and economic implications of which are not yet apparent, leads them to urge that both broadcasting and television should be treated in the same way and on the same plane as questions of education and other matters which profoundly affect the life and thought of whole communities. When the dust of party political conflict has subsided, attacks on the integrity of men like Lord Halifax and Lord Waverley, for example, can be seen for what they are worth; and the genuineness of the concern of such men that television and broadcasting may profoundly affect the character of our people for good or ill is unquestionable. It is indeed the belief that we need all the help we can get from this new instrument, of which science has made us masters, that has led to such stress being laid on the principle of public service—the principle that such power should be exercised responsibly for the public good. Broadcasting and television are necessarily and above all, as the Archbishop of Canterbury said in the debate on July 1, instruments of education. They provide ideas and information in such a way as to evoke, create, and contribute to mental, moral and spiritual reactions in the hearer or viewer. As with the cinema, their function as entertainment cannot be separated from this process of stimulus and reaction, even when it amounts to no more than passive acceptance. Indeed, the gravest danger of television appears to be that, instead of encouraging the process of education, it will foster a sluggish torpidity of mind which will render many incapable of being educated at all.

Even so, it would be going too far to consider the system created under the Television Act solely or even primarily as an educational instrument, though that aspect cannot be disregarded in considering any aspect of the system. What needs to be remembered is that this is a matter of influence, not of power, and its effect should be considered along with that of such other public influences as the Press and the cinema, and not in isolation. Failure to do so has encouraged the mistaken belief that the British Broadcasting Corporation possesses great power, whereas in fact it possesses little or no power but great influence.

Even the summary of the report of the Drogheda Committee* of inquiry into British Overseas Information Services, which the Government published last April, should help to remove that belief and to put broadcasting in its proper perspective as a vehicle for the communication of ideas and information. The Drogheda Committee could not avoid the conclusion that a modern government has to concern itself with public opinion abroad and be properly equipped to deal with it, and it followed accordingly that overseas information services play an important and indeed an essential part in support of foreign, Commonwealth and Colonial policies. The report faces fairly and squarely the implications of propaganda and counter-propaganda as a means of influencing public opinion in other countries, which the development of methods of mass communication has made possible.

It is obvious from the Government's treatment of the report, and the negative attitude which the Government spokesman, Mr. H. A. Nutting, had to reveal, particularly his denunciation of co-ordination, in the debate on July 6, that some, at any rate, of the findings of the Committee, and particularly its recommendations for a concerted and long-term policy, are unpalatable. But to the impartial observer, those findings, on the evidence published, are the more impressive because of the moderation with which they are presented. The case is not over-stated. Although the need for official information services is argued convincingly, it is never suggested that propaganda is a substitute for policy or for military strength, economic efficiency or financial stability. Its effect on the course of events is unlikely to be more than marginal; but in certain circumstances it could be a decisive factor in determining diplomatic success or failure. Even in this supplementary role, it can, however, make a contribution of outstanding importance to the efficiency with which Great Britain's resources are used to further policy.

The Drogheda Committee presents a case for the support of overseas information services, including broadcasting, with adequate resources for objectives which are broadly but clearly defined. No attempt has been made to refute that case, or to deny the Committee's assertion that the resources at present provided are entirely inadequate to meet those purposes. The increased expenditure of some two million pounds recommended by the Drogheda Committee, bringing the total to some twelve and a half million a year, is insignificant in comparison with its importance to the military and economic strength of Britain, and any political party which shirks finding the necessary funds because unpopular economies are involved elsewhere is clearly guilty of dereliction of public duty.

The published summary of this report shows how carefully the Drogheda Committee examined broadcasting as a means of influencing public opinion in relation to other means of promoting an understanding of the British way of life and point of view such as books, periodicals and newspapers. It is admitted that it is difficult to assess the effectiveness of any information service, whether spoken or printed, and that broadcasting as a means of influencing opinion is always in danger of falling between the two stools of the mass audience and the influential minority. Nevertheless, the Committee holds that the high reputation of the British Broadcasting Corporation External Service for objective and honest news-reporting is a priceless asset which sets that service apart from all other broadcasting systems. This high reputation for objectivity must be maintained at all costs, and the concern with which the Government's attitude to commercial broadcasting and television is regarded arises, at least to some extent, from the belief that the Government is unwilling to put at the disposal of the new Authority sufficient resources to make it independent of influences which could destroy that objectivity.

It is perhaps unlikely that any attempt will be made by the Government to use the British Broadcasting Corporation for anything in the way of direct propaganda; but, apart from indirect effects which commercial broadcasting might have, and also commercial television, measures which entail financial stringency threaten more than the scale of the Corporation's factual presentation to other countries of the news and of British views concerning the news. The Government must make up its mind either to provide sufficient support for overseas information services to enable them to be planned as a whole on a long-term basis, safeguarded against the changes which destroy efficiency, or see that the British Broadcasting Corporation itself is provided with sufficient resources to provide the services required without risk of their magnitude or content being subjected to sectional interests or pressure. Once the reputation for objectivity is lost or the opportunities for presenting the British point of view are missed they are not easily recovered.

These related problems are internal as well as external, and they were considered by Sir William Haley in the Clayton Memorial Lecture delivered before the Manchester Literary and Philosophical

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* Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. Pp. 56. (Cmd. 9138.) (London: H.M. Stationery Office, 1954.) 1s. 9d. net.

Society last March*. That penetrating lecture, on the theme of the part which the Press and broadcasting play in building up public opinion and thus, in a democracy, in shaping public policy, deserves to be read widely. It is a valuable contribution to the clear thinking which is required on the problems arising out of the interplay of the means of information, education and entertainment in the world to-day and their bearing on wise government. The reception of the Drogheda Report itself is sufficient evidence of the dangers which arise if a government feels itself insufficiently secure to take steps imperative in the public interest because to do so may involve other unpopular measures the necessity for which could not perhaps be clearly explained to the public in the conditions of party political debate.

What Sir William Haley said bears closely on this vital matter of securing an alert, informed and intelligent public opinion. First, he explained the difference in the nature of broadcasting and the Press. Apart from its comparative novelty, though geographically the most pervading form of communication yet devised, broadcasting has limitations. Compared with the Press, it is comparatively inaccessible, being limited by time both in range and in space. Against the advantage of immediacy, especially on great occasions, has to be set its complexity and comparative inflexibility of operation compared with the Press. The Press, said Sir William, is far freer and less inhibited in political matters: because each individual reader can comprehend its output, a newspaper can have an impact which no broadcasting station can possess. It is not merely free to have a policy, an attitude, a way of thought: it can also make these things felt. Moreover, the printed word is more enduring than the spoken word, and while much of the best broadcasting is aimed at the emotions, most of the best journalism is aimed at the head.

Sir William Haley here makes a point which has received little attention in the debates over television and broadcasting of the past few years. The limitations to which he refers arise not out of the nature of the British Broadcasting Corporation and its monopoly; they apply to any system of broadcasting and are inherent in the nature of the medium. The use we make either of broadcasting or of television and the influence they exert in our own or any other community depend not only on technique and on the way in which we use them, but also on the nature of the medium. Ultimately, practical and physical considerations must determine what is done, and Sir William's comments on television in this connexion are shrewd and disturbing.

He emphasizes what is often overlooked—that over the programme field as a whole television, from its nature, cannot have the same range as sound broadcasting. Moreover, although television robs broadcasting of the great stimulus of the listener's imagination, for whole sections of the population television threatens to become the whole of broadcasting. Because thereby passivity instead of co-operation is encouraged, the whole educational purpose of broadcasting is at stake.

This is true whatever the outcome of the struggle between the idea of public purpose and commercial interest in television and broadcasting, and the picture Sir William gives of how much is at stake, particularly in politics and news, is disturbing. He pays a tribute to the way in which in the past the combined wisdom of Parliament, of the early committees on broadcasting, of the political party leaders and elder statesmen in both Houses of Parliament and of responsible directors and governors of the British Broadcasting Corporation, have given us a panoply of political broadcasting which has led the nation to be informed, persuaded, fairly exhorted, and given the requisite facts or opinions upon which to make up its mind, while simultaneously defending it against irresponsibility, demagogy and abuse. These same experienced forces, he believes, will bring wisdom and judgment to bear on the use of television, but they cannot ignore the nature of the medium with which they are working; and Sir William regards the coming of the television screen into every home, and the visual presentation of political affairs and politicians in this way, as a major sociological influence of our time.

Sir William Haley is disturbed because much news, particularly the most significant and important news, has no visual quality. The nature of the medium, accordingly, is likely to be continually at war with the real values of the news, and though he is confident that the B.B.C. will make an imaginative, courageous and thoroughly honest attempt to reconcile this conflict, he is less confident as to the outcome. On its outcome the future influence of both broadcasting and the Press may well depend; but it is difficult to feel as sure as Sir William that if the televized news bulletin proves a failure, the ordinary man or woman will revert to the printed word. There is the effect of television on the viewer, on education, and on literacy to be considered. Lord Reith was right at least in asserting that in the Television Act social, political, intellectual and ethical issues of incalculable gravity are at stake. He did not believe that its supporters would wittingly or willingly suborn moral responsibility or do moral hurt to their country at any one's dictation; but he may not have been so very wide of the mark in suggesting the possibility that the Government has surrendered a fundamental principle, moral values and intellectual and ethical objectives that should be cherished.

The reality of such dangers appears more clearly as we reflect upon Sir William Haley's observations on the inter-relations of the Press and broadcasting and the way their influence is exerted in the society of to-day. He believes that the Press still has great influence, but the character of its influence has changed; it is now not so much political as informative and interpretative, and while the great masses of the people may, as Sir William suggests, eschew opinions on the bewildering range of our manifold problems to-day and leave it to their representatives, we cannot entirely ignore the outlook and opinions of the general population. The serious Press is undoubtedly able to inform those representatives on hosts of important matters, and has sources of information and of informed judgment which in total are not available to the ordinary member of Parliament and can often supplement the knowledge of Ministers. Its influence on serious public opinion can be powerful, constructive, widespread and continuous.

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* "The Public Influence of Broadcasting and the Press". By Sir William Haley. (Clayton Memorial Lecture.) (Manchester: Literary and Philosophical Society, 1954.)

Nevertheless, leaders of thought and action inside and outside Parliament, those of all classes in industry, the universities and schools, the professions, the churches and every walk of life who take an intelligent interest in events, still form only a fraction, though probably a greater part than formerly, of the nation. As voters in the electorate their influence could be ineffective, and Sir William Haley is clearly disturbed that the national temper may be such that the judgment and wisdom of the informed minority may fail to avert disaster. The symptoms and tendencies which he notes, moreover, may well be fostered as television encourages further both passivity and the expectancy that the individual can and should receive everything of the nation without contributing in return.

Sir William's own conclusion is not too pessimistic. He says quite frankly that certain daily and weekly newspapers with huge circulations among the less discerning and discriminating section of the community are indirectly and cumulatively building up an attitude of mind in the new generation which can be disastrous unless it is counteracted, and he points out that the Press has missed some opportunities which broadcasting has given it; but he recognizes that much of the Press has done and is doing fine work. He regards the Press and broadcasting as complementary, not inimical to each other. The Press, he suggests, could have concentrated on what broadcasting could not at one time do, namely, providing the background, explanation, opinion, exegesis and illustration, and maintaining a sense of values.

It does not appear, however, that Sir William is over-confident that should television take over the major part of the broadcasting audience and the televized news bulletins prove a failure, the popular Press will return to its proper role and again become an educative force. That might happen, he thinks, under the influence of public opinion, and he reminds us of the short time since we created a nation that can read. We have yet to make it a literate nation; whether television will assist or hinder that step remains to be seen.

Sir William suggested in this lecture that the most significant influence of the popular Press is now on what he calls morals, whereas the influence of British broadcasting has been mostly on manners. That influence could equally continue in television, but the arguments against commercial television indicate that widespread doubts are entertained as to whether in such a context television or broadcasting can raise standards of conduct or taste, or even maintain them. However that may be, Sir William's contention that the Press as well as broadcasting should resume their role as leaders rather than followers of public opinion is indeed timely Unless they remain true to their earliest ideals and seek to guide and uplift and not debase public opinion, we are on the way to an essentially uneducated nation, with all that is thereby implied in the abandonment of democracy and the growth of regimentation and intolerance.

What needs to be emphasized is that for the Press no less than for broadcasting and television, the educational purpose cannot, without danger to the whole basis of the British way of life, be subordinated to the entertainment function. The two purposes must be harmonized and reconciled, but it must not be by the abdication of leadership and the disregard of the responsibility for the accurate and fair presentation of facts, opinions and events. Sir William Haley denounces rightly as humbug and nonsense the doctrine that the public should be given nothing but what it wants, and that any design to give it or to lead it to want something better is highly dangerous and anti-democratic.

If, however, the Press and broadcasting are to exercise their role of leadership, they must recognize that their roles are complementary, and must respect each other's functions. Largely, broadcasting, perhaps even television, can be a stimulator, and the Press can satisfy the stimulated appetite. But how-effectively that educative function is discharged depends also on whether informed public opinion cares enough to maintain and advance standards, and to see that vigour and openmindedness are brought to the discussion of values and that no shibboleth goes unchallenged; and to speak out to that end, with vision, with care and with courage.

PRINCIPLES OF EXPERIMENTAL PHYSICS

The Physics of Experimental Method

By Dr. H. J. J. Braddick. Pp. xx+404. (London Chapman and Hall, Ltd., 1954.) 35s. net.

THE development of experimental ability rest not only upon example, precept and experience but also upon the prudent use of books which deal with the methods of experiment. Books of this kind with a wide range and suitable for advanced student are rather few. They tend to concentrate either upon laboratory arts and practice, or upon a course of typical experiments, or upon a range of particula instruments or measurements. Dr. H. J. J. Braddick' book has a different aim. Although he describe various techniques, experiments and instruments, h is concerned to bring out the physical principles by which apparatus may be designed and used to th best advantage in scientific experiments within th general field of physics. As Prof. P. M. S. Blacket remarks in the foreword, physical measurements ar now used in most sciences, so that the title "Th Physics of Experimental Method" has a topical appropriateness. No single book could fulfil so broad a title, and therefore the author has essentially t make an individual choice of the subjects included He treats, in fact, the general questions of th tatistical interpretation and mathematical manipu-ation of experimental results and also the natural imits of measurement set by thermal agitation and ther fluctuation phenomena. He describes four elds of measurement and methods, namely, elec-rical measurements and electronic devices, vacuum echniques, optical and photographic methods and a umber of the methods of nuclear physics. In these ields he gives in each section examples of the ppropriate instrument technology. He also makes ome observations on the construction of apparatus, oth design and materials.

The author writes little on the design of experiments, probably because it would have little relevance o the rest of the book. Similarly, he wisely limits he discussion of mechanical features to principles uch as kinematic design: mechanical engineering annot be compressed into a chapter. It was prob-bly also wise to omit subjects adequately treated in tandard text-books, such as bridges, potentiometers nd many electrical measurements. X-ray analysis nd electron diffraction and microscopy need special raining outside a general course. On the other hand, nterferometry, phase-contrast and polarization would eem to deserve places. Since d.c. amplification and ervo-systems are mentioned, the magnetic amplifier hould have been appropriately treated. The cathode-ay oscillograph has joined the more traditional tools f general application. Electrostatic instruments and igh voltages have now to be used by substantial groups of physicists. The most serious weaknesses are in the chapter on materials, where some data are quoted which are useful to industrialists for limited omparisons of similar materials by artificial tests, ut are quite misleading for any other purpose. The author would have done well to restrict himself here o physical principles as he has done elsewhere with uch success.

Criticisms of omission are but too easy; they do not mean that anyone else would have made a better hoice than Dr. Braddick. In general, he has made he wise selection which is to be expected from his nowledge, ability and experience. He has had to reserve a nice balance between subjects where a hysicist will need a special training, subjects where he physicist will usually give instructions to an nstrument technologist or laboratory technician, subjects where apparatus can be assembled as elivered from the makers, and subjects where the oung physicist, at least, will have to make some-hing himself. If Dr. Braddick has let the balance ome down somewhat on the side of his personal nterest, this is consistent with the spirit of original work. A book of this kind must be impressed with he character of its author. This character is that of a fine experimentalist and an excellent teacher. Some will think Dr. Braddick has attempted an impossible task; but a student's time is very limited, and he cannot learn everything that everyone would like him to know, so that usually a single book of this type must suffice for detailed study. Nevertheless, in the diversity of university education there is room for various outlooks. We might hope for other books to present outlooks different from that under consideration. Perhaps Dr. Braddick will write one or more of them. There is no doubt that he has made an important contribution to the literature of the subject, that his book should be made available to all advanced students of physics and that other scientists can be confidently recommended to consult it.

S. WHITEHEAD

A LANDMARK IN THE THEORY OF ELASTICITY

Singular Integral Equations

Boundary Problems of Function Theory and their Application to Mathematical Physics. By N. I. Muskhelishvili. (Second edition, Moscow, 1946.) Pp. viii+448. (Groningen: P. Noordhoff, N.V., 1953.) 28.50 florins.

Some Basic Problems of the Mathematical Theory of Elasticity

Fundamental Equations, Plane Theory of Elasticity, Torsion and Bending. By N. I. Muskhelishvili. Translated from the Russian by J. R. M. Radok. (Third, revised and augmented edition, Moscow, 1949.) Pp. xxxi+704. (Groningen: P. Noordhoff, N.V., 1953.) 38 florins.

THE first edition of Muskhelishvili's prize-winning monograph on the mathematical theory of elasticity was published in the U.S.S.R. in 1933. The second edition appeared in 1935, but was soon out of print; a third edition, considerably revised and augmented, was published in 1949. However, the extent of Muskhelishvili's signal contributions to the subject still remained comparatively unknown to Western scientists. The appearance of this translation, excellent in every way, is an event of first-rate importance.

It was in 1909 that G. V. Kolosov first demonstrated that a general plane state of stress in an elastic solid can be expressed, with profit, in terms of two arbitrary analytic functions of a complex variable. Muskhelishvili, first in a joint paper with Kolosov in 1915, and then on his own in a series of some twenty papers at intervals up to 1942, developed this idea in great detail and by its means solved a number of capital new problems and corrected or shortened the treatment of old ones. Kolosov and several other Russians, especially D. I. Sherman since 1934, have also contributed extensively. Similar ideas were formulated independently in 1939 in England by A. C. Stevenson, but the scope of the Russian work has been wider and much more thorough, and has drawn very considerably on complex function theory. In particular, Cauchy integrals play a prominent part, while the general solutions of the two fundamental and the mixed problems of elasticity have been obtained in the form of singular integral equations. Muskhelishvili and others have shown further that these general solutions are not only of academic interest, but also that they yield significant advantages over conventional methods in certain boundary-value problems.

The full account of the basic analysis is to be found in the book on "Singular Integral Equations". Its contents include chapters on the Hilbert and Riemann boundary problems, integral equations with Cauchy-type kernels, the Dirichlet problem, and solution of the generalized Riemann–Hilbert–Poincaré problem. A sufficient discussion of the relevant portions of this analysis appears in the book on elasticity.

The latter's range is indicated by the following selection from the twenty-five chapter headings: solution for regions bounded by a circle; application of conformal mapping; boundary values of holomorphic functions; solution of the fundamental problems for regions mapped on to a circle by rational functions; solution of the fundamental problems for the half-plane; some general methods of solutions of boundary-value problems; the problem of linear relationship. Complex variable methods are also used in the concluding chapters (amounting to about one-sixth of the whole), which treat the torsion and bending of simple and compound bars of different moduli.

Muskhelishvili's writings cannot fail to make the most vivid impression on every reader by their clarity, their pleasant leisurely style, and their scrupulous attention to detail. There is nothing slipshod in the entire thousand or so pages; every essential point is explained; the exposition is sustained on the highest level even through the appendixes (that on elementary tensor analysis has never been bettered, in the reviewer's opinion). If there is anything to regret, it is that the author's point of view throughout is that of a pure mathematician dealing with a branch of mechanics. The subject is not presented in the round: one aspect only is illuminated. But with what brilliance!

R. HILL

PROBLEMS OF WATER SUPPLY

Vegetation and Watershed Management

An Appraisal of Vegetation Management in Relation to Water Supply, Flood Control, and Soil Erosion. By E. A. Colman. (Sponsored by The Conservation Foundation.) Pp. xv+412+16 plates. (New York: The Ronald Press Company, 1953.) 7 dollars.

ALMOST everywhere in the world there is increasing domestic and industrial use of water, and the rising demand is making more and more difficult the task of the water engineer in supplying an adequate quantity of water of good quality all the year round. Leaving aside the doubtful possibility of significant weather modification by cloud seeding, the engineer's raw material is, at most, that part of natural rain and snow not lost to the atmosphere as evaporation from his catchment areas. This evaporation loss is predominantly a transpiration loss that gives an economic return where it is the working capital of the farmer and forester in the growing of crops, so much so that in many parts of the world it is deliberately increased—by irrigation—as a necessary condition for human survival. Removal of vegetation is not an acceptable solution of the water problem, even if clearance is restricted to that which is valueless as food or timber. The gain in total annual discharge would bring with it increased flood flow, more severe erosion on the catchment area and in the stream channels, more sediment in reservoirs, and still greater shortage of water in dry weather.

The role of vegetation in hydrology is obviously important, and there is complexity in the study of its many aspects: how it influences the evaporation loss, how it affects the retention of rain and snow on the ground, how it affects the penetration of rain and melt-water into the soil and so to underground storage, how it impedes run-off and restricts erosion. Given such basic information and some unifying ideas it should be possible to consider ways of managing the vegetation to exploit the good and minimize the evil effects. Much of the information does exist, and some of the ideas too; but the literature is very scattered, and there is a need for a comprehensive survey of present knowledge and practice. Dr. E. A. Colman, chief of a research division of the United States Forest Services, has attempted such a survey, but it falls a little short of what i could have been.

The book is written for the non-scientist; but this scarcely justifies Dr. Colman in discarding the precision of language he uses in his scientific papers to substitute a wordiness that leaves little or nothing to the imagination. The result is that interest flags as case after case is treated on its merits, based on the philosophy that results from one catchment cannot be applied to another in a different climate or with a different kind of vegetation. Scientifically, this is a philosophy of despair, but even if it is accepted as being all that is possible or desirable at present, the writing still suffers too much from needless repetition within sections. Drastic pruning would have made this a much better book, a book to be read with pleasure and profit.

The subject is so important that many British readers will be ready to take the profit and let the pleasure go, for this account of American experience in management of catchment areas covers a wide range of climates and vegetation types, including all that are found in Britain and many met in the Commonwealth. There are a long bibliography and two indexes—of authors and subjects—the second of which could usefully have been longer by adding more place names. Several of the famous management experiments, such as Wagon Wheel Gap and Coweeta, are best known by their sites; but sit names rarely appear in the index of subjects.

The book is well printed, with its subject-matte admirably illustrated in a collection of good photographs and some clear folded maps of the United States. The maps in black-and-white show th distribution of important hydrological elements another, in colour, shows the distribution of natural vegetation and the types of farming that have been imposed upon it. By modern standards the price is not exorbitantly high, and the book will prove a useful investment for those with an engineering or scientific interest in water, soil, or vegetation.

H. L. PENMAN

RELAXATION IN PHYSICS AND ENGINEERING

Relaxation Methods

By D. N. de G. Allen. Pp. ix+257. (London McGraw-Hill Publishing Company, Ltd., 1954. 53*s*. 6*d*.

An Introduction to Relaxation Methods

By F. S. Shaw. Pp. iv+396. (New York: Dove Publications, Inc., 1953.) 5.50 dollars.

THE method of relaxation has now become an established and important technique in mathematical physics and engineering. The object of the present two volumes is to provide a practical introduction to the technique of relaxation and to illustrate it by reference to the various types of problem which have been successfully solved by this means. As Mr D. N. de G. Allen so well emphasizes in his book, it i an essential feature of relaxation methods that they are extremely flexible and that they leave the maximum of initiative with the computor. For this reason there can scarcely be a completely systematic accoun of relaxation, since the whole spirit of the method is t avoid systematization. Both these books give a account of the various devices which have been successfully employed, such as over-relaxation, block relaxation, group relaxation and the use of multiplying factors; but the great purpose of each book is, of course, to stimulate the student to develop for himself the techniques which are appropriate to the special problems with which he is confronted.

The scope of these books covers linear algebraic equations, linear ordinary differential equations and certain linear partial differential equations, with a special emphasis on the questions of Laplace and Poisson and the biharmonic equation. Another important group of applications of relaxation methods is to eigenvalue problems for algebraic and differential equations. Quite another field of application is to problems where there are free boundaries the form of which is unknown at the beginning of the investigation. Allen's book also gives an account of the use of triangular nets, of the problem of heat conduction and of Southwell's method of intensification in calculating eigenvalues. Shaw's book also deals with the application of relaxation methods to integral equations, the use of Fox's "difference corrections" and gives tables for computing irregular star first and second derivatives near a boundary.

It is very difficult to compare two such similar works; but perhaps it is fair to say that Shaw's book is the more elementary and Allen's is the more philosophical. Certain omissions from Allen's book are quite deliberate, and the author promises another volume in which he will deal with a number of related topics. It would be extremely interesting to have a careful comparison of the method of relaxation with the method of squares as developed by Thom, Morris's escalator method and the hypercircle method of Synge. When a second edition of this book is called for, it would increase its value if some reference were made to the accuracy of the higher eigenvalues obtained by intensification methods and to Tosio Kato's method for estimating the accuracy of eigenvalues in general. G. TEMPLE

BELIEFS AND SOCIETY

African Worlds

Studies in the Cosmological Ideas and Social Values of African Peoples. Edited by Daryll Forde. Pp. xvii+244. (Published for the International African Institute.) (London: Oxford University Press, 1954.) 30s. net.

BY now a certain amount is known of the social life of non-Western peoples. In the African field we have analyses of political institutions and of kinship, and several general accounts of diverse social systems. This book is an attempt to discuss the beliefs associated with some of them, to analyse the character and the contexts of the value systems of certain African societies. We are given accounts of the cosmological ideas, myths and social values of nine peoples, of varying economic and political organization, from various parts of Africa, and an introduction by the editor.

For several years it has been one of the tenets of social anthropology that there may be a functional interrelationship between the parts of any social system. This hypothesis has been at least tacitly accepted, and research and analysis based upon it have shown its general validity. Research into religious and magical beliefs has demonstrated a close relationship between the system of social relations and that of values, sanctions, codes of conduct and so on, in any one society. An example is that of witchcraft beliefs. What may at first seem a jumble of superstition is integrated closely with, and derives its significance from, the social organization. It is also seen to form a coherent set of beliefs. Once certain premises are accepted—including some denied by Western scientific thought—then the entire structure built upon them is logical and reasonable. Such a system has two aspects, so far as analysis is concerned: its effectiveness in providing values and sanctions for orderly social interaction, and its coherence as a single set of beliefs. But although beliefs in witches may have a similar function in different societies, their form may vary. Similarly with, say, myths of the creation of the world, such as are described in this book. All these peoples have different ideas about the creation and the relationship of men with God and the world. One can regard these ideas as forming closed systems, quite apart from their place in the total scheme of social values. In other words, there is a distinction between the practical and the metaphysical significance of a set of beliefs. The distinction is implicit in every essay in this book.

A system of values, providing a guide to social behaviour, plays an integral part in any society. The types of organization of these various African societies vary, and with them the nature and significance of ties of kinship, territory and so on, from the great kingdoms of Ruanda and Ashanti to the stateless societies of the Lele and the Abaluyia. It can be expected that this variation will be reflected in the social values held by their members. If social anthropology is a comparative discipline, then here is an obvious case for taxonomy as a means towards understanding.

But it is not at all certain that this is so at the level of the myths and cosmologies also described. Since partly, at least, myths explain the place of men in the world, then the form of the society may be reflected to some extent in their content. Those of the Shilluk kingship provide an admirable example, as giving a means for the comprehension by the Shilluk, through the use of symbols, of the nature of the Shilluk polity. But there is much in Shilluk myth that seems to have no function, in this sense, at all. This is even more true of the cosmologies described, notably the elaborate system of the Dogon. Even here there is consistency, or at least a lack of contradiction. But this interrelationship is of a very different order from that between the form of social relations of a society and the code of behaviour prescribed by certain of its social values.

In short, this book tries to consider two problems, which are not clearly distinguished: the relationship between society and those of its values which guide social action, and that between society and its myths and cosmological ideas. There is clearly a functional relationship in the first case, but the nature of the relation in the latter is open to doubt. The myths may validate the existing status systems of persons and groups, but the cosmologies seem to defy attempts to analyse them as anything but closed systems of thought. We are given nine excellent and fascinating essays; but these do not, as one feels that perhaps they might have done, combine to make a book which advances our sociological understanding of religious belief. The fact that they do not do so raises the underlying problem of the ultimate limits of sociological analysis. JOHN MIDDLETON

ACOUSTICS OF THE SINGING VOICE

AT the Friday Evening Discourse given in the Royal Institution, London, on June 18, Mr. G. Mackworth-Young spoke on "What Happens in Singing". Much argument has been devoted to the question of whether singing is an art or a science. To the extent that the singer needs as his prime requisites a nice appreciation of pitch and good muscular control, it is primarily an art; yet in the process of learning to sing it is helpful to know something of the physics and physiology of the voice, though, of course, one does not while singing continually and consciously set the vocal apparatus into positions which theory would indicate as desirable. It is rather like riding a bicycle; at the beginning it is necessary to know something of the technique of propelling and balancing the machine, but in time this becomes automatic and to think consciously of each movement soon results in falling off.

The human vocal apparatus consists of the chest (bellows), larynx containing the vocal cords (source of vibration) and the throat, mouth and nasal cavities (resonators). The production of tone has often been likened to that in a reed pipe of the wood-wind class, but perhaps a brass instrument of the trombone type gives a closer analogy, since both the size of the resonators and the tension and length of the vibrating tissues are adjustable. The true or lower vocal cords are set in vibration by approximating their edges under the tension necessary to produce a note of the required frequency, and the breath is expelled through the narrow slit between them. This process sets the edges in vibration either as a whole (normal register) or in part (falsetto register), and these vibrations may be seen with a combination of the laryngoscope and stroboscope. The mathematical theory of this vibrating system has been given by Wegel. Experiments on excised larynxes have shown that, as would be expected, the quality of the unaided vocal cords is raucous and unmusical. It is mainly by the modulating influence of the resonating cavities upon the laryngeal tone that man is able to transcend the lower animals in speech and song, though the parrot and certain members of the ape family possess this faculty to a limited extent.

We turn to the important modifications produced on this still rather unmelodious 'buzzer' note by the resonance column, which it now has to pass through. The natural vibrations of the latter in the absence of a buzzer note may be heard in whispered speech or in whistling, when the vocal bands are drawn aside and a stream of air passes through practically uninterrupted at the larynx. Phoneticians usually distinguish three principal resonances: the back cavity (throat), the front cavity (of the mouth) and the nasal cavity. The acoustic impedance of the latter is then a 'shunt' upon the front part of the mouth. Further, the nasal cavity may be completely cut out, in the production of certain sounds, by the large impedance of the constriction where it joins the throat. In the absence of damping, each cavity may be regarded as an acoustic capacitance and each constriction as an inertance.

Of course, the division into capacitances and inertances must not be regarded as too rigorous. In some vowels the whole resonance system approximates to a wide open funnel stretching from larynx to lips. Actually, the damping is very large, much more so than in a wind instrument, owing to the resilient nature of the walls of the cavities. This has the practical effect of broadening all the resonances. It makes it rather difficult, in fact, to test the natural resonances of the system held in a given position by such methods as bringing tuning forks in front of the mouth. Again, although tables of resonances for various vowels are given, there are small discrepancies between the resonances detected by different investigators, and those not entirely due to phonetic uncertainties—for example, in the pronunciation of the vowels or the pitch of the cord note. Damping tends, in fact, to confound together the theories of Helmholtz and Hermann on the subject of the wave forms of vowels.

While it is true that we find, with the latter, that as one sings a vowel up the scale each cord-note has the 'formant' of the fixed resonance cavities impressed upon it, these resonances are so broad that the probability will be that a number of the harmonics of the cord-note will elicit some resonance in the mouth cavities, giving apparent agreement with the Helmholtz relative pitch theory of vowel overtones. This has the result that, within limits, the wave-form of a vowel is preserved as the cord-note is changed. This would not be so in a brass instrument where rigid walls and consequent sharp resonances impress a very pronounced formant on each note, altering the wave form as the player moves up the scale.

One difference between artificial wind instruments and the voice is in the type of resonance employed. In nearly all wind instruments standing waves are set up in the resonance tube, and the pitch of the note is therefore decided by the tube length. The voice, on the other hand, employs resonators of the Helmholtz type in which the inertance of the mouth and nose orifices is in series with the capacitance of the oral cavities. The resonance frequency therefore depends not only on the size of the cavities but also on the size and shape of the opening. The throat and mouth cavities are chambers of easily variable shape having soft elastic walls. They form resonators of low 'Q' in comparison to the resonator of a wind instrument, and so are readily tuned to a range of pitch. They accept a note from the vocal cords and give it body and quality by tuning their resonances to coincide with either the fundamental cord frequency or with certain harmonics. The auxiliary head resonators, being of fixed size and shape, contribute higher harmonics by forced vibration.

The fact that the bass voice can produce notes of wave-length 11–14 ft. indicates that here the voice resonance must all take place on the higher harmonics. Although the greater part of the sound energy is distributed among these harmonic resonances, we normally associate the pitch with the fundamental. This is due to the ear, which has the gift of extracting the fundamental, even if weak, from such harmonics as are presented to it.

Before dealing with the resonance compass of the various voices, it is necessary to consider briefly the question of vowel production. The combination of two resonances at a particular frequency produces an additional quality in the voice which no other instrument possesses and which the ear perceives as a vowel. Different vowels are produced by modulating the resonance of the cavities in much the same way as when reinforcing a vocal cord note. However, the vowel resonances ('formants') need not bear harmonic relation to each other. It follows that, in singing, the cavities are required to produce resonances which must be harmonics of the vocal note and at the same time fall within the formants of the vowel. These two requirements may conflict, and the claims of the note must then take precedence. This is the case in the upper range of the soprano voice where vowel production becomes a matter of great difficulty. The lower voices, being richer in harmonics within the resonant compass, are less troubled by this effect.

Much research has been carried out to determine the range of resonance in the throat and mouth cavities employed in the various voices, and recently this work has been greatly facilitated by the introduction of new electro-acoustic techniques. The normal range of resonance of the throat cavity for the male voice extends from $A_1\flat$ to $E_2\flat$ in the treble clef. Bass and baritone notes from the lowest up to $E_1\flat$ (on the bottom line of the treble clef) are reinforced on whatever harmonics lie within this compass. Notes lying between $E_1\flat$ and G_1 are resonated on the fundamental by a forced enlargement of the throat cavity. In women the normal compass of resonance stands squarely in the middle of the soprano voice extending upwards from the G_1 in the treble clef to the $F_2\sharp$ above. The notes within this range will naturally be reinforced on the fundamental, while lower tones find resonance on the first or second harmonic. When the voice rises above $F_2\sharp$ the throat resonance must be raised above its normal range, and this is achieved in trained voices by an enlargement of the throat cavity aperture.

Mr. Mackworth-Young has himself demonstrated the existence of two resonant zones in the throat having a compass of four semi-tones each in the men's voices (four and eight semi-tones in women's voices). It was found that if the vocal note happened to have harmonics in both zones, then both harmonics were heard. Notes which have two harmonics within the same zone may be resonated on either one but not both. The exact significance of this discovery awaits interpretation.

The normal compass of resonance for each voice shows a remarkable uniformity among singers of differing ages and nationality, individual variations rarely amounting to more than a semi-tone in either direction. The vowel, demanding as it does absolute pitch of resonance, is even more exacting in its requirements. This uniformity is achieved because the note of a Helmholtz resonator varies according to its size in relation to its opening; and as the mouth and throat capacities of the two sexes and various ages differ, so the mouth openings differ with them, thus maintaining the same proportions.

The throat cavity resonance on any particular note appears to be independent of the vowel which is being sung. It would appear, therefore, that throat resonance plays little or no part in vowel production, but the matter is still open to question. The nature of the vowel sounds has been under investigation since the beginning of the nineteenth century, and the pitches of the formants involved in the production of each vowel are now well established. For some vowels the lower formant does lie within the compass of throat resonance, while the upper formant is undoubtedly supplied by mouth resonance. For other vowels (for example, *ai* and *ee*) the mouth is divided by the tongue into two cavities which appear to provide the two formants independently of the throat resonance.

Much remains to be done to elucidate the acoustical processes in full of orchestral wind instruments; so it is with the voice. A good singer may be readily distinguishable from an indifferent one merely by listening to him; but if the indifferent singer is to be helped to improve, the scientific principles underlying the good singer's skill must be studied. In particular, studies should be made of 'attack' and 'vibrato' as practised by trained singers.

THE INTERNATIONAL BOTANICAL CONGRESS IN PARIS

IN 1854 the Société Botanique de France was founded, and it was very fitting that the centenary of this event should coincide with the meeting of the Eighth International Botanical Congress in Paris during July 2–14. The Congress was very well attended; the incomplete list of members and those accompanying members contains more than two thousand names, derived from about seventy different countries. Thus this Congress was even more truly international than that held in Stockholm in 1950.

The work of the Congress was divided between twenty-seven sections: International Union of Botanical Sciences; Nomenclature; Terminology; Taxonomy; Palæobotany; Palynology; Phytogeography; Morphology and Anatomy; Cytology; Genetics; Plant Physiology; Agronomy; Forestry; Standardization of Raw Materials of Plant Origin; Ethnobotany; Bryology; Phycology; Lichenology; Mycology; Plant Pathology; Bacteriology; Protection of Materials and Equipment; Soil and Water Microbiology; Nature Conservation; History of Botany; Botanic Gardens; Mediterranean Botany.

The above list may seem to disperse the subject over a very wide field, but it should also be noted that many sections were still further divided; for example, there were three sub-sections of Physiology, namely, Nutrition, Growth, Physiological Ecology. On a day chosen at random there were thirty-five different papers being read simultaneously; thus the subject had been so dissected that there were very few papers of general interest, and those attending the Congress had to be very ruthless in their decisions which section to attend, otherwise much valuable time was lost trying to keep track of two fields of interest housed in widely separate parts of the Sorbonne. One wonders if this process of sub-division has gone too far and there really is no longer a science called 'botany' but only some twenty or thirty separate sciences. One factor, however, eased this situation. The nine volumes comprising the Congress papers were available at the beginning and enabled one to decide which communications were most appropriate to one's own interest.

Most sections, while allowing time for miscellaneous communications, concentrated on a few main topics on which colloquia were held. These colloquia took the form of a *rapport* which usually summarized the position and lasted for an hour, followed by discussion for thirty minutes. Then came a series of brief communications by workers in the field under discussion. Thus one was given a fairly comprehensive background plus an indication of the growing points of the topic, and the discussion of the points raised was also very valuable. There were also many joint colloquia; for example, a discussion of "Quaternary Climate" organized by the Palynology Section was attended by the Phytogeography Section, while one on "Fungal Growth" embraced mycologists and physiologists.

The programme on the whole was well organized, although a lax attitude to time-keeping often meant that valuable communications were crowded out or had to be presented in a form so abbreviated as to be incomprehensible and almost valueless. There was also a certain confusion in some sections where papers were allocated 'time-units'. At an international congress, the symposium is the best form of meeting; but the clarity of the paper should not be sacrificed to length.

There was much variety between the sections in the use of language. The Congress programme laid it down that French and English were the preferred languages, but the writer also heard papers in German. One agrees that German should be allowed at such meetings; but in the discussions the use of an interpreter was urgently needed on several occasions, a question being asked in one language, answered in another, while part of the audience was more at home in a third. Translation, of course, uses valuable time but it is worth it, for those who do not understand may be those who might contribute most to the discussion.

It is impossible to give an adequate idea of the topics dealt with during the Congress, but there should be some indication of the subjects studied. Among others, the following were very valuable and interesting symposia: secondary and tertiary floras (palaeobotany); ecology of cold areas (phytogeography and ecology); experimental embryology (morphology); extra-nuclear inheritance (genetics); photosynthesis (physiology); photoperiodicity (physiology); morphological and physiological gradients (morphology and anatomy); forest pathology (forestry); ecology of marine algae (phycology); bryogeography (bryology); taxonomy of lichens (lichenology); fungal pigments (mycology); virus diseases (plant pathology); etc.

The social side of the Congress was well organized. The opening plenary meeting was held on July 2 in the Grand Amphitheatre of the Sorbonne under the presidency of the Rector of the University of Paris. Short addresses were given by Profs. Schopfer (Berne), Thimann (Harvard–Cambridge) and Heim (Paris). On the evening of Saturday, July 3, the Muséum National d'Histoire Naturelle gave a reception to all members of the Congress in the Zoo at Vincennes. Sunday was free to take advantage of the facilities offered by the Congress to visit the gardens and greenhouses of the Museum and the Arboretum Vilmorinianum in Verrières-le-Buisson. On Wednesday, July 7, at 5 p.m., the Congress met with the Société Botanique de France, and official delegates presented addresses and good wishes on behalf of their parent societies. M. Roger de Vilmorin delivered a short address and showed many beautiful coloured slides of the vegetation of France.

On Tuesday there was a general excursion to Versailles. The final general excursion was held on July 9, when many members enjoyed a day trip to Fontainebleau. The many members who attended had a relatively fine day which made botanizing in the Forest a pleasure.

There were sundry receptions for official delegates by various bodies; but the Congress concluded its official business at a plenary session on Monday, July 13. Here addresses of thanks and good wishes were delivered and the Congress closed with the decision that the Ninth International Botanical Congress should be held in Canada in 1958.

There were many excursions, some fairly local, some going as far afield as North Africa. In addition, the Section Mediterranean Botany held an extension of the Congress in Nice, where in addition to communications there were many excursions along the coast and into the mountainous hinterland.

In such a brief account of the proceedings of the Congress it is inevitable that emphasis is laid on those aspects of the proceedings which deserve re-examination. But criticism of details should not in any way detract from the general excellence of the work of the organizing committee. The Congress viewed *in toto* ran smoothly and well, and it is to be hoped that subsequent Congresses will follow the admirable precedents set by those at Stockholm and Paris.

A. R. GEMMELL

LOCALIZATION IN THE CEREBRAL CORTEX

A SYMPOSIUM on localization of function in the cerebral cortex was held in Oxford on September 8. Arranged by Section I (Physiology) of the British Association jointly with the Physiological Society, this symposium brought together workers from a number of disciplines converging on neurology and a large audience evidently drawn from many sections of the Association. Although the problem of cerebral localization is nowadays too complex to provide a clear-cut issue, there can be no doubt that it represents a convenient theme around which to group a variety of contemporary inquiries in the neurological field. The organizers of the symposium are to be congratulated on their choice of a topic which is not only of central importance in neurology but which also can be relied upon to attract widespread interest among biologists.

Intelligence and Brain-Size

The symposium was introduced—most appropriately—by Dr. E. D. Adrian, president this year of the British Association, who raised two important, if closely related, issues. First, the question of brain size in relation to the type of activity commonly called intelligent; and secondly, the mode of specialization of function within the cortex. As regards the first issue, Dr. Adrian pointed out that absolute size of brain no less than its general arrangement would appear an important factor in the evolution of the mammalian nervous system. He suggested that this might be explained either by supposing that an increase in brain-size permits greater subdivision—and hence localization—of function, or by assuming that intelligent activity depends upon a large amount of unspecialized cortical tissue. Both answers, in Dr. Adrian's view, are right up to a point, and the real question we have to ask is how much of the brain is allotted to special activities and "what happens to the rest".

Dr. Adrian then gave a summary review of the history of cerebral localization of function, ranging from Gall, through Broca, Fritsch and Hitzig, and Ferrier, to the more guarded concepts of localization characteristic of present-day neurology. While steering a careful course between the Scylla of extreme localization and the Charybdis of cerebral mass-action, Dr. Adrian left no doubt that the integration of behaviour to meet the needs of the environment presupposes, in his view, some measure of localization of its component functions. Only in the case of the sensory projection areas of the cortex, however, can we regard the evidence for functional segregation as really complete; and even here, Dr. Adrian was careful to point out, we cannot speak of the translation of sensory signals to sensation as being 'localized' in these areas—or indeed anywhere else. In the same way, he warned against the dangers of undue rigidity in arguing from the results of cortical stimulation experiments to the localization of motor function. In the control of behaviour, he suggested, total mass of cerebral tissue may be just as important as the finer details of structure. None the less, Dr. Adrian appeared to envisage some degree of cortical specialization, motor no less than sensory, the final integrative activity of the brain being unified in some way not as yet understood. "We are still entangled in the Departments," he concluded; "it may be long before we get through to H.Q."

The Excitable Motor Cortex

The problem of cerebral motor function was taken up in greater detail by Prof. E. G. T. Liddell (Oxford), who gave a masterly survey of experiments on the motor cortex, using the method of direct electrical stimulation. In discussing the earlier work, particularly that of Ferrier, he suggested that the punctate localization of discrete movements which it appeared to indicate was due at least as much to meticulous draughtsmanship as to the realities of cerebral organization. None the less, given the many and often ill-controlled variables in these experiments, the consistency of the results was not a little surprising. Turning to more recent work, Prof. Liddell directed attention to the great importance of proper control of the parameters of stimulation. He pointed out that the use of single strong stimuli in the anæsthetized brain, or of repetitive stimuli in the unanæsthetized human brain, leads to an appreciable increase in the size of the cortical area from which discrete movements of a given part of the body may be elicited. Had the earlier investigators used single instead of repetitive stimuli, he contended, they would have obtained a 'motor map' corresponding far more closely with that inferred by Hughlings Jackson from the sequence of events in epileptic seizures. He considered that the modern 'motor map', constructed on the basis of the responses given to single stimuli of varying intensity, provides an important clue to the functional organization of the motor cortex in man.

Prof. Liddell made it clear that the movements evoked by cortical stimulation can in no sense be equated with the 'voluntary' movements of the intact organism. Their time relations, in particular, are very different. Movements evoked by cortical stimulation show long latency and gradual build-up. Voluntary movements, on the other hand, are considerably more rapid. Evoked movements, moreover, are not unlike those obtained when the crossed extensor reflex of the cord is elicited by stimulation of a mixed nerve. This similarity, in Prof. Liddell's view, may be due to the fact that in both cases inhibitory no less than excitatory effects are involved. In support of this contention, he adduced the fact that weak single stimuli applied to the cortex evoke a 'flick' response of very brief duration.

Although these relationships stand in need of further elucidation, Prof. Liddell was able to offer a tentative hypothesis of cerebral motor organization. Integrated action, he suggested, presupposes inhibition no less than excitation. In voluntary movement, large groups of skeletal muscles must adopt a static postural attitude as background to the specific movement demanded. It is therefore likely that the central activity issuing in a particular movement, no matter how small, involves a large area, if not the whole, of the motor cortex. In this connexion, Prof. Liddell directed attention to the smaller cells in the motor cortex, which may well play an important part in integration, particularly in its inhibitory aspects. Although this hypothesis necessarily lacks precision, Prof. Liddell indicated its broad agreement with what is known regarding the organization of subcortical neural mechanisms, for example, the respiratory centre in the medulla, and with certain evidence from clinical neurology regarding the organization of the human motor cortex.

A Radical View of Cortical Motor Function

Dr. J. A. V. Bates (Neurological Research Unit, National Hospital, Queen Square, London, W.C.1) took issue with the traditional conception of the motor cortex as the 'repository of willed movements'. In Dr. Bates's view, the only inference that can be drawn from the results of experiments on cortical stimulation is that anatomical connexions exist between particular points in the cortex and particular groups of voluntary muscles. In this connexion, he referred to Burdon-Sanderson's demonstration (which he himself had confirmed) that precisely the same results are obtained by stimulation of the white fibres of the cortico-spinal pathway as by stimulation of the grey matter itself. Dr. Bates further stressed the infantile and athetoid character of the movements evoked by stimulation and their obvious similarity to epileptic phenomena. In his view, the only special qualities associated with cortical evocation are in relation to latency, facilitation and after-discharge. In short, the findings of cortical stimulation reveal no more than the facts of motor organization at the spinal level.

As further evidence in support of his thesis, Dr. Bates adduced the frequent contradiction between the results of experiments on stimulation and ablation of the motor cortex. In certain cases of long-standing unilateral brain disease, for example, he has found that a complete 'motor map' may be obtained from stimulation of the affected hemisphere. None the less, its removal is not followed by loss of the movements produced by stimulation. Despite the classical evidence of hemiplegia, therefore, it is becoming increasingly difficult to regard the motor cortex as in any sense the 'organ' of volitional movement.

In view of these, and many related, considerations, Dr. Bates has been led to propose the radical view that the whole conception of the cortical representation of movement, as evolved by Hughlings

Jackson and traditionally accepted in neurology, be abandoned. The only truly motor centres, he suggested, are in the spinal cord. "It may be that stimulation of the cortex in general does not demonstrate that fibres are efferent from a functioning motor centre, but rather that in the region of the electrode there is the origin of one of the many sets of afferents arising from perhaps a dozen or more different regions on both sides of the hind, middle and fore brains to impinge on each spinal centre." On this view, therefore, the cortico-spinal pathway is to be regarded as afferent rather than efferent in function, and the motor cortex itself as possessing no special role in the representation of voluntary movement.

It is plain that Dr. Bates's position implies a radical break with the traditional doctrine of the hierarchical organization of function in the central nervous system. Although his view is perhaps unduly extreme, it is unlikely that Dr. Bates meant to suggest that the cortex plays no part whatever in the initiation of voluntary movement—indeed, mere comparison of a decorticate preparation with an intact animal is sufficient to establish the contrary. What he doubtless meant to stress is that the motor cortex cannot be regarded as a 'centre for movement', that is, as an essential organ possessing its own intrinsic functions. Support for this view comes from many sources, not least the experiments of Lashley on the effects of ablation of the motor cortex upon acquired skills in rats and monkeys. None the less, it is unlikely that many neurologists will see fit wholly to endorse Dr. Bates's opinion at the present time. The more cautious view of Prof. Liddell, which ascribes some part at least of the integrative activity issuing in movement to the excitable motor cortex, is likely to secure a wider measure of acceptance.

Ablation Studies in Monkeys

The effects of ablation of small areas of the motor cortex in monkeys were described by Dr. F. P. Glees (Oxford), who directed particular attention to the summative influence of multiple small lesions in a given area. In the case of the 'arm area', for example, small lesions which individually occasion little or no disability 'sum up' in regard to their effects upon arm function. Dr. Glees further laid emphasis on functional factors in the establishment of connexions between the motor cortex and the effector organs of the body.

A short film illustrating tests of manipulative skill suitable for use with monkeys in ablation experiments was presented by Mr. J. Cole (Oxford).

Speech and Handedness

Prof. O. L. Zangwill (Cambridge) was concerned with the general relationship between handedness, cerebral dominance and aphasia. He directed attention to the frequency of aphasia associated with lesions of the left cerebral hemisphere in left-handed patients, and suggested that a dissociation between handedness and cerebral dominance is far from unusual. In explanation, Prof. Zangwill pointed to the fact that neither hand preference nor cerebral dominance is fully established at birth. In view of what is known regarding the growth of hand preferences in children, it is entirely possible that many left-handers owe their left-handedness not to heredity but to some more or less contingent circumstance of early development. In such cases, he argued, it would appear that language none the less becomes organized in the left hemisphere, as in the congenitally right-handed individual. At the same time, Prof. Zangwill was careful to indicate the complexity of the relationship between innate and acquired factors in cerebral dominance and the need for their further elucidation.

Cortical Factors in Nystagmus

Dr. E. A. Carmichael, Dr. R. M. Dix and Dr. C. S. Hallpike (National Hospital, Queen Square, London, W.C.1) reported on the effects of localized cerebral lesions upon optokinetic and caloric nystagmus. Dr. Hallpike, who read this paper, pointed out that a characteristic disturbance of optokinetic nystagmus, presented as directional preponderance towards the side of the lesion, occurs only when the latter involves the posterior parietal region of the cortex. A comparable disturbance of caloric nystagmus, on the other hand, occurs only in cases in which the posterior temporal region is involved. Although both types of nystagmus are known to depend on subcortical reflex mechanisms, Dr. Hallpike pointed out that the cortex must obviously exert a modifying influence. Its precise nature, unfortunately, is not at present understood. None the less, these findings have evident value in providing additional 'localizing signs' of circumscribed cerebral disease.

O. L. ZANGWILL

HORMONES AND CONTROL OF ZOOLOGICAL FUNCTION

A MEETING of Section D (Zoology) of the British Association was held in Oxford on September 7, with Prof. J. E. Smith in the chair, to discuss "Hormones and Control of Zoological Function". It was opened by Mr. D. B. Carlisle with a review of recent advances in our knowledge of the hormonal control of moulting in the Crustacea. The discovery during the past few years of the true nature of the X-organ – sinus gland complex of the eye-stalk has proved a stimulus to research in this field, and it is now established that the accelerating effect upon moulting of removal of the eye-stalk in crabs and crayfish is a result of the production in the neurosecretory cells of the X-organ of a hormone which is stored in the sinus gland and which restrains the onset of the moult. Carlisle brought forward evidence that the contradictory results sometimes reported may be due to the existence in most higher Crustacea (except crabs and crayfish) of a second (distal) part of the X-organ which resembles the sinus gland in consisting partly of enlarged nerve endings. In such forms the neurosecretory complex of the eye-stalk produces a second hormone which accelerates the processes of the premoult, probably acting primarily upon the separation of the old shell; and the effect of the removal of the eye-stalk will then depend upon the balance normally existing between the two hormones. This, he suggested, could account for the fact that in some species the operation had been found to result in either acceleration or retardation of the moult according to the particular population under investigation.

Moulting itself cannot be regarded as an isolated act, for it is preceded and followed by periods in which the metabolism and behaviour of the animal are greatly modified, while growth, in the sense of increase in organic matter, takes place during the intermoult phase when the metabolism and behaviour have returned to 'normal'. Since the moulting hormones influence the duration of this latter phase, they must be regarded also as growth hormones, and it is to be expected, therefore, that further complications of endocrine control remain to be revealed in this field; it is thus significant that Gabe has recently postulated a third hormone, in the absence of which the act of moulting cannot take place even though the premoult may have proceeded normally.

Elasmobranch Endocrine Organs

Research in vertebrate endocrinology has been concentrated so largely upon the Mammalia that there exist at the present time startling gaps in our knowledge of the lower forms, a situation well brought out by Mr. C. K. Goddard's review of the physiological status of elasmobranch endocrine organs, in which he referred also to work in progress at the Gatty Marine Laboratory. The pituitary appears to be the 'master gland' in this group, as in others; but the evidence for the existence of some of its expected hormones is very incomplete, and there is need for much more information as to the source of these hormones within the gland. So far, only the chromatophore-expanding and diabetogenic hormones have been localized, the former in the neuro-intermediate and the latter in the anterior lobe. Thyrotrophic hormone is thought to be present, but the evidence for its existence is meagre in the extreme; indeed, evidence that the thyroid shows little or no sign of involution at nine to ten weeks after hypophysectomy, and that goitrogens are ineffective, as judged by histological criteria, at dosage-levels that will elicit a response in teleosts and mammals, would seem to cast some doubt on the importance of this hormone in elasmobranch physiology.

Gonadotrophins are thought to be present in elasmobranchs, for hypophysectomy results in a slow involution of the gonads; it has also been claimed that the pituitary is necessary for ovulation in the viviparous *Mustelus canis*, but this appears not to be the case in the oviparous *Scylliorhinus canicula*. Possible endocrine functions of the gonads are suggested by observations that testosterone will increase the length of the claspers in young males and that oestrogens cause growth of the reproductive tract in young females; but this is a field in which direct evidence is greatly needed. Work so far done on the inter-renals has provided evidence that they are essential to the life of the skate, and that extracts prepared from them will maintain life and growth in adrenalectomized rats, while mammalian cortical extract has been found to prolong the life of inter-renalectomized *Torpedo*. Such observations support the view that the elasmobranch inter-renals are the homologue of the mammalian adrenal cortex; but the fact that they seem to play no part in electrolyte metabolism suggests at least one important difference in function. It seems clear that the comparatively few pioneer workers in elasmobranch endocrinology have inevitably been much influenced by preconceptions drawn from mammalian physiology. The results so far obtained certainly suggest some similarity of pattern between the lower and higher vertebrates, but the evidence at present is so fragmentary that it would seem prudent at this stage not to anticipate too close a correspondence, but rather to be vigilant for the significant points of difference.

Use of the South African Clawed Toad

One of the obstacles to the study of elasmobranchs is the obvious difficulty of maintaining them satisfactorily in the laboratory, and a refreshing contrast to this is evidently provided by the South African clawed toad, *Xenopus laevis*, which was dealt with in the next two papers, and which was shown in them to be an admirable subject for endocrmological research and assay. This animal, which can be induced to reproduce at any time of the year, and which differs from British amphibians in lacking the complication of a terrestrial phase in its life-cycle, has proved of value in pregnancy diagnosis; analysis of the influence upon it of gonadotrophins is thus of considerable practical importance, and was the subject of Mr. B. M. Hobson's review. The effect of the pituitary in maintaining the activity of the gonads is clearly shown by the results of hypophysectomy, which leads in six months to a 70 per cent reduction in the weight of the ovaries and a 66 per cent reduction in that of the testes, while marked regression of the oviducts also occurs, to the extent of a 50 per cent loss in their weight within three months. A further result can be observed in males, for in these, when they are in breeding condition, there develop so-called 'gloves', consisting of closely-set pigmented spines which appear in three clearly-defined stages, first on the skin covering the digits and metacarpals, then over the radio-ulna and lastly over the humerus as far as the axilla. Hypophysectomy of the 'fully-gloved' male results in complete loss of the 'gloves' in five to fifteen days after the operation, although they can be maintained in existence by the injection at frequent intervals of suitable doses of gonadotrophins. That the pituitary exerts this effect through the gonads, possibly by stimulating the production of an androgenic hormone, is shown by the fact that castration also results in the loss of the 'gloves', and that these cannot, in the absence of the gonads, be maintained by gonadotrophin injections.

Gonadotrophins from various sources (for example, anterior lobe of the pituitary, or pregnancy urine) will, if given in sufficiently large doses, affect both sexes of *Xenopus* and bring about the release of ripe sperm and ova, the male being more sensitive in its response than the female. In this way a supply of tadpoles can be obtained throughout the year, and Dr. J. M. Dodd, in his account of recent work on their metamorphosis, described the extensive observations which he has made in order to establish satisfactory techniques for the use of this very convenient material for purposes of assay. The effects of food and temperature on growth and metamorphosis of the larvae were considered in some detail, and it was shown that foods of vegetable origin are virtually inactive in producing growth, provided that the water is changed regularly so that decomposition products are removed and micro-organisms not allowed to develop. The ciliary feeding habits of the larva make it convenient to use liver powders as food, but it appears that these may contain widely varying amounts of a 'metamorphic principle' (presumably organic iodine), so that metamorphosis under fully controlled experimental conditions may be induced in some cases in as little as ten days, whereas in other cases no metamorphic signs are visible even after 260 days. The effect of temperature on growth and metamorphosis was also considered, and it was shown that, contrary to previously accepted practice, large metamorphically-retarded larvæ suitable for assay work can best be reared at a temperature of 15° C.

The practical value of such studies was shown when Dodd described his procedures for assaying by immersion and injection, and explained the use which can be made of thyroidectomized tadpoles, for he has been able to compare the metamorphic potency of L-tri-iodothyronine and L-thyroxine, to assay thyroid powders from lower vertebrates, to examine the iodine content of blood serum from patients suffering from various disorders of the thyroid, and to assay minute quantities of thyrotrophic hormone.

In conclusion, he referred to the discovery in the neighbourhood of St. Andrews of a population of the newt, ***Triturus helveticus***, in which five specimens were found to be neotenous and to show extensive enlargement of the thyroid glands. He suggested that these goitres might well be due to the action of goitrogens from yellow turnips growing in the vicinity, and expressed the hope that others might look for similar populations elsewhere, since this condition is unique in the literature and has not so far recurred in the St. Andrews population.

The Thyroid in Vertebrate Evolution

In the last paper of the session, Prof. E. J. W. Barrington discussed the thyroid gland in relation to vertebrate evolution, with particular reference to some problems of teleost endocrinology which are under investigation at Nottingham. Goitres have long been known to arise in trout which lack an adequate supply of iodine, and it is now well established that chemical goitrogens will cause hyperplasia and hypertrophy of the thyroid in teleosts similar to the effects produced by them in mammals. There is much evidence that the production of thyrotrophic hormone by the teleost pituitary is the agent in this response, and Barrington and Matty have been able to identify the cells which actually produce this hormone in the minnow. They are found to be cyanophils, positive to the McManus – Hotchkiss periodic acid – Schiff (PAS) reaction, which are coloured by the aldehyde-fuchsin stain of Gomori and Halmi, and the situation bears a striking resemblance in detail to that already known to exist in the mammalian pituitary.

These results, taken in conjunction with the work of Atz in the United States, indicate that already in teleosts the pituitary – thyroid relationship is established in an essentially mammalian form, and this suggests that from an early stage in vertebrate evolution the thyroid may have had an important part to play in adaptation to the external environment and to its seasonal changes. In considering the nature of this role, there is little positive evidence for an involvement of the thyroid in the stimulation of metabolism in fish. Although there are several reports of gonadal regression resulting from the immobilization of the thyroid by thiourea, it is not clear that this effect is actually mediated through that gland, for it has been found that minnows can complete spermatogenesis during winter, under the stimulus of artificial light, when the thyroid is immobilized by a different goitrogen, thiouracil. However, evidence is accumulating from various sources that fluctuation of thyroid action occurs in correlation with the phases of migration and spawning in certain teleosts, and the future may well show that it is the function of this gland to provide support at these periods of physiological stress or, as Hoar has argued, to activate the nervous centres which set off the characteristic appetitive behaviour associated with them.

Little time was available for discussion; but the papers alone made it clear that the field of comparative endocrinology, now attracting a welcome and rapidly increasing attention, offers scope for extensive cultivation. It is evident, too, that a satisfactory grasp of the principles of functioning of endocrine systems demands careful investigation of the problem of how far these systems have been subjected to functional changes in response to the changing stresses which the major groups of animals have encountered in extending their conquest of their environment. E. J. W. BARRINGTON

OBITUARIES

Dame Janet M. Campbell, D.B.E.

THE gratifying reduction of maternal mortality which has occurred in the past decade is largely due to the scientific discoveries of the sulphonamide drugs and the antibiotics which inhibit the organisms responsible for puerperal sepsis. Again, in the reduction of infant mortality these preparations are of service; and the advances made in biochemistry, especially in the discovery of vitamins, enable children to be brought up on sound principles of nutrition, as demonstrated by the special arrangements made for the diet of mothers and children during the Second World War.

Equally, however, merit must be assigned to the administrative pioneers in maternity and child welfare, who made it possible for these triumphs of research and knowledge of the best methods for the care of mothers and the nurture of children to be applied in British homes. Among these pioneers, Dame Janet Campbell, whose death occurred in London on September 27, takes high place.

Janet Mary Campbell was born in 1877, daughter of George Campbell, of Barnham, Sussex. She studied at the London School of Medicine for Women, graduating M.B., B.S. in 1901, proceeding to M.D. in 1904, and to M.S. in 1905 in the University of London. After holding hospital appointments, she became an assistant school medical inspector under the London County Council in 1905. In 1908 she was appointed a medical inspector of the Board of Education. Much voluntary work by suitable infant nurture and feeding had been done first in France and afterwards in Great Britain to combat the high rates of infantile mortality; but the rates were stil high in industrial towns. It was time for the State to take legislative action. The Board of Education in 1907 was empowered to give grants-in-aid for educational work in infant welfare and later for 'Schools for Mothers'. Sir George Newman, the chief medical officer of the Board, assigned the medical direction of this work to Dr. Janet Campbell. She made valuable suggestions which were incorporated in official memoranda, and undertook extensive tours throughout England and Wales to impress the need for infant welfare on local educational authorities. At this time also Sir Arthur Newsholme's important reports influenced the Local Government Board to stimulate local authorities by State grants to provide a maternity and child-welfare service. The establishment of the Ministry of Health in 1919 with Dr. Campbell as the senior medical officer of the Maternity and Child Welfare Branch and similar rank in the Board of Education integrated medical administrative work in Whitehall on this subject.

At the Ministry of Health, Dame Janet and her able staff did excellent work. In addition to serving on a number of important Government committees, including the War Cabinet Committee on Women in Industry, the Committee on the Training of Midwives and the Committee on Maternal Mortality, she served on the Health Committee of the League of Nations and rendered valuable service to international maternity and child welfare work during 1930–36. She also wrote a number of searching reports on her special subject. These led to many important reforms which have helped to reduce maternal and infant mortality in recent years.

She was created a D.B.E. in 1924, received the honorary degree of doctor of hygiene of the University of Durham, and was a justice of the peace for Surrey and for Gloucestershire. On her retirement in 1934 she married Mr. Michael Heseltine, registrar of the General Medical Council; he died in 1952.

Dame Janet was tall and good-looking. A somewhat reserved manner cloaked her enthusiasm for the cause to which she devoted her life, but those who knew her and worked with her fully appreciated her great qualities. ARTHUR S. MACNALTY

Mr. A. de C. Sowerby

ARTHUR DE CARLE SOWERBY, who died in Washington, D.C., on August 16, was a member of that branch of the Sowerby family which included such well-known scientific figures as James Sowerby, the artist-naturalist of "English Botany" fame, and James de Carle Sowerby, who was first secretary of the Royal Botanic Gardens in Regent's Park, London.

Arthur de Carle Sowerby was born in 1885 at Taiyuan-Fu, Shansi, and during an adventurous career accomplished much to promote the study of China's natural history, both as an explorer and as a writer. Among the expeditions in which Sowerby took a prominent part was a trip to Shansi and the Ordos Desert in 1908, with Mr. Malcolm Anderson, who was collecting mammals for the British Museum under the auspices of the Duke of Bedford's Zoological Exploration of Eastern Asia. This venture was successful and resulted in many new forms of mammals being collected and sent to the British Museum, where they were duly described and reported upon. In 1909 Sowerby, in the capacity of naturalist, accompanied Mr. Robert Sterling Clark to north-western China, and thereafter, up to the end of 1917, he travelled in northern and eastern China, Inner Mongolia and Manchuria, collecting on behalf of the United States National Museum in Washington.

These journeys and their scientific results have been described by Sowerby in the travel-books which he published between 1912 and 1930. Thus, the Clark Expedition was described in "Through Shên-Kan" (1912), written jointly with R. S. Clark. Perhaps the most important of these works by Sowerby is his "Naturalist in Manchuria", published in five volumes between 1922 and 1930, containing an account of the vertebrate and invertebrate fauna of the region.

In 1911 he organized and led the Shensi Relief Expedition during the Chinese Revolution, a mission which was successfully carried out after a journey of 2,000 miles.

After the First World War, Sowerby returned to China and busied himself with further explorations and collecting work in Fukien Province, and later made a biological survey of the country accessible from Shanghai.

In 1923 he founded the *China Journal of Science and Arts*, of which he was the editor for fifteen years. This valuable journal was a noteworthy contribution to cultural activities in Shanghai. It continued until 1941 and contains much valuable material on the natural history and antiquities of China, "handled", as Sowerby himself has expressed it, "in a more or less popular, but at the same time thoroughly authentic way".

He was also associated with the Shanghai Museum of the Royal Asiatic Society, becoming later honorary director of the Museum and president of the North China Branch of the Society from 1936 until 1940. He also helped to found the China Society of Science and Art, and the Numismatic Society of China, of which he was president. He was also president of the Naturalists' Club of Shanghai, founded in 1935, and to which he delivered the first presidential address, taking as his subject the "Progress of Biological Work in China".

He contributed many articles to scientific journals, newspapers, and to the *China Journal*. During 1943–49, the Heude Museum of Shanghai published several of his papers, the most considerable of which were probably his account of the birds of the Shanghai area, and a review of the mammals of the Japanese Islands, both of which were published in 1943.

Sowerby was interned by the Japanese in 1944, and when released, made his way *via* England to the United States, where he finally took up residence, in Washington, D.C. At the time of his death this genial and many-sided man was engaged upon a history of the Sowerby family, which he entitled "The Sowerby Saga". This was written in collaboration with his wife and a cousin, and the first three mimeographed parts appeared in 1952. In the first two parts of this work the origin and early and middle history of the Sowerby family are discussed, while the third part begins the story of Arthur de Carle's own life and activities down to 1912. It is to be hoped that it will be found possible to publish a further instalment of this vivid and interesting narrative. A. C. TOWNSEND

Mr. Talbot Peel

MR. TALBOT PEEL, whose death at the age of eighty-two occurred at Cambridge on September 17, had been a Fellow of Magdalene College for some forty-five years. Born on July 4, 1872, he was the son of Norris Peel, of Stonegarth, Huddersfield.

From Huddersfield College he proceeded to Magdalene College, where he was fifth Wrangler in the Mathematical Tripos (1893) and placed in the first class of the Mechanical Sciences Tripos (1894). He then went to C. A. Parsons, Ltd., Newcastle upon

Tyne, for a period of training in practical engineering, in particular on steam turbines, which were then in the early stages of development. He returned to Cambridge to take up a teaching post at the Leys School. Later he joined the staff of the Engineering Department of the University and, in 1909, was elected a Fellow of Magdalene College. Here he was director of studies in mechanical sciences and, for many years, bursar and steward, offices which he filled with enthusiasm and distinction. He was appointed to the Hopkinson lectureship in applied thermodynamics in 1930 and occupied that post until he reached the retiring age.

Peel's interests were by no means confined to the academic sphere; for example, he represented the University on the Borough Council for eleven years, was a member of the General Committee of Addenbrooke's Hospital and also served on the Finance Committee of the Evelyn Nursing Home.

His long connexion with the University and City of Cambridge was marked by never-failing courtesy and gentleness, characteristics which endeared him to all those with whom he came into contact. He is survived by his wife Elsie, *née* Penman, whom he married in 1914, and by their daughter Elizabeth.

J. TREVOR SPITTLE

NEWS and VIEWS

Atomic Energy for Peaceful Purposes

ON September 6, President Eisenhower announced that agreement had been reached between the United States and six other nations to establish an international agency which would foster the growth and spread of the new atomic technology for peaceful purposes. Atomic materials would be set aside for projects sponsored by the agency, and when arrangements were complete the United States would establish a reactor school to train representatives of friendly nations in the skills needed for their own atomic purposes. The United States was about to negotiate with the Belgian Government on the building of an atomic power reactor in that country, and discussions with Canada and with other countries that intended to build their own research reactor units would follow. President Eisenhower expressed the hope that no nation would stand aloof from such co-operation. Since then, at the General Assembly of the United Nations, Mr. Leslie Pearson, the Canadian Foreign Minister, on September 23 said that Canada believed that even without Soviet participation an international atomic agency along the lines proposed by President Eisenhower could usefully be formed, and Mr. Dulles, the American Secretary of State, affirmed the determination of the United States to implement the proposals originally made by President Eisenhower on December 8, 1953. Mr. Dulles indicated that it was now proposed to create an international agency the initial membership of which included nations from all regions of the world; to call an international conference next spring, under the auspices of the United Nations, to consider the whole subject; to open next year in the United States a reactor-training school where students from abroad might learn the working principles of atomic energy with specific reference to its peace-time uses; and to invite medical and surgical experts from abroad to participate in the work of American cancer hospitals, in which atomic energy techniques were among the most hopeful approaches to the control of this disease. No nation would be excluded from participation in this venture. On September 26, the State Department published without comment twelve notes, memoranda and aides-mémoire, exchanged in Washington and during the Berlin Conference in February between the United States and the Soviet Union, giving details of President Eisenhower's proposals of December 8, and showing how the two countries failed to reach agreement, but were still willing to continue the negotiations.

Journal of Nuclear Energy

RESEARCH work in the field of nuclear energy is now being carried out in many national establishments throughout Europe. Much of this work is of interest to nuclear physicists in general, but has perhaps tended to remain unpublished because of its specialized technical nature. The appearance of the quarterly *Journal of Nuclear Energy*, edited by J. V. Dunworth, J. Guéron and G. Randers, will therefore be welcomed not only by members of the official organizations, among whom it will circulate technical information, but also by many others with an interest in the experimental possibilities of nuclear reactors (London: Pergamon Press. Single issues 25*s*.; annual subscription, 4 issues, 90*s*.). The articles in the first number of the new *Journal* justify the claim of the publishers that it will "provide an outlet for papers dealing with the scientific, engineering, biological and economic aspects of nuclear energy". All these are represented, and at least two of the articles, those by C. A. Rennie on "Economic Power from Fast Breeder Reactors" and by J. F. Loutit on "Protection against Ionising Radiation", are of wide general interest. Although most of the papers in the first number come from Harwell, contributions from Kjeller (Norway) and Saclay (France) are included, and all are of a high scientific standard. The layout of the new *Journal* is attractive, and the printing and illustrations are of good quality; it deserves a wide circulation.

Communications and Electronics

A NEW British technical journal was launched in September under the title *Communications and Electronics*; it is intended to present monthly a review of the new practical applications of communications and electronic techniques, which are rapidly becoming one of the major industries in Great Britain. The purpose of this new journal is well illustrated in an introductory article in the first issue, by Sir Walter Puckey, who states that "the aim is to show other specialists what telecommunication and electronic systems can do, rather than how they work". Bearing in mind that these techniques are nowadays applied over a very wide range of industry and commerce, as well as to medicine and almost every field of research, this new publication may well fill a long-felt need. The scope is illustrated by the series of articles in the first issue. These deal on the radio side with such subjects as navigational aids in civil aviation, telecommunications at London

Airport, safety at sea, radio and allied techniques on British Railways, and with the present and future of colour television. Other articles provide a review of the present position of transistors, and of the significance of automatic computation in research, industry and commerce. There are also interesting sections of this issue dealing with "Electronics in Action" and "New Equipment and Components". The presentation and layout of the journal, with its excellent photographs, diagrams and explanatory charts, are of a high standard, and are a credit to the publishers, Heywood and Co., Ltd., Drury House, Russell Street, London, W.C.1; it is only available by annual subscription of £1 10*s*. for twelve issues, post paid (6 dollars in the United States and Canada).

Agriculture: Diamond Jubilee Number

STARTING as a quarterly publication in 1894, *Agriculture*, the now monthly journal of the Ministry of Agriculture, has maintained an unbroken and increasingly useful service to the farming community of England and Wales. Both the scope and influence of the journal have widened considerably since it first began, and it is now regarded as an authoritative source of scientific and practical information for farmers, market gardeners and fruit growers alike. The journal celebrated its diamond jubilee last September and the number for that occasion (London: H.M.S.O. 1*s*. net) contains various articles of interest, each contributed by specialists in the subject. The underlying theme is the progress made during the past sixty years in such fields as plant and animal nutrition and breeding, crop protection, horticulture and mechanization, and it is hard to realize how comparatively recent are many of the accepted practices of to-day. Other articles describe the changes that have taken place in Welsh agriculture, landownership and rural social conditions, while contributions of a more general nature deal with agricultural research, climate and the part played by agricultural societies, press and radio. Many readers will enjoy the personal touch provided by "I remember", a miscellany of recollections by some members of the older generation, and the beautiful illustrations depicting the varied nature of the English farming countryside.

Phyto-Sanitary Convention for Africa South of the Sahara

THE member governments of the Commission for Technical Co-operation in Africa South of the Sahara (Belgium, France, the Federation of Rhodesia and Nyasaland, Portugal, the Union of South Africa and the United Kingdom) have signed in London a Phyto-Sanitary Convention for Africa South of the Sahara. The objects of the Convention are to prevent the introduction of plant pests and diseases and other enemies of plants into any part of Africa south of the Sahara, to eradicate or control any that are at present in the area and to prevent their spread. It has established an Inter-African Phyto-Sanitary Commission on which each of the participating governments will be represented, and each participating government, as may be considered necessary by the Commission, will be required to exercise control of plant importations, and to apply measures of quarantine certification and inspection. It will also take any necessary action to deal effectively with diseases, insects, pests and other enemies of plants which have become or are likely to become a serious danger within the area, and to prohibit the importation of any plant material, seed or packing material which the Commission considers should be refused admittance into the area. The Commission is to have a scientific secretary and there is to be set up in London a Permanent Committee of Information consisting of the directors of the Commonwealth Institutes of Entomology and Mycology and the Scientific Secretary. This Committee will act as an intermediary between the two Commonwealth Institutes concerned and the African Phyto-Sanitary Commission for the transmission of relevant information about diseases, etc. The Convention will come into force as soon as it has been ratified.

Commonwealth Oceanographic Conference

A COMMONWEALTH Oceanographic Conference is to be held in the National Institute of Oceanography at Wormley, near Godalming, Surrey, during October 18–22. Australia, New Zealand, Canada, India and Pakistan are sending representatives, and observers will be attending on behalf of South Africa and Ceylon. Delegates from the United Kingdom will include representatives of the many government departments and scientific bodies interested in oceanographic research. The Conference has been arranged on the initiative of the National Oceanographic Council, to consider the possibility of closer co-operation in oceanographic research throughout the British Commonwealth. The need for such co-operation has become more pressing in recent years, as the tendency in oceanography has been to devote more and more effort to theoretical studies in an attempt to understand the fundamental physical and biological processes which are responsible for and cause variations in the properties of the waters, rather than to collect and analyse data concerning the water movements, temperature, chemical properties, distribution of marine life, etc., formerly the main activity. This change in approach has increased the difficulty of oceanographic laboratories in finding sufficiently qualified staff and providing the necessary facilities. The problems to be solved call for the attention of physicists of the highest calibre, and it will be a long time before any single country can interest an adequate number of such men in marine problems. Furthermore, it is becoming increasingly expensive to build, equip and operate a marine ocean-going research vessel. It is hoped that, as a result of the Conference, conclusions will be reached on the degree to which it is desirable for the Commonwealth countries to co-ordinate their oceanographic research programmes and to collaborate in solving outstanding fundamental problems.

City and Guilds of London Institute

THE growing importance of the City and Guilds of London Institute, and the part that it plays in advancing the cause of technical education, is the happy outcome of the enterprise of the Corporation and the Livery Companies of the City of London, which in this matter are acting fully in accordance with the tradition and past history of their respective organizations. In 1953 the Institute celebrated the seventy-fifth anniversary of its incorporation. Its progress during 1953 is described in the annual report, which contains an account of the successful launching of an appeal for £100,000 in order that the Institute could more readily meet increasing demands by industry and commerce. One of the outstanding events of 1953 was an unexpected rise in the number of candidates who sat for the City and Guilds examinations. The steep rise over the years 1941–50 was followed by only moderate increases in 1951 (834) and 1952 (1,479). In 1953 there was a sharp increase of 4,336, the number being fairly evenly spread over most established subjects.

Another important development in 1953 was the establishment of a new examining body provisionally entitled the Joint Examinations Board for the General Certificate of Education. This body will offer examinations having a bias towards the particular needs of pupils in secondary technical, commercial and modern schools and classes and the needs of students in institutions for further education. The Institute has undertaken, during the initial stages, the administrative and financial responsibilities of the Board, of which it is one of the sixteen sponsoring bodies.

Properties of 'Nimonic 95'

A RECENT addition to the well-known series of 'Nimonic' alloys is discussed in a technical publication of Henry Wiggin and Co., Ltd., Thames House, Millbank, London, S.W.1. The highest creep resistance is normally obtained by solution-treating the alloy for 4 hr. at 1,150° C., or, if a coarser grain size is not a serious matter, for 1–2 hr. at 1,200° C. This is followed by reheating for 6–8 hr. at 1,080° C., followed by 16 hr. at 700° C. In each case the sample is air-cooled after the treatment. Among the high-temperature properties which are given, the 0·1 per cent proof stress, which is 51 tons/sq. in. at ordinary temperatures, is still 43 tons at 700° C., 17 at 900° C., and 4·1 at 1,000° C. The corresponding figures for the elongation per cent, measured on four times the square root of the area, are 25, 4·5, 11 and 59, the modulus of rigidity being 30, 25, 18 and 14 × 10^6 lb./sq. in. At 870° C. the endurance under a stress of 20 tons/sq. in. is 10 × 10^6 cycles, and at 16·8 tons 45 × 10^6 cycles in about 300 hr. Among the creep data given the following figures may be mentioned: under a stress of 8 tons/sq. in., a creep extension of 0·2 per cent occurs in 10,000 hr. at 750° C., at a stress of 7·5 tons at 815° C. in 1,000 hr., and under a stress of 4 tons/sq. in. in the same time at 870° C. Rupture under creep in 1,000 hr. occurs under stresses of 16, 8·5, 5·5 and 2·2 tons/sq. in. at temperatures of 750, 815, 870 and 925° C. respectively.

Gamma-Ray Sources for Radiography

A REVISED second edition of the "Memorandum on Gamma-Ray Sources for Radiography", first published in 1952 (see *Nature*, 170, 186; 1952), has recently been issued (pp. 28. London: Institute of Physics, 1954; 3*s.* 6*d.*). As previously, it has been prepared by a committee of the Non-destructive Testing Group (formerly the Industrial Radiology Group) of the Institute of Physics. The physical characteristics of gamma-ray sources, with particular reference to the products of the Atomic Energy Research Establishment, Harwell, and of the Radiochemical Centre, Amersham, are summarized, and attention is directed to radiographic technique, protection of personnel and to the costs involved. The subject-matter has been brought up to date and has been extended in many respects, particularly with regard to the number of radioactive materials considered. For industrial radiography, sources consisting of the naturally radioactive gas radon-222, which is of high activity and small bulk, and cæsium-137, can be obtained from Amersham, and artificially radioactive sources—cobalt-60, tantalum-182, iridium-192 and thulium-170—from Harwell; in addition, the shorter-lived sodium-24 and gold-198 sources can be supplied from Harwell when specially ordered. One section of the memorandum deals with the sizes of sources and the design of source capsules, and in another an outline of gamma-ray radiographic technique—which, it is pointed out, is similar to that of X-rays—is given with references to further details. Other sections deal with the protection of personnel, the handling and transport of sources and the cost of installing equipment for gamma-ray radiography. The memorandum concludes with a comprehensive and useful bibliography and with data sheets for each of the longer-lived radioactive sources mentioned above. The data are reproduced from official sources.

Cotton Growing in Northern Nigeria during the Season 1952–53

THE progress report for the season 1952–53 from the Experiment Stations in Northern Nigeria of the Empire Cotton Growing Corporation (pp. 19. London: Empire Cotton Growing Corporation, 1954; 9*d.*) reports that, following the previous season's record yield of 113,510 bales of cotton, 17 per cent more seed was issued, although not all was planted, and some, which was taken by inexperienced cultivators, gave very little return. Early rains made cotton planting unduly late, and confidence induced by the easily obtained good yields of the previous crop led to less attention to planting and weeding. In consequence, the crop for export was only 95,445 bales, and the average return per ton of seed fell from 10 to 7 bales of lint. At Samaru, in Zaria Province generally and in some other areas yields were as good as in the 1951–52 season; the growth of the industry in the Gombe area (Bauchi Province) has been remarkable and is clearly capable of expansion. Yields in South Katsina were well below those of the previous season. Rainfall at Samaru was unusually heavy in July, well below normal in August, and about normal in total and in time of cessation (October). The growth of the crop was in general satisfactory. Insect damage was not unduly severe, that attributed to mirids (*Campylomma* and/or *Lygus* spp.) being less than in the two previous seasons. Red bollworm populations were lower except at Kontagora and Yola, and pink bollworm was higher than elsewhere at Yola and Gombe. Good control of *Campylomma* and a marked reduction in leaf tattering was achieved at Samaru by late spraying with 1 per cent DDT emulsion, and at Daudawa treatment with DDT emulsion gave a 50 per cent increase in the yield of clean seed cotton. Bacterial blight (*Xanthomonas malvacearum*) was more in evidence than in 1950–51 or 1951–52, and it seems probable that this disease in its several manifestations can be responsible for much damage to bolls, although differences between strains in the severity of symptoms displayed are not related obviously to differences in yield.

Manganese and Metabolism in Potatoes

THE importance of manganese in plant metabolism, though now established, is but little understood. In a study of the effect of manganese on the assimilation and respiration-rate of isolated rooted leaves of the potato, H. C. Ruck and B. D. Bolas (*Ann. Bot.*, N.S., 18, 71, 267; 1954) have found that normal potato leaves will root readily after treatment with α-naphthaleneacetic acid (2 p.p.m.) but that very few manganese-deficient leaves will respond in this way, the critical level being about 15 p.p.m. manganese on a dry-weight basis. The growth of the manganese-deficient leaves was also less, but they did not develop the characteristic symptoms of this mineral deficiency, even when the level had fallen below that at which symptoms would have appeared on attached leaves. In leaves which had a high or a low manganese content at the time of rooting there was a marked difference in the net assimilation-rate; but the addition of manganese after rooting to leaves of low content did not increase the assimilation-rate. The effect of manganese content on respiration was found to be slight, though a higher respiration-rate was consistently associated with a higher manganese content. No effect on translocation was detected. The authors point out that the effect of manganese on the assimilation apparatus may occur during the development of the leaf and that once the chloroplast system has become fully developed any manganese deficiency which develops during that phase cannot afterwards be made good. They also indicate, however, that the capacity for chlorophyll formation in deficient leaves is not lost, since considerable greening can be produced by injection, provided the manganese deficiency has not become too advanced.

The National Museums, Ceylon

THE administration report of the National Museums, Ceylon, for 1953 records the activities at Colombo, Kandy, Ratnapura and Jaffna. It is interesting to note that at the Colombo National Museum an annual attendance of 207,438 included 35,171 schoolchildren in organized groups. The acquisition of the only known incisor tooth of *Rhinoceros sinhaleyus* and a series of bone implements, including some notched for attachment to hafts from cave deposits, is reported. On the proposal of the Director, the Colombo Museum Committee decided to conduct a speleological survey of Ceylon to include the zoology and prehistory of all the caves in the Island. Accordingly, a Speleological Association of Ceylon, the membership of which is open to the public, was formed in July 1953.

Swedish National Committee for Physics

THE seventh general physics conference of the Swedish National Committee for Physics was held at he Chalmers Institute of Technology, Gothenberg, during September 28–30, 1953. The director, Prof. Nils Ryde, gave details of the facilities available at the Institute and described the research work in progress, and Prof. S. Eklöf spoke about the organzation of teaching and research in the Electrical Engineering Department. Several distinguished visitors from outside Sweden attended the conference and gave addresses. These included Dr. M. Edlund (Oak Ridge Laboratories), who gave a survey of recent reactor developments in the United States; Prof. T. W. Bonner (Rice Institute, Houston), who lectured on excited states of light nuclei; and Dr. A. Bohr and Dr. T. Huus (Copenhagen), who spoke about rotational states of atomic nuclei and the Coulomb excitation of heavier atomic nuclei, respectively. Summaries of the other forty-six papers contributed to the conference are printed in *Arkiv för Physik*, 8, 1; May 1954. They include several contributions from the Atomic Energy Laboratory, tockholm, and from the Nobel Institute of Physics, tockholm.

The Nature Conservancy: Awards for 1954

THE Nature Conservancy announces the following awards of research studentships for postgraduate training in ecology, tenable for periods of up to three years at the universities and other institutions named: *Botany:* A. P. Hughes (Trinity Hall, Cambridge); E. Lodge (University College, London); N. M. Pritchard (Balliol College, Oxford); T. O. Pritchard (Leeds); V. I. Stewart (Aberdeen). *Zoology:* J. M. Colebrook (Freshwater Biological Association, Far Sawrey, Ambleside); J. C. Coulson (Durham); J. B. Ford (Southampton); Miss T. J. White (Imperial College of Science and Technology, London).

Announcements

THE Council of the Royal Society has appointed Prof. M. L. E. Oliphant, of the Australian National University, as the Rutherford Memorial Lecturer for 1955. Prof. Oliphant will deliver lectures in India and Pakistan.

THE 1954 Eddington Lecture is to be given in Cambridge, at the Arts' School Lecture Theatre, Bene't Street, on November 2, at 5 p.m., by Prof. H. Dingle, professor of the history and philosophy of science in University College, London. Prof. Dingle will speak on "The Sources of Eddington's Philosophy".

THE War Office announces that Prof. S. J. Davies has been appointed dean of the Royal Military College of Science, Shrivenham. Prof. Davies is professor of mechanical engineering in the University of London at King's College, and will retain his chair until the end of the present academic year.

DR. E. H. SONDHEIMER, lecturer in mathematics in the Imperial College of Science and Technology, London, has been appointed to the University readership in applied mathematics tenable at Queen Mary College, University of London.

THE Metallurgical Laboratories of the British Welding Research Association are holding open days on November 23 and 24. Admission will be by ticket, obtainable from the Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

REFERRING to the article on "The Golgi Apparatus" (*Nature*, July 3, p. 21), Mr. Dennis Lacy writes: "I may inadvertently have given the impression that the views of Dr. J. R. Baker and his colleagues are based solely upon the study of only three different cells (neurones of *L. migratoria*, epithelial cells of the intestine, and Paneth cells). They have indeed published careful accounts which deal specifically with the Golgi problem in nineteen different kinds of cells".

ERRATUM. In the article on the report for 1953 of the Rothamsted Experimental Station (*Nature*, September 11, p. 498), referring to the work of the Bee Department, it is said that the fumes produced by adding small quantities of ammonium nitrate to burning smoker fuel provide a simple anaesthetic for use when transferring bee colonies from one site to another a short distance away, since on recovery it is claimed that the bees lose their tendency to drift back to the original site. It should have been added that the Rothamsted work has failed to substantiate this claim, but it is considered that the method, provided that the minimum proportion of ammonium nitrate to fuel is used, is the most efficient and simple one so far suggested for anaesthetizing whole colonies of bees *in situ*.

USE OF SCIENTIFIC DEVELOPMENTS IN INDUSTRY

TWO papers given before Section F (Economics) of the British Association at Oxford on September 7 supplemented the account of the work of the Science and Industry Committee included in the first report of the Committee on Human Relations in Industry issued last June (see *Nature*, 174, 49; 1954). In the first of these, Prof. C. F. Carter gave a brief account of the way in which the interest taken in the work of the committee originally set up by the Council of the British Association at the Belfast meeting in 1952 to study "the problems of speeding up in industry the application of the results of scientific research" had led last spring to the reconstitution of the committee under the joint sponsorship of the British Association, the Royal Society of Arts and the Nuffield Foundation. Prof. Carter, emphasizing that the situation is changing and requires constant reassessment, explained the way in which the Committee has sought both to obtain an overall view of the relative importance and the inter-relations of the various factors and of the way in which it operates in particular firms. It has attempted, for example, to collect further information as to the validity of the view that British industry is inadequately supplied at the higher management or directorate level with persons with scientific and technical knowledge, and to elucidate the question whether the use of scientific knowledge is being impeded by restrictive practices on the part of management, the latter with the view of weakening or strengthening the suspicion that it does not pay to be quick in exploiting new scientific discoveries or methods.

The first year was spent in preliminary planning, in securing funds and in recruiting staff, and Prof. Carter did not attempt to give an interim report on the Committee's conclusions even during its second year's work. He remarked that certain possible hindrances to the use of science which *a priori* looked important have obstinately failed to appear in the case studies so far conducted. The attitude of industry to science is unlikely to be the mechanical result of a set of material factors. While such matters as the shortage of scientists or of equity capital, the influence on investment of the size of firms, or the proportions of management with certain qualifications, though very troublesome to investigate, can be reduced to questions of fact which are precisely defined, at every point questions of fact are inextricably mixed with those of attitude. The demand for scientists, for example, depends on the attitude of different types and sizes of firms as to the usefulness of employing scientists, and this depends on a general climate of opinion. So, too, the effect of taxation on the utilization of scientific knowledge is the resultant of the different ways in which the same taxation system causes different people to act; nor did Prof. Carter venture to predict how much the Science and Industry Committee could add to knowledge on a matter which involves these puzzling problems of attitude.

Prof. B. R. Williams's paper explained the methods employed by the Committee in the studies it has sponsored of the action of particular firms facing particular opportunities in new applications of science. Like Prof. Carter, he emphasized the willingness of firms to co-operate and the great interest taken everywhere in the work of the Committee. Following a first attempt to obtain information on the origin of both successful and unsuccessful developments, the difficulties encountered and the time scale as well as, for new products, the particular sales problems, the Committee hopes to investigate more fully some fifty firms with the view of obtaining further insight into what determines the rate at which new products or processes are created and taken up. For this purpose a rough classification of problems has been attempted into those of communication and conversion generally, those due to the structure of the relevant industry, and those due to the structure of British industry.

Only one inquiry is almost complete at this stage—that into the rate at which, and means by which, tunnel kilns and kiln furnitures have been improved in the pottery industry. Here tunnel kilns which, when working properly, give significant savings of fuel, labour and wasted ware and facilitate the flow of work within the factory, were taken up very slowly until after the War, since when a large number had been installed. Prof. Williams said this can be attributed to four main factors. The pottery industry is in large measure a craft industry with a craft attitude to the job as a whole and great suspicion of new-fangled methods. Costing methods are primitive or non-existent. The large amount of space required by tunnel kilns involves extensive building, and this is a great impediment when output is not expanding and profits are very low. The small firms predominating in the industry have difficulty in financing rebuilding and installation when profits are low, and are reluctant to raise capital in a way that endangers family succession. The increased installations since the War can be traced to the breakdown of some of these impediments.

Commenting generally on the investigations, Prof. Williams stressed the value of such inquiries sponsored by a body constituted like the Science and Industry Committee. The Committee has facilitated deployment of the expert knowledge and experience of its members without subjecting them to intolerable strain. The method employed in the second stage inquiries works best with firms that have squarely faced the application of science to industry, and particularly with firms large enough to maintain an organization for that purpose. He emphasized the need for caution in generalizing direct from the peculiar conditions of the post-war period and also in judging whether a firm is reasonably fast or unreasonably slow in the industrial application of science. The firm which most impressed him with the speed and whole-heartedness with which it applied science to industry had only been saved from bankruptcy recently by a manager who insisted on cutting research and development far below the level at which he found it; in consequence, the firm will probably soon be spending more on research and development than before its near bankruptcy.

ATOMIC LINE SPECTRA

IN the course of a long history, the branch of physics concerned with the study of optical spectra has been exceedingly fruitful of fundamental results and concepts, and in application. A period of remarkable advance—the golden age of the interpretation of line spectra and extranuclear atomic structure—extended over little more than ten years following the First World War. At the opening of that period, a number of significant regularities had been found empirically in, for the most part, the simpler series spectra, by diligent efforts of a number of workers subsequent to Balmer's discovery, in 1885, of the distribution law of the hydrogen line series which bears his name. In addition, Bohr had produced his postulates for hydrogen-like atoms in 1913, and calculated the Rydberg constant. However, the spectra of most elements consisted of bewilderingly large numbers of lines having little apparent order. The great achievements of the early 1920's resulted from application of the Bohr theory and its elaboration, at the hands of Bohr, Sommerfeld, Landé, Pauli, Russell and others, into the older quantum theory and vector model, and from the provision, in 1922, of the key to the analysis of complex spectra by Catalán's paper on the arc spectrum of manganese. Simultaneously, development of a theoretical background capable of co-ordinating much of the accumulated observational material stimulated vigorous laboratory investigations, aimed at improved accuracy and methods.

Later in the 1920's, the formulations of quantum mechanics removed much of the *ad hoc* appearance of the older theory. Achievement was, in fact, so rapid and extensive that, by the beginning of the decade following, the impression was widespread that study of atomic spectra had become, in essence, a closed field; correspondingly, though with notable exceptions, the vigour of laboratory investigations faded, and the number of active workers declined. The view that a particular field is exhausted of further basically important discoveries is of a risky nature; in the case of line spectra, much of fundamental interest may repay investigation of the finer details of even, at present, well analysed spectra. In some cases—for example, those of the complicated rare-earth and transuranic spectra—little more than a start has been made in analysis. Measurements of line intensities and oscillator-strengths, while of fundamental significance, are beginning to receive the attention needed largely because of the demands of the astrophysicist. A similar position is probably arising regarding Stark and other line-broadening effects, in relation to spectroscopic study of discharge plasmas. Again, interconfiguration interactions and autoionization phenomena are little understood—and the theme can be developed.

The present position and current directions of work on atomic spectra received excellent demonstration at the recent "Rydberg Centennial Conference", held during July 1–5 in the Physical Laboratory of the University of Lund. The meeting was organized, under the auspices of the International Union of Pure and Applied Physics, by the Swedish National Committee of Physics, and marked the centenary of the birth of Johannes Robert Rydberg (1854–1919). Rydberg, while holding the chair of physics at Lund, successfully applied a genius for the handling of numerical data to the search for regularities in line spectra.

The conference met under the presidency of an eminent contributor to line-analysis, Dr. W. F. Meggers, of the U.S. Bureau of Standards, and owed much for initiation and excellence of organization to Prof. B. Edlén, the present occupant of Rydberg's chair, whose work on the spectra of stripped atoms and of the solar corona is renowned. During the four days a total of more than sixty papers was read, most centres of currently active research on line spectra being well represented.

The proceedings of the first day, devoted to the general structure and analysis of atomic spectra, were distinguished by review addresses by N. Bohr (Copenhagen) on "Rydberg's Discovery of the Spectral Laws", W. Pauli (Zurich) on "Rydberg and the Periodic System" and A. G. Shenstone (Princeton) on "Series in Line Spectra". B. Edlén (Lund) discussed improvements in spectral series representation, and showed that all series in alkali arc spectra and in Ca II can be accurately represented by addition of one or two terms to the usual Ritz denominator. Present accepted values of the ionization potentials of ions up to the nineteenth stage were reviewed by W. Finkelnburg (Erlangen), who indicated improved methods of extrapolation along isoelectronic sequences. C. C. Kiess (Washington) described results of the analysis of Mo II; with the aid of new wave-length and Zeeman effect observations, 80 per cent of the observed lines are classifiable. The analyses of Os I and II, utilizing Zeeman patterns at 85,000 gauss, were discussed by J. C. van den Bosch (Amsterdam). Papers by S. Glad (Lund) and by O. Garcia-Riquelme and R. Velasco (Madrid) described work on the astrophysically important spectra of Fe III and Ni III, respectively. In dealing with complicated spectra, search for real constant-frequency intervals is extremely time consuming; in this connexion L. F. H. Bovey (Harwell) discussed the applicability of standard computing equipment to term analysis.

A number of interesting papers on methods and results of high-resolution spectroscopy were presented during the second and third days. H. Kopfermann (Heidelberg) reviewed past contributions and present trends of investigations on optical hyperfine structures and isotope-shifts in relation to nuclear properties, namely, spin, magnetic and quadrupole moments. This kind of work has always made great demands on instrumental refinement and technical skill; the elegance of some of the experimental arrangements outlined indicated that progress in these respects continues. Thus, P. Jacquinot (Bellevue, S. et O.) described a recording Fabry–Perot interferometer which employs a photomultiplier or photo-conductive detector placed behind an annular exit-slit, upon which the ring system is focused concentrically; scanning of the pattern is performed by moving the fringes across the slit, by cyclic variation of either the gas pressure in the interferometer housing or of the étalon spacing. This type of instrument has been used by H. Chantrel, who reported an investigation of the abundance-ratio of lead and neodymium isotopes and a determination of the quadrupole-moment of mercury-201, and by J. Blaise, who described results on hyperfine structure, in Pb I and II and the first measurement of a hyperfine structure pattern of a line lying beyond the photographic limit in the infra-red. Other work of high refinement consisted in combination of an atomic-beam light source and a large-gap étalon; described by K. W. Meissner (Lafayette, Ind.), this apparatus has been used to obtain wave-lengths of eight lines of germanium to an estimated ± 4 × 10^{-4} A. Successful measurements of very small isotope shifts in Sn II and Cd II were reported by H. G. Kuhn (Oxford); in this work enriched isotope samples were employed. E. Rasmussen (Copenhagen) gave results on isotope shifts in krypton; here, the isotopes, separated in a mass-spectrometer, were collected on aluminium foil from which the gas could afterwards be released by radio-frequency heating. Description of the measurement of isotope shifts in the spectra of the lightest elements by J. E. Mack (Madison) included a discussion of their interpretation in terms of the specific mass contribution. Work at Amsterdam on the spectra of plutonium-239 was described by P. F. A. Klinkenberg; high-resolution studies have led to the conclusion that this isotope has a nuclear spin of ½. High-resolution work at the Oak Ridge Laboratories of the U.S. Atomic Energy Commission, described by J. R. McNally, has included isotope-shift and abundance studies in the heavy elements and transuranics; for example, uranium-233 and 235 were stated to have probable nuclear spins of 5/2 and 7/2, respectively. Two papers were concerned with the important topic of the Lamb–Retherford shift, both being marked by the skill of the techniques employed. G. W. Series (Oxford) had studied the fine structure of He II λ4686, using two étalons in series and a discharge-tube cooled in liquid hydrogen; he reported that the results departed appreciably from Dirac theory expectations, and possibly also showed a smaller departure from predictions of the new quantum electrodynamics. G. Herzberg (Ottawa) described measurements of the wave-length of the first line of the Lyman series of deuterium; for this work, the fifth-order of a three-metre vacuum grating was employed, and the line obtained in absorption by the partially dissociated gas drawn from a Wood tube; again, there are indications that the shift of the ground-level of deuterium shows a small departure from theory.

A welcome feature of the conference was the presence of a number of prominent workers on theoretical spectroscopy—this especially since the most recent monograph available is the monumental effort of Condon and Shortley, now some twenty years old. The scope of current theory applied to actual classification problems was reviewed by G. Racah (Jerusalem), with particular mention of complex ($l^m d^n$-configuration) and very complex ($l^m f^n$-configuration) spectra. Several papers referred to features of two-electron spectra; E. A. Hylleraas (Oslo) gave results of new calculations of singlet and triplet series, and P. Pluvinage (Strasbourg) presented new results for the ground-state and first-excited state of He I. The interesting question of the effect of interconfiguration interaction in He I-like spectra was dealt with by L. C. Green (Haverford, Pa.). L. Biermann (Göttingen) reported theoretical calculations of *f*-values, and directed attention to the importance of interconfiguration perturbations; thus, in the case of the singlet resonance line of Ca I, the theoretical value of $f = 2 \cdot 2$ is reduced to 1·48 when the effect of *4pmp* terms is included.

Several papers formed general or specific reports on laboratory methods. Infra-red atomic spectroscopy was comprehensively reviewed by C. J. Humphries (Corona, Cal.) with particular emphasis on the use of modern photoconductive detectors; the certain usefulness of these techniques in the investigation of rare-earth spectra was indicated. R. A. Fisher (Evanston, Ill.) described a use of Edser–Butler fringes for facilitating wave-length calibration of recording spectrometers. Experience with the use of multilayer highly reflecting films on Fabry–Perot plates was described by F. A. Jenkins (Berkeley). In a paper on stigmatic concave gratings, F. Zernike (Groningen) proposed the novel solution of replacing the usual straight ruling by a system of concentric circular arcs. E. Hulthén (Stockholm) described experiments made with plane gratings immersed in liquids as a means of raising resolving power and dispersion. Several developments of light sources were described; for example, convenient forms of demountable hollow-cathode tubes (H. Schüler, Hechingen), the 'vacuum sliding-spark' (N. Astoin and B. Vodar, Bellevue) and the pulsed high-frequency electrodeless discharge (L. Minnhagen, Lund). All these sources are useful in the study of spectra of the lower ionization stages, the 'sliding spark' being the most energetic; the use of this source was illustrated by K. Bockasten (Lund) for O III and IV.

The study of line intensities and *f*-values was well represented. W. F. Meggers (Washington) reported measurements of arc intensities of 30,000 lines from seventy elements introduced as small admixtures in a base of powdered copper; copper lines used as intermediate intensity standards were finally compared with radiation from a tungsten lamp. Use of a King furnace at Amsterdam, for measurement of relative *f*-values of Fe I lines, was described by C. J. Bakker. The promising technique of rotation-stabilized arcs, which makes possible the realization of a portion of matter in thermal equilibrium at a temperature of up to 50,000° K., was described by H. Maecker (Erlangen). R. H. Garstang (London) reviewed theoretical computations of atomic transition probabilities, and presented the results of his own calculations and their comparison with experiment.

The final day of the conference was occupied with papers on miscellaneous experimental topics, compilations of data, and astrophysical applications. Autoionization phenomena were discussed by W. R. S. Garton (London) in connexion with vacuum ultra-violet absorption spectra. Two papers dealt with elegant experimental techniques developed at the École Normale Supérieure, Paris. A. Kastler described applications of a method involving optical detection of the partial spatial orientation produced in an atomic beam which is subjected to a perpendicular magnetic field and, parallel to this, a beam of circularly polarized resonance radiation. J. Brossel and J. E. Blamont described measurements on the Stark effect of the $6\,^3P_1$ state of Hg I, based on observation of the change in the magnetic resonance curve following superposition of an electric on the main magnetic field. Statistical Stark broadening in the spectra of discharge plasmas was discussed by W. Lochte-Holtgreven (Kiel), with particular reference to determination of ion concentrations in the high-power arcs developed at Kiel. L. Herman (Bellevue) compared experimental and theoretical contours of Balmer series lines exhibiting strong ionic Stark broadening. Use of a statistical theory, based on a Lennard-Jones potential function, was suggested by B. Vodar (Bellevue) to account for the results of experiments on the shifts of resonance lines of the alkalis, mercury and xenon, occasioned by high pressures of foreign gases. Features of time-resolved spectra of long sparks in air, and of pulsed centimetre-wave discharges in rare gases, were described respectively by A. Vassy (Paris) and by I. Eyraud and J. Janin (Lyons). Measurements of wave-length standards by means of a reflecting échelon were described by T. A. Littlefield (Newcastle), who directed attention to the necessity for certain corrections; P. Risberg (Lund) explained the establishment of accurate vacuum ultra-violet wave-length standards by application of the combination principle to newly measured long wave-length lines of Mg II and Ca II.

Mrs. C. E. Moore-Sitterly (Washington) spoke on one of the several valuable compilations of data for which all spectroscopists are indebted to her, namely, a second revision of Rowland's Solar Wave-length Table. Announcement of the preparation of a useful table of forbidden multiplets of astrophysical significance was made by J. W. Swennson (Liège). Of the specifically astrophysical papers, that of E. Finlay-Freundlich (St. Andrews) on his well-known hypothesis in explanation of the general red-shift in celestial spectra produced much discussion; the possibility of fluorescence by line-coincidence was illustrated by J. Gauzit (Lyon), and Mrs. C. Payne-Gaposchkin (Cambridge, Mass.) contributed results of a spectrometric study of a rotating star. The conference ended with a general discussion, under Prof. Edlén, concerning proposals for defining the metre in terms of the wave-length of a chosen spectral line produced under specific conditions.

Limitations of space preclude a fuller account of the many important contributions to this conference, which demonstrated that the study of line spectra continues to flourish.

W. R. S. Garton
L. F. H. Bovey

RIDERLESS MICROCHEMICAL BALANCES

At the recent symposium on analytical chemistry held in the University of Birmingham by the Midlands Society for Analytical Chemistry, one of the most interesting features in the display of modern laboratory apparatus was the adoption of the riderless beam principle by the firm of L. Oertling, Ltd. (Cray Valley Road, St. Mary Cray, Orpington, Kent), in the construction of its two new microchemical balances.

There is little doubt that one of the most serious sources of error in weighing on a microchemical balance (apart from the personal factor) is associated with the use of the rider. These errors have been attributed to variations in the mass of the rider, its angular placement on the beam, the shape of the notch and the accurate location of the notches on the beam. The cumulative effect of these errors over the several weighing operations involved in a gravimetric analysis may result in considerable inaccuracy. Some workers have estimated the probable error of any one reading on a microchemical balance at ± 3 μgm., while work undertaken for the American Chemical Society by others gave values of 0·9–23·3 μgm. for the standard deviation of thirty-two different microchemical balances used with a 1-gm. load. The elimination of every possible source of error is therefore highly desirable.

Few fundamental advances have been made in the design of microchemical balances since the evolution of the original Kuhlmann model, but the elimination of the rider error in these two new microbalances by Messrs. Oertling will undoubtedly be hailed as such by many.

In place of the conventional rider system, a plain beam is used in conjunction with a series of fractional rider weights. These fractional riders are loaded on to a special carrier bar, attached to the pan-suspension system, by means of levers operated by a calibrated dial attached to the right-hand side of the balance case. In the more sensitive of the two balances, these fractional riders have a displacement value equivalent to 9 mgm., so that when the 1-mgm. range of the graduated optical scale is added, a total displacement of 10 mgm. can be observed, rendering the use of weights less than 10 mgm. superfluous.

Needless to say, the possibility of errors of another nature is introduced by the riderless beam principle, and one still has to reckon with variation in the weights of the fractional riders; but nevertheless weighing operations are speeded up considerably, and the inherent errors involved would seem to be less serious, for the manufacturers claim that for the first time in microchemical weighing it is possible to weigh with certainty to the nearest microgram.

T. S. West

ACTIVITIES OF THE INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

The Policy Board of the International Union of Biological Sciences met in Paris during June 28–30 and made a number of recommendations regarding the future structure of the Union. The Board consisted of Prof. P. Weiss (United States) and six other members: Prof. A. Frey-Wyssling (Switzerland), Prof. J. Monod (France), Dr. L. Harrison Matthews, representing Prof. C. F. A. Pantin (United Kingdom), Prof. B. Rensch (German Federal Republic), Prof. John Runnström (Sweden) and Prof. M. J. Sirks (Netherlands); a number of officers of the Union and of other International Unions were also in attendance for parts of the meeting. One of the principal recommendations was that the Union should consist of eleven Sections, as follows: Biochemistry, Biometry, Botany, Cell Biology, Developmental Biology (including embryology), Ecology (including limnology), Genetics, Microbiology, Physiology, Experimental Psychology and Zoology (including entomology). This would involve setting up four new Sections—those of Biochemistry, Developmental Biology, Physiology and Experimental Psychology—and incorporating the present Sections of Embryology and Entomology as indicated.

The work of the Union is of a varied nature. Research institutes available to workers of all nationalities have been supported or founded: for example, a culture collection of wild species of *Drosophila* at Pavia; Centres for the Biological Control of the Pests of Plants at Geneva and Mentone; the International Depot of Microscopical Preparations at Louvain; the International Bureau of Human Heredity at Copenhagen; and the Serological Museum at Rutgers University, New Brunswick. The Union organizes and partly finances symposia for the discussion of current research (usually three a year) by small groups of specialists, and also helps in the organization of international congresses relevant to its work. Catalogues of types in national museums, and a list of type-genera and species of mites have been published, thanks to financial aid from the Union, and annual grants have been made to certain periodical publications of an international character concerned with bibliography, such as the *Zoological Record*, *Biological Abstracts*, *l'Année Biologique* and *Resumptio Genetica*; the publications of the International Commissions for Zoological Nomenclature, Botanical Nomenclature and Bacteriological Nomenclature have also been supported financially.

The officers of the Union are as follows: *President*, Prof. S. Hörstadius (Sweden); *Vice-President*, Prof. R. E. Cleland (United States); *General Secretary*, Prof. G. Montalenti (Italy); *Secretary*, Prof. R. Ulrich, France (Laboratoire de Physiologie Végétale, 1 rue Victor Cousin, Paris 5e); and *Treasurer*, Prof. A. Linder (Switzerland). Publications of the Union are available from the secretary, Prof. Ulrich. All other communications should be directed to the general secretary, Prof. G. Montalenti, at the headquarters of the Union, Istituto di Genetica, Via Mezzocannone 8, Naples.

CRYSTALLINE BACTERIAL ARRAYS AND SPECIFIC LONG-RANGE FORCES

By Dr. R. J. GOLDACRE

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THE purpose of this communication is to show that, like viruses, some bacteria can be crystallized. The bacterial cells form regular three-dimensional arrays in which each cell corresponds to a molecule in a conventional crystal; with rod-shaped bacteria, the rods are parallel.

This helps to bridge the gap between the microscopic and the molecular. For the first time it is possible to see easily with the light microscope particles which behave in some respects like molecules. This can be done when they are in their natural medium, without drying as required for the electron microscope.

There is reason to think that specific forces may operate over distances much greater than the range of ordinary valency forces. While the work of Rothen[1] remains controversial and has been to some extent disproved[2,3], it is undisputed that in suspensions of bentonite[4], solutions of tobacco mosaic virus[5] and of some other colloidal substances[6], individual particles are under certain conditions held orientated parallel to one another when the distances separating the particles are as large as several hundred angstrom units. The largest spacing so far recorded is 8000 A. in the Schiller layers of iron oxide[7]. As Bernal[8] has said: "There is evidence that between extended particles there are forces which act at distances of the same order as the size of the particles themselves". In the bacterial aggregates to be described the forces appear to operate over distances of 10,000–50,000 A. Regular arrays were obtained both in two dimensions and in three.

(*a*) *Two-dimensional arrays.* During work on *Amoeba proteus* in hanging drops of Chalkley's[9] medium—a very dilute balanced salt solution—it was noticed that fine parallel striations appeared on the surface, especially if the drops were set aside for a few days. These gave brilliant diffraction colours with the light from the condenser, and on close inspection the striations were found to be made up of thousands of parallel bacterial rods. These bacteria occurred naturally in association with the amoebæ and multiplied after the amoebæ cytolysed. Stirring with a micromanipulator disorientated the rods, but after the removal of the needle they rapidly became parallel again. This shows that the orientation was not due to adhesion of the cells after division. Small islands containing about thirty parallel rods sometimes occurred. These were in dynamic equilibrium with the free individual bacteria in the solution, which were highly mobile either due to locomotor organs or lively Brownian movement. Bacteria approaching an island were captured, and snapped parallel to the rest of the group, and others broke free from time to time elsewhere and escaped into the solution. A cell prized off by the micromanipulator by more than 5 μ from the edge of the island would swim away freely in the solution.

In regions of the surface where the cells were not parallel, they could be made to become so by stroking with a micromanipulator needle, and the influence spread far beyond the area stroked. This recalls the scratching technique used by chemists to induce crystallization in a supersaturated solution. A needle placed in the surface of the drop induced the cells to arrange themselves in palisades on each side, the orientation extending outwards for about ten rows or 40 μ before fading out. The tip of the needle by itself induced a radial arrangement, resembling an aster. Similar effects could be produced by fragments of glass, algal cells or other relatively large disturbance of the surface. When two such fragments were within about 80 μ, the appearance of the mitotic spindle was simulated. Tripolar effects could also be obtained.

The side spacing between the rods was commonly about 3 μ, compared with a cell width of about ½–1 μ and a length of 3 μ, but spacings of from one to five microns were sometimes observed with smaller and larger species. The cells were not in contact, for (1) electron micrographs showed no jelly, capsule, flagellæ or other material between them; (2) they could be pushed closer together by the micromanipulator and sprang apart when released; (3) if mobile rods of a smaller species were introduced, they swam up and down between the rows in straight lines without disturbing the structure, or being captured.

The aggregates appear to be the result of a long-range attraction and a shorter-range repulsion. Specificity is suggested by the occurrence side by side of many homogeneous aggregates of different species which separated out from a mixed suspension; and also by (3) above.

Surface tension forces probably account for some, but not all, of the interaction. Some of the effects (parallel orientation, spindles, asters) could be duplicated with human hair, chopped into 1-mm. lengths, floating on water, and by cardboard rods with alternate water-attracting and water-repelling bands, creating a pattern of attraction and repulsion which attracted a similar pattern but in general repelled a dissimilar pattern. But always the bodies came into contact, and surface tension cannot account for (1)

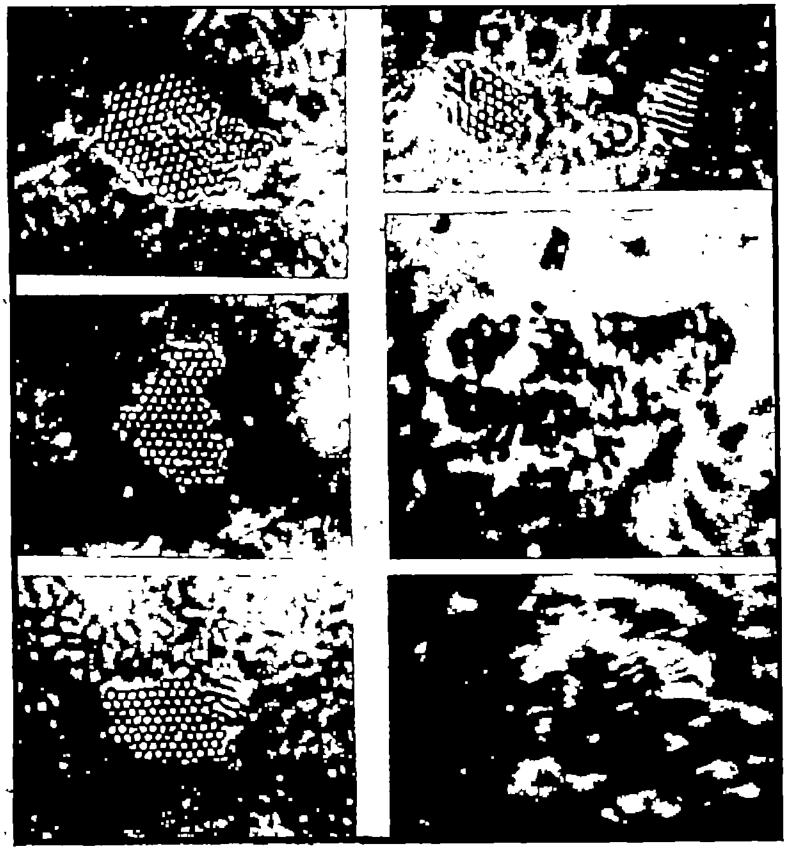

Fig. 1 Three-dimensional bacterial arrays. Left-hand side: end-on view. Right-hand side: side view

the lack of contact of the cells; (2) the fact that some species of bacilli did not orientate parallel (even when alongside others that did), especially if much salt was present (for example, *E. coli* in broth); (3) the occurrence of orientated aggregates in three dimensions, when any forces must act through the medium.

(*b*) *Three-dimensional aggregates.* Attempts to salt-out bacteria with ammonium sulphate (as used by Weibull[10] for bacterial flagellæ) resulted only in disorientated aggregates. Eventually regular three-dimensional aggregates were produced by accident during work on the effect of glycerol on amoebæ. Amoebæ and their associated food organisms were placed in serial dilutions of glycerol in Chalkley's medium in hanging drops, and set aside for a few days. In the range 1·5–3 per cent glycerol, the bacteria were found to have multiplied and in places built up, especially after 2–3 weeks, regular three-dimensional arrays, with the rods arranged parallel and in several layers (see Fig. 1).

All stages were visible, from aggregates of three and four through dozens to hundreds and thousands in dynamic equilibrium with the individual free-swimming ones in the solution. In the same field, the aggregates could be seen end-on (left-hand side of Fig. 1) showing the hexagonal packing of the rods; and sideways on, showing the rows of parallel palisades (right-hand side of Fig. 1); and half end-on, half sideways-on, showing both the ends and the sides of the rods. Focusing up and down showed that the depth of these aggregates was between 10 and 20 μ, corresponding to many layers of cells. The largest aggregate seen was 100 μ long, but it was somewhat twisted, showing that the forces are weak (that is, the crystal is soft). Each crystal had a shimmering or writhing movement, due to thermal agitation of its units or perhaps some residue of suppressed motility. For this reason and owing to the convexity of the sideways-on position, it was difficult to obtain good photographs. By focusing up and down in life the arrangement appears more clearly.

The appearance of the crystals is very similar to electron microscope pictures of virus crystals, for example, tobacco necrosis virus taken by Wyckoff[11], except that the spacing between the bacterial units is about a hundred times greater.

The question arises, should the bacterial arrays be called crystals? This question also arose in connexion with the crystallinity of virus arrays about fifteen years ago. Then Bernal and Fankuchen[8] stated that "crystallinity presupposes an indefinite repetition of identical units in three-dimensional space". The bacterial aggregates fulfil this condition, if one ignores the possible second-order differences within the individual cells. One might add a further stipulation, that the array should result from the mutual attraction of the units, so as to exclude such artificial arrays as pyramids of oranges.

The force required to hold the bacterial arrays together is quite small. A single polypeptide chain has a breaking strength of at least 10^{-4} mgm. weight (calculated from the tensile strength of silk, 30 tons/sq. in.). The weight of a bacterial cell (of volume 1 μ^3) is 10^{-9} mgm., so that a single molecular chain could support the weight of 100,000 bacterial cells, or, allowing for the buoyancy of water, one million bacterial cells. This shows how weak the force between the cells could be compared with a covalent bond.

When subcultures were made from the bacterial arrays in glucose broth, no crystals appeared; but on washing the bacteria and resuspending in 3 per cent glycerol, the crystals formed again. With insufficient washing, three-dimensional spindle-shaped aggregates, up to 100 μ long, containing thousands of approximately parallel cells, were formed on standing.

It is hoped to identify the coliform bacilli which form the arrays and to elucidate those factors in the medium which evoke the force involved. Further details will be published elsewhere.

It seems possible that the forces shown to operate between the bacterial cells may be concerned in various biological processes involving action at a distance of the order of a micron, such as between similar chromosomes at various stages of mitosis and meiosis[12]; between the submicroscopic rod-shaped particles of cellulose which Frey-Wyssling (1952) has shown orientate themselves parallel to one another at the surface of plant cells; between red cells in rouleaux formation; and between orientated fibrils in muscle cells which, when striated, align their bands.

I wish to thank Profs. A. Haddow and J. D. Bernal for their encouragement. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Aug. 11.

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EFFECT OF DEEP AND SHALLOW INCISIONS ON ORGANOGENESIS AT THE FERN APEX

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In earlier studies of the apex of *Dryopteris aristata* (*D. austriaca*), it has been shown that if the I_1 position (that is, that of the next leaf primordium to appear), or the last formed primordium, P_1, is isolated from the apical cell group by a deep tangential incision, so that the pre-vascular tissue is severed, a bud is formed; and if I_1, P_1, P_2 or P_3 are isolated from the adjacent older leaf primordia by deep radial incisions, they rapidly increase in size and outgrow older primordia[1,2]. A leaf primordium originates near the base of the apical cone by the enlargement of an elliptical group of superficial meristematic cells and the active division of the small underlying cells. The evidence thus far obtained supports the view that a leaf site is a well-defined locus of accumulation of substances which promote meristematic activity and growth, and that a primordium will be formed when external conditions are suitable and when the regulative effects of the apical cell-group and of the adjacent older primordia admit. The substances determining rapid growth in leaf sites may be accumulated from the adjacent superficial prism-shaped cells or from the underlying pre-vascular tissue.

The histological evidence is indicative of the movement of metabolites between the superficial cells of the apical meristem and the underlying pre-vascular layer. If the latter tissue affords a path for the rapid translocation of nutrients and growth-regulating substances in the apex, it will clearly have a particular importance in morphogenesis. The hypothesis was entertained that the regulative effect of the apical cell group, and of the two adjacent primordia, on the inception and development of a new leaf primordium is exercised by way of the pre-vascular tissue. This hypothesis has been investigated experimentally by comparing the effects on organ formation of various deep and shallow incisions as indicated in Figs. 1 and 2. In the deep incisions, the pre-vascular tissue was completely severed; in the shallow incisions, only the superficial prism-shaped cells were affected, the pre-vascular tissue remaining intact. The exactitude of the surgical operations was verified in appropriate microtome sections of apices.

The following information has been obtained:

(1) When a deep tangential incision is made on the adaxial side of I_1 (or of a young P_1, and sometimes also early-plastochrone P_2 and P_3[2]), a bud and not a leaf is formed; this bud grows rapidly, relative to the adjacent primordia. When the incision is shallow a leaf is formed.

(2) When I_1 (or P_1, P_2, etc.) is isolated by deep radial cuts from the adjacent older leaf primordia, a leaf primordium develops with an accelerated growth-rate and soon outgrows primordia several plastochrones older. With shallow radial cuts, accelerated growth has not been observed.

(3) Deep and shallow cuts abaxial to I_1, P_1, P_2, etc., are apparently not important from the point of view of organogenesis.

(4) When I_1 or P_1 (and sometimes P_2 and P_3) is isolated by four deep cuts, a bud and not a leaf is formed. When the four incisions are shallow, a normally-growing leaf primordium is formed. This latter result relates to the months of active apical growth. In apices which were operated upon during the earlier and later parts of the growing season, however, a very different result was obtained. When the I_1 position was isolated by shallow incisions no primordium appeared; and P_1 and P_2 similarly

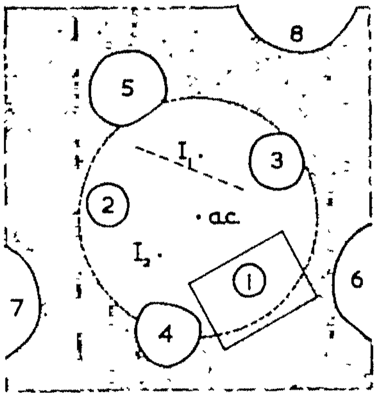

Fig. 1

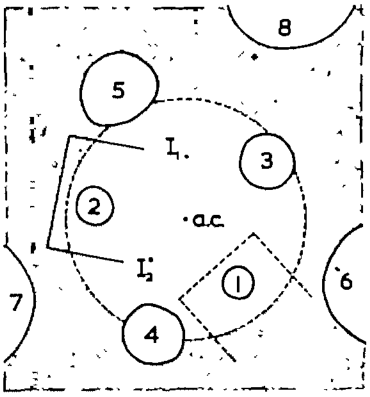

Fig. 2

Fig. 1. Apex of *Dryopteris* as seen from above (diagrammatic). The position of the next primordium to be formed, that is, I_1, has been isolated from the apex by a shallow tangential incision (broken line). Similar deep incisions were also made in other apices. The youngest visible primordium, that is, P_1, has been isolated by four deep incisions (continuous lines), similar shallow incisions being also made in other apices

Fig. 2. Primordium P_1 has been isolated by three shallow incisions, one adaxial, and P_2 by three deep incisions, one abaxial

treated not only failed to grow but gradually disappeared. Primordial growth was, however, usually obtained with a single shallow tangential cut (*see* (1) above).

(5) When early-plastochrone P_1, or P_2, is isolated by four shallow incisions, and the apical cell group of the main axis is punctured, a bud is usually formed.

The hypothesis under consideration, that is, that the regulative action of the apical cell group and adjacent leaf primordia takes place by way of the pre-vascular tissue, is supported by the results obtained. The severance of the pre-vascular tissue leads to important changes in the normal organogenic activity of the apex. Shallow incisions, by contrast, yield no comparable results.

The transformation of an organ of dorsiventral symmetry and ultimately limited growth into one of radial symmetry and potentially unlimited growth, by a simple surgical operation, is of course a remarkable phenomenon for which an explanation must be sought. The suggestion has already been made[1] that the characteristic symmetry and orientation of the leaf, with its limited adaxial growth and extensive tangential and abaxial growth, may be due to the position in which it originates, that is, on the side of the conical apex, together with inhibitional effects proceeding from the apical cell group. The present investigation has shed no new light on this problem; but further experiments directed to this end are in progress. It may here be noted, however, that a deep adaxial incision will not only preclude the basipetal movement of possible growth-inhibiting substances from the apical cell group: it will interfere radically with the whole system of metabolic gradients in the sector of the incision, the more so as a rapid and extensive wound-reaction is a conspicuous feature of injured meristems.

With shallow incisions there was (*a*) a marked wound-reaction and (*b*) the very curious and unexpected disappearance of young primordia at certain times of the year, and the failure of I_1 to appear. It may well be that the latter is directly related to the former, that is, that the rapid formation of wound tissue leads to a dispersal of the substances essential for leaf inception and growth. But since I_1, P_1 or P_2, isolated by deep cuts during the same period, do grow, it may be inferred that the isolated panel has enough of the substance(s) required for organ formation, provided the inhibitive or regulative effects of the apical cell-group and adjacent leaf primordia are eliminated.

The facts that nascent or very young leaf primordia may actually disappear when isolated by shallow incisions, that very young leaf primordia may be induced to develop as buds, and that both leaves and buds may be formed on the same apical meristem when the apical cell has been punctured[3], indicate that the normal fern meristem is a delicately regulated system and that the physiological changes induced in it by some surgical treatment are probably of a radical and far-reaching character.

The investigations briefly outlined here have been carried out in duplicate, that is, by each of the authors using considerable numbers of apices in each experiment and with close observations of each others specimens at critical stages. A fuller account of this work will be given elsewhere. [Sept. 2.

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QUALITATIVE ANALYSIS OF ORGANIC COMPOUNDS BY MASS SPECTROMETRY

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IT is well known that mass spectrometers are extensively used for quantitative analysis of mixtures of known components, but it is not so widely realized that they can also be used for qualitative analysis of unknown substances. The purpose of this communication is to direct attention to the potentialities of the mass spectrometer for this purpose and to describe developments which enhance its power. Like other analytical instruments, the mass spectrometer can be used more easily for identifying a pure substance than a mixture; but it has the advantage that it is usually possible from the mass spectrum of an unknown material to determine whether or not it is a mixture. Since the mass spectrometer can handle milligram quantities of material boiling below about 400° C., vapour phase chromatography offers an ideal method for the separation of mixtures into their component parts prior to analysis.

Qualitative analysis by examination of the mass : charge ratios and relative abundances of the various positive ion species formed when a vapour is bombarded with electrons of about 50 eV. energy is based on empirical relationships derived from examination of large numbers of mass spectra; for example, those collected together by the American Petroleum Institute[1]. Terminal groups can often be identified by characteristic peaks; for example, a large peak at mass : charge ratio 30 is strong evidence in favour of an amine or imine. Information as to the general structure of the molecule is also easily obtained. For example, a large 'parent' peak (corresponding to ionization of the whole molecule without fragmentation) indicates a strong structure such as a ring, and the relative abundances of fragment ions usually enable one to decide whether the ring is resonance-stabilized or not. Alkyl side-chains on an aromatic ring tend to break under electron bombardment at the bond next but one to the ring, giving a positive ion containing the ring, whereas a saturated ring tends to break at the bond joining the alkyl group to the ring. Many similar empirical rules can readily be deduced from published mass spectra.

From an analytical point of view, the molecular weight is perhaps the most useful single item of information obtainable by mass spectrometry, and this is determined by mass measurement of the parent peak. If the substance is known to be a hydrocarbon, the molecular weight leads directly to the empirical formula or, in the case of high molecular weights, to a small number of possible empirical formulæ. Thus a molecular weight of 106 gives an empirical formula of C_8H_{10}, and with the aid of rules of breakdown based on comparison spectra it is a simple matter to limit the molecular formula to a small number of possibilities, which can be investigated separately by the use of reference samples, or known chemical or physical properties. If, however, the material is not known to be a hydrocarbon, a much larger number of possible empirical formulæ

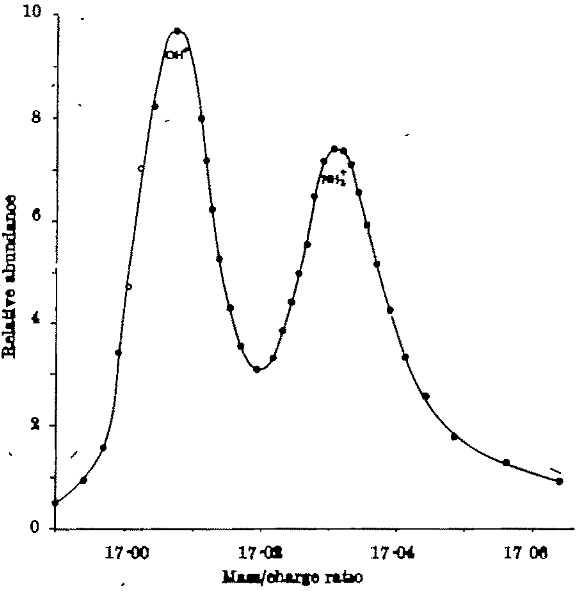


Fig. 1

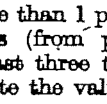
correspond to a given molecular weight, and often the only useful information to be derived from the molecular weight concerns the number of nitrogen atoms, since all organic compounds of carbon, hydrogen, nitrogen, oxygen, sulphur, phosphorus and the halogens having an odd molecular weight must contain an odd number of nitrogen atoms. Since chlorine and bromine have very abundant isotopes, which are two mass numbers heavier than the main isotopes, the number of chlorine and bromine atoms present in an unknown molecule can usually be determined immediately from the strengths of the isotopic peaks. Numerous atomic arrangements can also be written for all but the lightest fragment ions in the mass spectra of non-hydrocarbon compounds and more than one type of ion may contribute to give a multiple but unresolved mass peak. To overcome the consequent difficulties in interpretation of such mass spectra the technique of accurate mass measurement has been devised.

The principle of this technique is to make use of the fact that atomic masses are not exactly integral multiples of a unit mass. Thus $^{12}CH_2{}^+$ and $^{14}N^+$, both nominally of mass 14, actually have masses of 14·0196 and 14·0070 A.M.U. respectively[3], and so on for more complicated combinations of atoms. It follows that if the mass of any ion is measured with sufficient precision, its elemental composition can immediately be deduced, and the mass spectrum of an unknown substance then gives not only the empirical formula, but also a great deal of information about the arrangement of the atoms within the molecule.

In order to apply the method to multiple mass peaks, a mass spectrometer of high resolving power is necessary, and such an instrument, with a resolving power of 2,500, is being built for this work in these laboratories by Metropolitan-Vickers, Ltd. However, it has been found possible to use an existing Nier type mass spectrometer[4] (90° sector type), with a resolving power of about 250, to prove the validity of the method by narrowing the exit slit. The resolving power attainable is shown in Fig. 1, and although peak heights then no longer give an accurate measure of the abundance of any ion species, this is of no importance during the mass measurements. For reference purposes, a mass spectrum is always plotted with the exit slit opened to its normal width before accurate mass measurements are commenced.

The mass measurements are made by scanning from the unknown mass peak to a reference mass peak of known mass by variation of the accelerating voltage at constant magnetic field. A constant fraction of the accelerating voltage corresponding to each mass is read on a Diesselhorst thermo-electric free potentiometer accurate to 1 part in 10^5. Then $m_1/m_2 = V_2/V_1$. Reference samples giving mass peaks of known composition as close as possible to the unknown mass peak or group of peaks are introduced through a separate sample-handling system to serve as mass standards. Several such samples are necessary for mass measurements on a complete mass spectrum. The principal inaccuracies in the measurements arise from three causes. These are errors due to: (1) neglect of the kinetic energy possessed by the ions on formation; (2) variation of either the magnetic field or accelerating voltage during the measurements; and (3) difficulty in setting on the exact summits of the peaks. The first and only systematic error will be eliminated by the use of double focusing in the new instrument, while the second and third inaccuracies will be very much reduced by more stable circuits and sharper-topped peaks. For the present, the first error is kept as small as possible by working at the highest possible accelerating potential (2,000 volts), and none of the mass peaks so far measured has proved to be in error by more than 1 part in 7,000. Measurements on parent peaks (from parent reference peaks) give results at least three times as accurate as this.

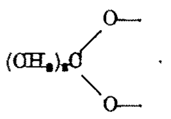
To illustrate the value of the method in deducing the molecular structure from the mass spectrum, accurate mass measurements have been made on the most abundant ionic species in the mass spectrum of α-pyrrolidone. The mass of the parent peak was measured from the parent peak of cyclohexene (82·1040) introduced as a reference, which gave a value of 85·0794. Consideration of the various combinations of carbon, hydrogen, nitrogen and oxygen which can give a nominal molecular weight of 85 then leads directly to the empirical formula. Thus, some of the possibilities are: $C_5H_{11}N^+ = 85·1159$; $C_4H_7NO^+ = 85·0794$; $C_3H_3NO_2{}^+ = 85·0430$; $C_4H_9N_2{}^+ = 85·0907$; $C_3H_5N_2O^+ = 85·0543$. Combinations containing an even number of nitrogen atoms are not included, on account of the odd numbered molecular weight, though their inclusion would lead to no confusion. Lower mass peaks in the spectrum were measured, with the results given in the table.

The fact that the parent peak is the strongest in the spectrum indicates a ring structure; the occurrence of CNO+ ions but not of NO+ ions suggests the presence of a  $-\underset{|}{N}-\overset{O}{\overset{\|}{C}}-$ group, and the ions $C_3H_6N^+$ and $C_3H_6{}^+$ show three adjacent $-CH_2-$ groups. The structure follows immediately.

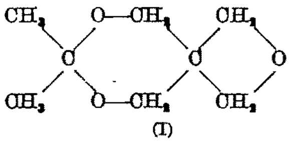
A further advantage of mass measurement appears when the peak of highest mass in the mass spectrum is very weak compared with the next highest peak and, therefore, is easily overlooked. Again, if the strong peak corresponds to an uneven mass, without accurate mass measurement it would be deduced that the compound responsible for it contained an

Reference peak	Nominal mass	Measured masses	Identification
$C_3H_4O^+$ from acetone	56 (triple peak)	56·0323 56·0446 56·0670	$C_2H_2NO^+$ = 56·0310 $C_3H_4O^+$ = 56·0436 $C_3H_6N^+$ = 56·0674
$C_2H_2O^+$ from acetone	42 (quadruple peak)	42·0102 42·0287 42·0538 42·0592	CNO^+ = 42·0109 $C_2H_2O^+$ = 42·0285 $C_2H_4N^+$ = 42·0473 $C_3H_6^+$ = 42·0590
C_2HO^+ from acetone	41 (triple peak)	41·0174 41·0443 41·0503	C_2HO^+ = 41·0158 $C_2H_3N^+$ = 41·0392 $C_3H_5^+$ = 41·0518
O_2^+ from air	30 (triple peak)	30·0169 30·0438 30·0533	CH_2O^+ = 30·0196 CH_4N^+ = 30·0435 $C_2H_6^+$ = 30·0561
CH_4N^+ from unknown	28 (triple peak)	28·0117 28·0268 28·0365	$CO^+ + N_2^+$ (from air) unresolved CH_2N^+ = 28·0272 $C_2H_4^+$ = 28·0398
CH_2N^+ from unknown	27 (double peak)	27·0184 27·0322	CHN^+ = 27·0190 $C_2H_3^+$ = 27·0316

odd number of nitrogen atoms. An example of this is provided by the mass spectrum of 6 : 6-dimethyl-1 : 5 : 7-trioxa-3 : 5-spirononane (I), which was selected as a test of the method. The first strong peak (143) is more than 3,000 times stronger than the parent peak (158), which might easily have been attributed to an impurity. Careful mass measurements on this and other strong mass peaks proved that the compound contained no nitrogen, but three atoms of oxygen. The empirical formula for ions of mass 143 was $C_7H_{11}O_3^+$ and the formula for the complete molecule was assumed to be $C_8H_{14}O_3$, since a prominent peak at mass 15 proved to be CH_3^+. Other peaks at 113 and 86 respectively proved to be $C_6H_9O_2^+$ and $C_5H_{10}O^+$ and clearly represent entirely different modes of fracture of the molecule. Assuming the molecule to be of the form $X + Y + Z$, the two peaks being $X + Y$ and $Y + Z$ respectively, we have $X = C_3H_4O_2$, $Y = C_3H_5$, $Z = C_2H_5O$ giving the dispositions of the carbons and oxygens. Too much reliance is not placed on the hydrogens due to the ease with which they take part in re-arrangements on ionization. A very strong peak at 41 ($C_3H_5^+$) could not have come from the centre of the molecule, so that the molecule is probably ($C_3H_?$) (O_2) ($C_3H_?$) ($C_2H_?O$). A knowledge of the chemistry involved, together with an infra-red spectrum, would usually enable the final step to the complete structure to be taken, while the empirical rules of breakdown referred to at the beginning of this communication suggest the group :

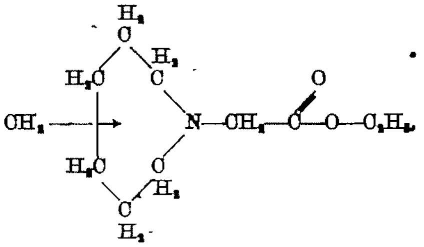


by analogy with similar compounds (for example, 2-methyl-1 : 3-dioxalane) which give very weak parent peaks. In this case the formula is :

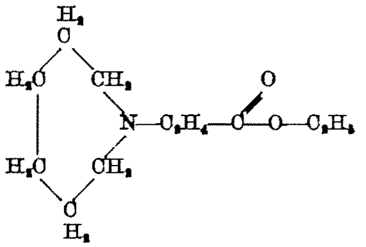


(I)

The compound of unknown constitution of highest molecular weight so far examined by this method was of molecular weight 199. Its structure was deduced by accurate mass measurements alone to be :



the arrow indicating that the position of the CH_3 group on the ring is uncertain. The actual structure was :



Our experience during the past three months has shown the above technique, either alone or in conjunction with infra-red spectroscopy, to be of wide application in the identification of small quantities of unknown organic compounds.

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[1] American Petroleum Institute Research Project 44, "Catalog of Mass Spectral Data", National Bureau of Standards, Washington, D.C.

[2] Ogata, K., and Matsuda, H., *Phys. Rev.*, **89**, 27 (1953).

[3] Graham, R. L., Harkness, A. L., and Thode, H. G., *J. Sci. Instr.*, **24**, 119 (1947).

TOXIC FLUORINE COMPOUNDS

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IN an earlier report[1] we have described the preparation and toxicities of several series of aliphatic compounds containing an ω-fluorine atom ; these included ω-fluorocarboxylates, ω-fluoroalcohols, ω-fluoroaldehydes, ω-fluoronitriles, ω-fluoroamines and ω-fluoro-ω′-nitroalkanes. An attempt was made to correlate the toxicities with known metabolic mechanisms ; in general, it was apparent that those compounds which could give rise *in vivo* to an ω-fluorocarboxylic acid containing an even number of carbon atoms were toxic, whereas all others were innocuous. The present communication gives a further account of the preparation and toxicity of allied compounds. Standard comparison figures and procedures for testing are the same as those described in the earlier report. To avoid ambiguity, fluorine is not generally referred to as a halogen throughout this report.

ω-Fluoroalkyl halides, $F(CH_2)_nX$. Several of the lower members of this series ($n = 2$–5) have already been described[2–4] ; of the preparations reported, the most satisfactory general method involves the partial fluorination of ω,ω′-dihalogenoalkanes using potassium fluoride in diethylene glycol[5].

We have obtained ω-fluoroalkyl halides by the following general routes :

$$(1)\ F(CH_2)_nOH \xrightarrow[\text{or } SOCl_2]{PBr_3} F(CH_2)_nX\ ;$$

$$(2)\ X(CH_2)_nX \xrightarrow{KF} F(CH_2)_nX\ ;$$

$$(3)\ F(CH_2)_nO.SO_2R + KX \rightarrow F(CH_2)_nX + KO.SO_2R\ (R = CH_3{}^- \text{ or } p\text{-}CH_3.C_6H_4{}^-)\ ;$$

$$(4)\ X(CH_2)_nO.SO_2R + KF \rightarrow X(CH_2)_nF + KO.SO_2R\ (R = CH_3{}^- \text{ or } p\text{-}CH_3.C_6H_4{}^-).$$

ω-Fluoroalkyl iodides are most readily prepared by method (3), or by treatment of the corresponding ω-fluoroalkyl chlorides with potassium iodide in acetone; methods (1) and (2) are most convenient for preparing the chlorides and bromides. A fifth general method is mentioned below, under 'anodic syntheses'.

The value of these derivatives lies in the greater stability of the carbon–fluorine bond relative to that of the other carbon–halogen bonds, making it possible to replace the halogen atom by standard reactions without affecting the fluorine atom. They have thus become valuable synthetic intermediates, and from them we have prepared ω-fluoroalkynes, ω-fluoroethers, ω-fluoronitriles, ω-fluoro-ω′-nitroalkanes, ω-fluorothiocyanates and other miscellaneous ω-fluorocompounds. Further reference to their importance in synthetic work will be made below, in connexion with Grignard reactions.

Very few references to the pharmacology of aliphatic monohalogen compounds are available. Ethyl chloride apparently does not form ethyl alcohol when used as a general anæsthetic, and ethyl iodide is very largely recovered unchanged in the urine and respiratory gases when used for testing circulatory rates[4]. If one applies these observations to the 2-fluoroethyl halides, it follows that they would not give rise to fluoroethanol and hence would not be toxic; this conclusion has already been confirmed by previous workers[5] in the case of 2-fluoroethyl chloride and 2-fluoroethyl bromide. In spite of this, we thought that certain representative higher members should be examined because of their more labile halogen, and hence more ready conversion to the corresponding fluoroalcohol. Some results are shown in Table 1.

Table 1

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
2-Fluoroethyl iodide	$F(CH_2)_2I$	23
3-Fluoropropyl bromide	$F(CH_2)_3Br$	> 100
4-Fluorobutyl chloride	$F(CH_2)_4Cl$	1·25
4-Fluorobutyl bromide	$F(CH_2)_4Br$	8·2
4-Fluorobutyl iodide	$F(CH_2)_4I$	5·2
5-Fluoroamyl chloride	$F(CH_2)_5Cl$	32
6-Fluorohexyl chloride	$F(CH_2)_6Cl$	5·8
6-Fluorohexyl bromide	$F(CH_2)_6Br$	12·8
7-Fluoroheptyl chloride	$F(CH_2)_7Cl$	> 100
8-Fluorooctyl chloride	$F(CH_2)_8Cl$	2·3
8-Fluorooctyl bromide	$F(CH_2)_8Br$	20
9-Fluorononyl chloride	$F(CH_2)_9Cl$	> 100
10-Fluorodecyl chloride	$F(CH_2)_{10}Cl$	5·0
11-Fluoroundecyl bromide	$F(CH_2)_{11}Br$	> 100
12-Fluorododecyl bromide	$F(CH_2)_{12}Br$	16

From these figures, it is apparent that the even members are of the same order of toxicity as the corresponding members of the original ω-fluorocarboxylate series. This in turn is good evidence of the ready loss of the halogen in all but the lowest members of the series.

Because of the resistance of the carbon–fluorine bond to hydrolysis, it was expected that the ω,ω′-*difluoroalkanes*, $F(CH_2)_nF$, would be excreted unchanged. Three members were submitted for routine testing and, surprisingly, were found to be moderately toxic. No alternation was apparent on the basis of the L.D. 50 figures: 1,4-difluorobutane ($n = 4$), 19·5 mgm./kgm.; 1,5-difluoropentane ($n = 5$), 12 mgm./kgm.; and 1,18-difluorooctadecane ($n = 18$), 10 mgm./kgm.

ω-*Fluoroalkenes* $F(CH_2)_nCH{=}CH_2$, *and* ω-*Fluoroalkynes*, $F(CH_2)_nC{\equiv}CH$. ω-*Fluoroalkenes* have not been studied extensively hitherto; the only member that we have prepared so far[1] is 11-fluoro-undec-1-ene, $F(CH_2)_9CH{=}CH_2$, which has an L.D. 50 of 9·3 mgm./kgm. It is thus considerably more toxic than 11-fluoroundecanol, 11-fluoroundecyl bromide or ethyl 11-fluoroundecanoate, all of which have an L.D. 50 greater than 100 mgm./kgm., but less toxic than 11-fluoro-1,2-dihydroxyundecane, $F(CH_2)_9CH(OH).CH_2OH$ (L.D. 50, 1·75 mgm./kgm.). It is suggested that some hydroxylation of the double bond occurs *in vivo* giving the dihydroxy-derivative, which is afterwards converted to the toxic 10-fluorodecanal:

$$F(CH_2)_9CH{=}CH_2 \rightarrow F(CH_2)_9CH(OH).CH_2OH \rightarrow F(CH_2)_9CHO.$$

ω-*Fluoroalkynes* can readily be prepared from ω-fluoroalkyl halides by reaction with sodium acetylide in liquid ammonia[6] or from the corresponding ω-chloroalkynes by fluorination with potassium fluoride:

$$F(CH_2)_nX + NaC{\equiv}CH \rightarrow F(CH_2)_nC{\equiv}CH + NaX$$
$$Cl(CH_2)_nC{\equiv}CH + KF \rightarrow F(CH_2)_nC{\equiv}CH + KCl.$$

They form solid metallic derivatives, for example, *bis*-6-fluorohex-1-ynyl mercury, $F(CH_2)_4C{\equiv}C.Hg.C{\equiv}C(CH_2)_4F$; but so far we have been unsuccessful in replacing the acetylenic hydrogen with organic groupings. Because the extreme electronegativity of fluorine leads to a highly polar carbon–fluorine bond, the ω-fluoroalkynes tend to lose fluorine in the presence of reagents such as sodamide and Grignard reagents, rather than undergo the reactions characteristic of the non-fluorinated alkynes. Thus, the reaction of 6-fluorohex-1-yne with sodamide produced an indeterminate mixture of products, and with ethyl magnesium bromide followed by carbon dioxide produced fluorine-free polymers.

It can be seen from Table 2 that the ω-fluorine atom confers toxic properties on the acetylenes.

ω-*Fluoroalkyl thiocyanates*, $F(CH_2)_nSCN$. These compounds were prepared in an attempt to combine the toxic action of the thiocyanate grouping with that of the ω-fluoroalkyl grouping. Two lower members had already been prepared, namely, 2-fluoroethyl thiocyanate[6], $F(CH_2)_2SCN$, and 3-fluoropropyl thiocyanate[7], $F(CH_2)_3SCN$. Since the toxicities of these two members differed only slightly, it was considered likely that the toxicity was associated exclusively with the thiocyanate grouping. To con-

Table 2

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
Hex-1-yne	$CH_3(CH_2)_3C{\equiv}CH$	> 400
6-Fluorohex-1-yne	$F(CH_2)_4C{\equiv}CH$	15
7-Fluorohept-1-yne	$F(CH_2)_5C{\equiv}CH$	20
8-Fluorooct-1-yne	$F(CH_2)_6C{\equiv}CH$	7·5
9-Fluoronon-1-yne	$F(CH_2)_7C{\equiv}CH$	70

Table 3

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
n-Amyl thiocyanate	$CH_3(CH_2)_4SCN$	75
2-Fluoroethyl thiocyanate	$F(CH_2)_2SCN$	15
3-Fluoropropyl thiocyanate	$F(CH_2)_3SCN$	18
4-Fluorobutyl thiocyanate	$F(CH_2)_4SCN$	2·6
5-Fluoroamyl thiocyanate	$F(CH_2)_5SCN$	30
6-Fluorohexyl thiocyanate	$F(CH_2)_6SCN$	5·0

firm this, three adjacent higher members, together with a non-fluorinated member, were prepared[8] from the corresponding halogen compounds by reaction with potassium thiocyanate. Results are shown in Table 3.

It can be seen that, contrary to expectation, the fluorine is essential for high toxicity, and that the even-membered derivatives are again the more toxic. It seemed possible that the thiocyanates were being reduced *in vivo* to hydrogen cyanide and the corresponding mercaptan:

$$F(CH_2)_nSCN + 2H \xrightarrow{\text{hydrogenase}} F(CH_2)_nSH + HCN.$$

This line of reasoning led us to investigate the ω-fluoroalkyl mercaptans, the high toxicity of which added weight to the suggestion.

ω-Fluoroalkyl mercaptans, $F(CH_2)_nSH$. As mentioned in the preceding section, mercaptans were prepared for comparison with the thiocyanates; they are also of interest as the sulphur analogues of the ω-fluoroalcohols. In the initial experiments, the preparation of the ω-fluoroalkyl mercaptans proved to be difficult. The standard reactions, such as interaction of the corresponding bromide with thiourea followed by hydrolysis, gave very low yields. Moreover, the members containing four, five and six carbon atoms tended to cyclize very readily, forming tetrahydrothiophene, tetrahydrothiopyran and hexamethylene sulphide, respectively. From a consideration of the behaviour of the thiocyanates, we decided to simulate the suggested biological reduction by treatment with lithium aluminium hydride. The ω-fluoroalkyl mercaptans were thus obtained[9–10] in 80 per cent yield. The only exception was 4-fluorobutyl mercaptan, which still cyclized to tetrahydrothiophene; accordingly, its acetate, 4-fluorobutyl thiolacetate, was synthesized[10] directly by the following steps:

$$F(CH_2)_4I + AgO.SO_2C_6H_4.CH_3 \rightarrow F(CH_2)_4O.SO_2C_6H_4.CH_3;$$
$$F(CH_2)_4O.SO_2C_6H_4.CH_3 + KSAc \rightarrow F(CH_2)_4SAc + KO.SO_2C_6H_4.CH_3.$$

We had previously shown this method to be satisfactory for the preparation of 2-fluoroethyl thiolacetate.

As can be seen from Table 4, a pronounced alternation is again apparent, with toxicities comparable to those of the ω-fluoroalcohol series. It is possible that those mercaptans with an even number of carbon atoms are toxic due to biological conversion to the corresponding ω-fluoroalcohols by transthiolation $[F(CH_2)_nSH \rightarrow F(CH_2)_nOH]$.

Table 4

Compound	Formula	L.D. 50 for mice (mgm./kgm.)
n-Amyl mercaptan	$CH_3(CH_2)_4SH$	>100
2-Fluoroethyl thiolacetate	$F(CH_2)_2SAc$	56
3-Fluoropropyl mercaptan	$F(CH_2)_3SH$	>100
4-Fluorobutyl thiolacetate	$F(CH_2)_4SAc$	1·8
5-Fluoroamyl mercaptan	$F(CH_2)_5SH$	>100
6-Fluorohexyl mercaptan	$F(CH_2)_6SH$	1·25

ω-Fluoroalkanesulphonyl chlorides and fluorides, $F(CH_2)_nSO_2X$. The ω-fluoroalkanesulphonic acids, $F(CH_2)_nSO_3H$, are the sulphonic acid analogues of the ω-fluorocarboxylate series, $F(CH_2)_nCOOH$, and the two classes thus bear a superficial resemblance to one another. In order to compare the effects of the two classes, representative derivatives of the former were prepared and tested. It has been reported that *n*-alkanesulphonic acids are non-toxic[11] and are excreted unchanged by the dog[12]; hence no great activity was anticipated for the ω-fluoro-derivatives. Two members of the sulphonyl chloride series had been prepared previously, 2-fluoroethanesulphonyl chloride[6], $F(CH_2)_2SO_2Cl$, and 3-fluoropropanesulphonyl chloride[7], $F(CH_2)_3SO_2Cl$; but toxicity determinations on these derivatives were indefinite. We prepared[10,13] the members listed in Table 5 by two general routes:

$$(1)\ F(CH_2)_nX \xrightarrow{\text{KCNS}} F(CH_2)_nSCN \xrightarrow{\text{Cl}_2\text{ aq.}} F(CH_2)_nSO_2Cl \xrightarrow{\text{KFHF}} F(CH_2)_nSO_2F;$$

$$(2)\ F(CH_2)_nOH \xrightarrow{\text{TsCl}} F(CH_2)_nOTs + S{=}C(NH_2)_2 \rightarrow [F(CH_2)_nS.C(NH_2) = NH_2]^{+}{}^{-}OTs$$
$$(Ts = p\text{-}CH_3.C_6H_4SO_2—)$$
$$\xrightarrow{\text{Cl}_2\text{ aq.}} F(CH_2)_nSO_2Cl \xrightarrow{\text{KFHF}} F(CH_2)_nSO_2F.$$

From an examination of the toxicity results so far available, it can be seen that the sulphonyl chlorides exhibit a definite alternation in toxicity. This suggests that β-oxidation of the sulphonyl chlorides may occur, a point which is being investigated further by the preparation and study of related compounds. On the other hand, little or no correlation between structure and toxicity is apparent in the case of the sulphonyl fluorides; such activity as they possess may be connected with cholinesterase inhibition[14].

Table 5

Value of *n* in $F(CH_2)_nSO_2X$	L.D. 50 for mice (mgm./kgm.)	
	X = Cl	*X* = F
2	< 10	—
3	64	84
4	18	10
5	> 100	88
6	9	45
$CH_3(CH_2)_5SO_2X$	> 100	70

Miscellaneous ω-fluoro sulphur compounds. Methyl and ethyl fluorothiolacetate, $FCH_2CO.SR$ ($R = CH_3—$ and $C_2H_5—$), were prepared for enzyme studies. Both had a toxicity very similar to that of methyl fluoroacetate. This is readily explained by hydrolysis *in vivo* to the toxic fluoroacetate ion.

ω-Fluoroalkyl methanesulphonates, benzenesulphonates and *p*-toluenesulphonates were prepared as intermediates for other syntheses. Three general methods of preparation were used:

$$(1)\ F(CH_2)_nOH + ClSO_2R \rightarrow F(CH_2)_nO.SO_2R + HCl \quad (R = CH_3—,\ C_6H_5—,\ p\text{-}CH_3.C_6H_4—)$$

$$(2)\ F(CH_2)_nOH + FSO_2R \rightarrow F(CH_2)_nO.SO_2R + HF \quad (R = CH_3—,\ p\text{-}CH_3.C_6H_4—);$$

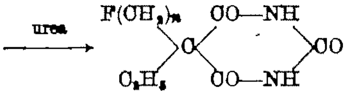
$$(3)\ F(CH_2)_nX + AgO.SO_2R \rightarrow F(CH_2)_nO.SO_2R + AgX \quad (R = CH_3—,\ p\text{-}CH_3.C_6H_4—).$$

It is of interest that both 2-fluoroethyl and 3-fluoropropyl methanesulphonate were non-toxic (L.D. 50, > 100 mgm./kgm.); since the two parent fluoro-alcohols show a marked difference of toxicity, the conclusion may be drawn that at least the 2-fluoroethyl derivative is not readily hydrolysed *in vivo*. On the other hand, the fact that 4-fluorobutyl methanesulphonate had an L.D. 50 of 1 mgm./kgm. suggests that hydrolysis of this member is occurring, giving rise to the toxic 4-fluorobutanol.

Compounds of Biological Interest

Two *fluorinated barbiturates*, 5-ethyl-5-(4′-fluorobutyl)-barbituric acid (fluoroneonal) and 5-ethyl-5-(5′-fluoroamyl)-barbituric acid, have been prepared[14] for comparison with the non-fluorinated materials. Their synthesis was carried out as follows:

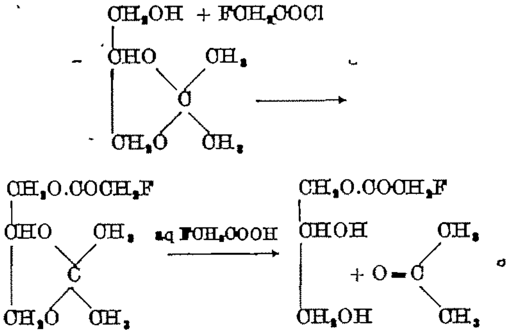
$$F(CH_2)_nX + NaCEt.(COOEt)_2 \rightarrow F(CH_2)_nCEt.(COOEt)_2$$



(n = 4 and 5; X = Br or I).

Their activity as central nervous depressants was considerably less than that of their non-fluorinated analogues and their toxicity was relatively low. These conclusions have been confirmed recently by Bruce and Huber[15], who prepared various 5-(3′-fluoropropyl)- and 5-(5′-fluoroamyl)-barbituric acids; they concluded that the products were less effective than the non-fluorinated analogues. The intermediate fluoro-esters obtained in our syntheses were non-toxic.

Chenoweth has reported[16] that glyceryl 1-monoacetate (monoacetin) is effective in offsetting the symptoms of fluoroacetate poisoning. If a reason for this therapy is the liberation of a particularly active 'C_2 fragment' for competition with fluoroacetate, then it follows that *glyceryl 1-monofluoroacetate* (fluoromonoacetin) might give rise to a particularly active 'fluoro-C_2 fragment', with resultant enhancement of toxicity or speed of action. This was prepared by an unequivocal route, and was found to be neither more toxic (L.D. 50 for mice, 12 mgm./kgm.) nor faster acting than methyl fluoroacetate.



Glyceryl tris-monofluoroacetate (fluorotriacetin), prepared for comparison with fluoromonoacetin, was found to be rather more toxic (L.D. 50 for mice, 6·7 mgm./kgm.) but otherwise did not differ in its effects.

For comparison with oxalacetic acid, *diethyl fluoro-oxalacetate*, $C_2H_5OOC.CHF.CO.COOC_2H_5$, was prepared[10] by a Claisen condensation of ethyl fluoroacetate and diethyl oxalate; it was found to be non-toxic (L.D. 50, > 400 mgm./kgm.).

Fluorinated esters and ethers are being screened for insecticidal properties. The following compounds have already been tested: fluoroethyl valerate, caproate, caprylate, pelargonate, caprate, laurate, tridecanoate, myristate, palmitate, stearate, oleate and benzoate; octyl, decyl, undecyl, dodecyl, tetradecyl, hexadecyl, octadecyl, undecylenyl and phenyl fluoroacetates; methyl 5-fluoroamyl ether, methyl 6-fluorohexyl ether, 1,2,2,2-tetrachloroethyl 2′-fluoroethyl ether and 2-fluoroethyl 2′-butoxyethyl ether.

Work is proceeding on the synthesis of fluorinated analogues of other drugs and metabolites; these are being examined for activity in the treatment of specific diseases. Other compounds are being prepared in which the fluorine will be used as a 'tag' in biochemical and pharmacological studies. Full details of these phases of this work will be reported at a later date.

Preparation of Monofluoro Compounds

A survey of the literature has shown that general methods of preparation of monofluorinated organic compounds have never been the object of an extensive investigation. This problem is now under review with special emphasis on metal fluorides, solvents, type of halogen, temperature and other reaction conditions.

At the present time the introduction of the fluorine atom is most readily carried out by the reaction of potassium fluoride with the corresponding halogen compound. The technique for this reaction is dependent on the stability and on the quantity of the material to be fluorinated. In general, the most satisfactory method involves heating with excess potassium fluoride in ethylene glycol or diethylene glycol with vigorous stirring[3,17,18]; acetamide has recently been reported as an alternative solvent for the reaction[19]. The product can be continuously distilled from the reaction mixture, or the heating may be carried out under reflux with subsequent isolation of the product. By modifications of temperature and concentrations, yields of 40–70 per cent are obtained. If the product or reactants are unstable in hydroxylic solvents, the reaction may be carried out in a stainless steel autoclave under anhydrous conditions using vigorous stirring and no solvent; however, only a limited number of compounds can be fluorinated satisfactorily by this method, and the large volume of our reaction bomb makes it useless for small-scale exploratory runs, particularly those involving expensive or rare intermediates.

When halogen exchange was not practicable, we have prepared[10] monofluoro compounds from alkyl sulphonates by treatment with potassium fluoride according to methods of earlier workers[4,20]. The alkyl sulphonates were originally prepared from the corresponding alcohols by reaction with sulphonyl chlorides in the presence of pyridine or sodium hydroxide:

$$R.OH + ClSO_2R' \rightarrow R.SO_2R' + HCl;$$

$$RO.SO_2R' + KF \rightarrow RF + KO.SO_2R'$$

(R', aliphatic or aromatic).

For satisfactory yields in the potassium fluoride cleavage, it is advantageous to exclude all traces of sulphonyl chlorides and ionic chloride. Consequently, we developed a modified preparation of the alkyl sulphonates to avoid these impurities: this involves treatment of an alcohol with a sulphonyl fluoride, in the presence of excess anhydrous potassium fluoride to remove the resultant hydrogen fluoride as potassium bifluoride. Excellent yields (90–95 per cent) of alkyl sulphonates were thus obtained. The advantages of carrying out the sulphonation and fluorination as a one-step process are being investigated.

We have made use of anhydrous hydrogen fluoride to a limited extent in a variety of reactions such as addition to unsaturated compounds and opening of cyclic ethers. In certain specific reactions, different metal fluorides have been employed; of these, silver fluoride is particularly useful for small-scale trial fluorinations of relatively stable halogen compounds. Zinc fluoride is convenient for forming acyl fluorides. The use of potassium bifluoride for forming sulphonyl fluorides has been mentioned earlier in this article.

The carbon–fluorine bond is stable to most reagents. Thus the functional groups of ω-fluoro compounds undergo a wide variety of reactions, such as replacements, oxidations and reductions, without simultaneous loss of fluorine. Many of these have been mentioned throughout these reports, but two general synthetic routes are worthy of comment here:

(*a*) *Grignard reactions.* The potentialities of ω-fluoroalkyl Grignard reagents, $F(CH_2)_nMgX$, are great, since they offer a simple and direct route to a large number of complex and otherwise inaccessible ω-fluoro compounds. Hoffmann[3] reported that although the ω-fluoroalkyl bromides appeared to react normally with magnesium and dry ether, the only products obtained were devoid of fluorine. Accordingly, it was postulated that transitory formation of the Grignard reagent resulted in preferential loss of magnesium fluoride. More recently, we reported[6] preliminary experiments using 11-fluoroundecyl bromide in which normal Grignard formation and reactions appeared to occur. We have now re-examined this problem, and have proved that, by very careful control of the initiation of Grignard formation and of conditions for subsequent replacements, the normal reactions can be made to take place[10]; for example:

$$F(CH_2)_6X \rightarrow F(CH_2)_6MgX \xrightarrow[-80°\,C.]{CO_2} F(CH_2)_6CO.OMgX \xrightarrow{hydr.}$$

$$F(CH_2)_6COOH \text{ (64 per cent overall yield).}$$

A systematic study is being undertaken to determine the effect of different chain-lengths, of different halogens, of different metals, of variations in conditions and of different types of Grignard reactions.

(*b*) *Anodic syntheses.* Except for one very recent reference[21], no mention appears in the literature of the Kolbe electrolytic coupling with any type of halogen-containing acid, other than halogenated acetic acids. As a preliminary study, we have developed[10] a route to ω,ω′-dihalides from ω-halogenoacids (*c.* 50 per cent yield). Thus 3-chloropropionic acid forms 1,4-dichlorobutane and 5-chlorovaleric acid forms 1,8-dichlorooctane:

$$2\ Cl(CH_2)_nCOOH \rightarrow Cl(CH_2)_{2n}Cl + 2\ CO_2 + H_2.$$

The dihalides on partial fluorination yield the corresponding ω-fluoroalkyl halides.

ω-Fluoroacids undergo this same type of reaction; for example, 10-fluorodecanoic acid forms 1,18-difluorooctadecane (69 per cent yield). We have now applied the method to mixed couplings of the following types:

$$F(CH_2)_nCOOH + HOOC(CH_2)_mCOOR \rightarrow F(CH_2)_{n+m}COOR + 2\ CO_2 + H_2;$$

$$F(CH_2)_nCOOH + HOOC(CH_2)_mCl \rightarrow F(CH_2)_{n+m}Cl + 2\ CO_2 + H_2.$$

Thus, 10-fluorodecanoic acid with methyl hydrogen sebacate forms methyl 18-fluorostearate, and with 5-chlorovaleric acid forms 13-fluorotridecyl chloride.

Summary. Representative members of various chemical species containing an ω-fluorine atom have been prepared and tested on mice by subcutaneous injection; chemical classes described in this article include ω-fluoroalkyl halides, ω-fluoroalkenes and ω-fluoroalkynes, ω-fluoroalkyl thiocyanates, ω-fluoroalkyl mercaptans, ω-fluoroalkanesulphonyl chlorides and fluorides, miscellaneous ω-fluoro sulphur compounds, and certain fluorinated analogues of significant pharmacological compounds. An attempt has been made to correlate the toxicities with known metabolic mechanisms: the results and conclusions exemplify a simple and clear-cut method of demonstrating *in vivo* conversions of certain functional groups in aliphatic compounds. The preparation and synthetic uses of these fluorine compounds have been surveyed briefly. Full details of preparation, physical constants and analytical data, together with a more complete bibliography, will be presented in the appropriate journals in due course.

We are indebted to the Defence Research Board of Canada for funds to provide salaries, chemicals and apparatus (Contract DRB *X*-24) and for permission to publish this work (DRB Report No. SW-1). We are very grateful to Drs. M. K. McPhail and F. C. G. Hoskin and Mr. P. A. Adie, Suffield Experimental Station, Ralston, Alberta, for carrying out the toxicity determinations, and to Dr. F. E. Shideman, University of Wisconsin, for testing the fluorobarbiturates as central nervous depressants. The following have collaborated in this work: G. M. Brown, R. R. Fraser, W. C. Howell, W. C. McMurray, J. E. Millington, J. J. Norman, J. B. Stothers and R. W. White. [May 3.

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LETTERS TO THE EDITORS

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Growth-regulating Activity of Certain 2 : 6-Substituted Phenoxyacetic Acids

In recent studies[1–4] of the mechanism of action of plant growth-regulating compounds it has been postulated that active phenoxyacetic acids become attached at two points to a specific substrate within the cell, the points of attachment being the carboxyl group and a position in the ring *ortho* to the side-chain. So far, phenoxyacetic acids substituted in the 2- and 6-ring positions have not been regarded as active in the *Avena* straight-growth test. On the basis of other tests it has been put forward that high activity in chlorophenoxyacetic acids is associated with the presence of two unsubstituted positions in the ring *para* to each other. It has also been claimed that 2 : 6-dichlorophenoxyacetic acid and 2 : 4 : 6-trichlorophenoxyacetic acid are not themselves active but behave as anti-auxins. That is, when these compounds are mixed with either indolylacetic acid or 2 : 4-dichlorophenoxyacetic acid the resulting stimulation in extension growth of *Avena* coleoptiles is less than that induced by indolylacetic acid or 2 : 4-dichlorophenoxyacetic acid alone. Evidence of this type has led to the proposal that 2 : 6-substituted compounds have only a single point of attachment to the substrate and act as anti-auxins by blocking one of the two-point attachments of other more active compounds. From experiments carried out in this Department, however, it is now clear that the interpretation of the above results requires further consideration.

Table 1. Activity of some 2 : 6-Substituted Phenoxy Acids in the Went Pea Curvature Test and *Avena* Extension Growth Test. Measurements after 24 Hours

Compound	Split pea stems		*Avena* coleoptiles	
	Optimum conc. (molar)	Max. degree curvature	Optimum conc. (molar)	Max. ext. growth % of control
2 : 4-Dichlorophenoxy-acetic acid	5×10^{-6}	304	5×10^{-6}	140
2 : 6-Dichlorophenoxy-acetic acid	$1·25 \times 10^{-4}$	228	—	—*
,, -propionic acid	$2·5 \times 10^{-5}$	286	10^{-4}	60
,, -butyric acid	5×10^{-5}	210	$2·5 \times 10^{-4}$	60
2 : 6-Dimethylphenoxy-acetic acid	6×10^{-4}	43	—	—*
,, -propionic acid	$2·5 \times 10^{-4}$	146	$7·5 \times 10^{-4}$	24
,, -butyric acid	5×10^{-5}	211	$2·5 \times 10^{-4}$	24
,, -valeric acid	5×10^{-5}	114	—	—*
2 : 4 : 6-Trichlorophenoxy-acetic acid	$2·5 \times 10^{-4}$	73	—	—*
-propionic acid	$2·5 \times 10^{-5}$	117	—	—*
2-Methyl-4 : 6-dichlorophenoxy-acetic acid	$1·5 \times 10^{-4}$	67	—	—*
,, -propionic acid	$2·5 \times 10^{-5}$	153	—	—*

* No statistically significant increase in extension growth

A series of 2 : 6-substituted phenoxyacetic acids with alkyl substitutions in the side-chain was synthesized and tested over a wide concentration-range in the Went pea curvature and *Avena* straight-growth tests. The results for curvature and extension growth after the conventional period of twenty-four hours are given in Table 1.

All the compounds induced curvature in the pea test and in every case substitution of methyl or ethyl groups in the side-chain resulted in an increase in activity. Only the α-methyl and α-ethyl substituted acetic acids of the 2 : 6-dichloro- and 2 : 6-dimethyl-phenoxy acids induced a statistically significant increase in straight growth in the *Avena* test. The fact that activity can be obtained when electropositive (chlorine) or electronegative (methyl) substituents are present in the ring is not in accord with previous electronic considerations of growth-regulating activity.

On the basis of the data recorded at the end of twenty-four hours none of the acetic acids which were unsubstituted in the side-chain induced extension growth of the *Avena* coleoptile. However, when measurements are made at intervals of 2, 4, 6, 9, 12 and 24 hr. different conclusions are reached. At a concentration of 125 p.p.m. of the 2 : 6-dichlorophenoxyacetic acid, extension growth was increased over that of the controls by 39 and 21 per cent at the end of 4 and 6 hours respectively, followed by growth inhibition at 9, 12 and 24 hours. On the other hand, no positive response was obtained with the 2 : 6-dimethyl-, 2 : 4 : 6-trichloro- or 2-methyl-4 : 6-dichlorophenoxyacetic acids.

Experiments carried out with segments of pea internodes have shown that extension growth is directly proportional to water uptake[5]. Using the latter as a measure of growth, it was found that 2 : 6-dimethylphenoxyacetic acid between 200 and 1,000 p.p.m. brought about a statistically significant increase in water uptake over that of controls after 4 and 6 hours, whereas no increase was apparent in measurements made at other time-intervals up to 24 hours.

When measured droplets of any of these compounds were applied to the adaxial surface of the first pair of leaves of four-leaf sunflower seedlings, it was found that concentrations more than two hundred times that of 2 : 4-dichlorophenoxyacetic acid were required to give a similar growth response. Such differences suggest that although these compounds are active when they have reached the site of action, they may penetrate slowly or are not readily translocated.

It would seem clear, therefore, that 2 : 6-substituted phenoxyacetic acids can no longer be simply classified as inactive compounds or as anti-auxins.

Further details of this work are being published elsewhere.

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Stimulation of the Discharge of Gametangia from a Brown Alga by a Change from Light to Darkness

While studying the polarity of the *Fucales* egg, I observed in 1951 that isolated receptacles of *Pelvetia fastigiata* could usually be stimulated to discharge gametangia by exposure to a brief period of darkness following a longer period of illumination. Thenceforth, gametes of *Pelvetia* have been obtained routinely by this means. It was further observed, especially at lower temperatures, that the shedding stimulus was sometimes transmitted from one region of a receptacle to another. Since no similar observations on algae have been published, and since the *Fucales* egg is an attractive object for embryological investigation, a brief report may be of interest.

Material was collected at Corona del Mar, California. Mature receptacles were cut free at their bases, brought indoors, and allowed to become air-dry until liquid was no longer visible upon them. Then they were placed inside a covered jar which was in turn inside an ice-cooled 'Thermos' jug and transported to the Earhart Plant Research Laboratory in Pasadena, where they were stored in closed jars, still dry, in the dark, and at 6° C. Even after more than two weeks of such storage, receptacles have yielded gametes which united to form zygotes showing more than 95 per cent normal germination.

The light–dark response was found to be weak or absent in receptacles stimulated before two or three days of such storage. Therefore, after at least two days of such storage, receptacles were transferred to sea-water at 16° or at 9° C. and were illuminated by about 500 ft.-candles of white light free from infra-red radiation. Receptacles that had been stored for relatively long times often extruded some gametangia while being illuminated, but such shedding did not affect the subsequent response to darkening.

Receptacles that were transferred to darkness after two hours of illumination did not respond; but those transferred after four or more hours of illumination usually began to shed eggs rapidly within ten minutes and yielded up to 10,000 eggs per receptacle within half an hour. Examination of the process of gamete liberation with a hand lens showed the oogonia being ejected from each ostiole one at a time, often succeeding each other so rapidly as to form long rows like green beads on a string. No upper limit to the effective light period was found; darkening after as long as 450 hr. of illumination evoked shedding in the usual manner. A dark period as short as 3 min. followed by a return to the original illumination brought forth the usual shedding ten minutes later. Thus shedding may be induced by a dark period so short that the discharge of gametangia begins and continues in the light.

In some experiments receptacles were illuminated in the usual way, and then only about one-half (basal or apical) of each receptacle was darkened, the other end remaining undisturbed in the same light. The darkened ends of the receptacles responded by discharging gametangia as usual and in many cases the other, still illuminated, ends also responded. This transmission of the shedding stimulus was observed to occur to a very much greater degree among experiments conducted at 9° C. than at 16° C.

I am indebted to Dr. Frits Went and to Dr. Anton Lang for their encouragement and aid in preparing this communication and to Dr. Gilbert Smith for identifying the species used. The work reported was carried out while I held a United States Atomic Energy Commission predoctoral fellowship.

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Abnormal Growths associated with Wool Follicles in Sheep

Burns and Clarkson[1] described 'capsules' in sheep skin which, when traced up towards the skin surface, were apparently degenerate follicles. Similar roughly spherical bodies have now been seen free in the dermis. These usually had lumina like the 'capsules' mentioned above and, although smaller, could presumably have arisen from degenerate follicles by disruption at a point on the longitudinal axis of the follicle. Thus, when in samples taken at different ages from various sheep breeds, these bodies were observed attached to the base of an otherwise normal follicle, usually not far above the bulb (Fig. 1), they were thought to have become secondarily attached. However, in this figure the connective tissue sheath can be seen to be split and 'pushed away' from the follicle, and in preparations stained with cyanol to show blood vessels[2] the capillary network of the follicle has been seen to extend around these bodies. This suggests that the body had, in fact, been formed as an outgrowth from the follicle and had not become secondarily attached. When one was seen in a sheep vibrissal follicle within the blood sinus, the suggestion of secondary attachment seemed untenable.

In Figs. 2 and 3 this body can be seen to be attached by a long stalk to the outer root sheath immediately below the sebaceous gland. In this instance one can see in the body a series of concentric zones having the appearance of stratum corneum. These are arranged around a spheroidal centre of homogeneous appearance which apparently contains some melanized granules. Most of the bodies, however, contain a lumen which in many instances appears to be collapsed. It is possible, therefore, that some of the bodies seen free in the skin represent outgrowths which have become detached from the follicle, and are not proximal parts of degenerate follicles. In

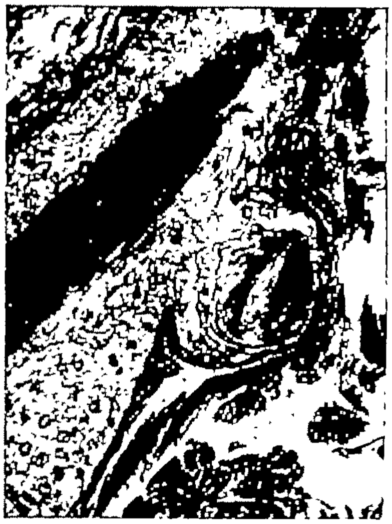

Fig. 1. Abnormal body attached to wool follicle. × c. 265

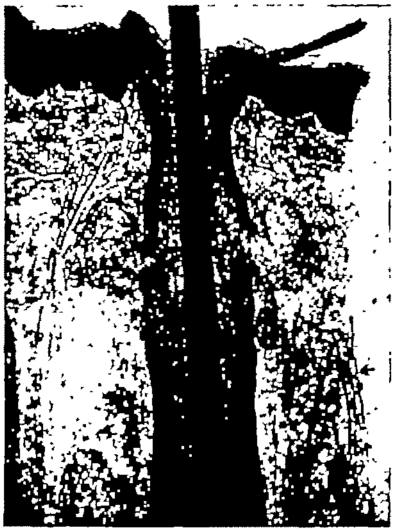

Fig. 2. Vibrissal follicle with an abnormal body. Wall of the sinus is indicated by an arrow. 150 µ frozen section. × c. 65

at least one large 'capsule' with a lumen, which may have arisen as an 'outgrowth' or from a degenerate follicle, foreign body giant cells were observed. This tends to support the suggestion that bodies with a lumen represent a later stage than those containing a central spheroid. The structures described here are smaller in size than the 'capsules' of Burns and Clarkson[1]; they are most comparable with their 'type D capsule' in which a second lumen exists for a distance up the follicle. Thus their 'type D capsule' may be identical with the bodies seen here, and may not fit in with the series of degeneration they suggested.

Certain stages of the cysts produced experimentally by Wolbach[3] in the mouse appear to be of a similar relative size to the 'capsules' of Burns and Clarkson and apparently have the same origin from an entire region of a follicle and not from an appendage.

Pinkus[4] described outgrowths of the human follicle wall in which there were keratinized 'beads'; he did not mention a lumen as observed here. It is interesting that a lumen might arise independently from the follicle lumen, and that keratinization morphologically comparable with stratum corneum might arise independently from the skin surface, as appears to happen in the formation of hair canals (cf. Wildman's[5] Plate 2). On the other hand, laminæ similar to stratum corneum might arise by re-absorption of solid keratinous structures[6].

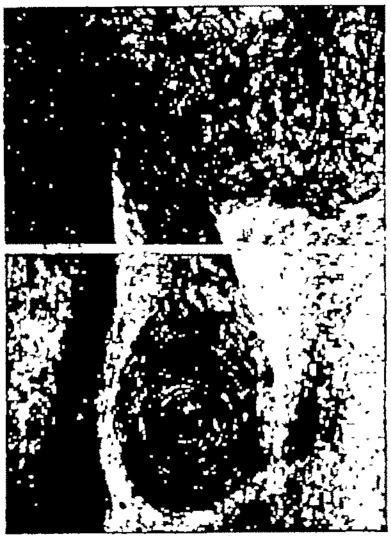

Fig. 3. Higher power photomicrographs of the body in Fig. 2. The upper one is at a focus level showing the attachment to the follicle wall beneath the sebaceous gland. The lower one shows the internal structure. × c. 300

One of us (M. L. R.) is studying the blood supply to follicles, hence the preparations to show the blood sinus of vibrissal follicles. It is noteworthy that in contrast to some other mammals (cf. Davidson and Hardy[7]) the vibrissal follicles of sheep lack a ringwulst (Fig. 2).

We are indebted to Dr. G. M. Bonser, of the School of Medicine, Leeds, for a most helpful discussion of these observations.

Our thanks are due to the Council of the Wool Industries Research Association for permission to publish these observations, also to Mr. H. M. Appleyard and Miss M. E. A. Perkin for preparing the photomicrographs.

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Biological Acetylation of Isoniazid

In the course of investigations involving sulphonamide acetylation it was observed that the acetylation of sulphanilamide by pigeon liver extracts was markedly inhibited by isoniazid (isonicotinylhydrazide) (unpublished results). By means of the procedure of Lineweaver and Burk[1] the inhibition was found to be competitive in nature. The probability that the inhibition was of the competing substrate type was increased by the recent findings of Hughes[2] and others[3] that, following the administration of isoniazid to man and monkeys, 1-isonicotinyl-2-acetylhydrazine appears in the urine. It has now been found that isoniazid is readily acetylated by pigeon liver extract, and that substances which inhibit sulphanilamide acetylation also inhibit the acetylation of isoniazid.

Acetone-dried pigeon liver was prepared as previously described[4]. The dry powder was extracted by grinding in a mortar for 5 min. with a medium

Table 1. ACETYLATION OF ISONIAZID BY PIGEON LIVER EXTRACT

Additions	Isoniazid recovered (µgm.)	Isoniazid acetylated (µgm.)	(per cent)
None	316	4	1
Adenosine triphosphate	266	54	17
,, + acetate	141	179	56
,, + citrate	178	142	44

Vessel components, pigeon liver extract 1 ml. (corresponding to 60 mgm. of acetone powder), potassium phosphate buffer, pH 7·4, 0·02 *M*, isoniazid initially added 320 µgm.; other additions as indicated. adenosine triphosphate 0·004 *M*, potassium acetate 0·02 *M*, potassium citrate 0·02 *M*. All concentrations are final in a total volume of 3 ml.; 90 min. incubation at 37° C.

Table 2 INHIBITION OF ISONIAZID AND SULPHANILAMIDE ACETYLATION IN PIGEON LIVER EXTRACTS

Exp. No.	Additions	Isoniazid acetylated (μM)	Inhibition of isoniazid acetylation (per cent)	Sulphanilamide acetylated (μM)	Inhibition of sulphanilamide acetylation (per cent)
1	Isoniazid	1·51	—	—	—
	Sulphanilamide	—	—	0·90	—
	Isoniazid, sulphanilamide	1·05	30	0·30	68
2	Sulphanilamide	—	—	1·22	—
	Sulphanilamide, p-aminosalicylate	—	—	0·76	38
	Sulphanilamide, 6-aminonicotinamide	—	—	0·70	43
3	Isoniazid	1·12	—	—	—
	Isoniazid, p-aminosalicylate	0·60	46	—	—
	Isoniazid, 6-aminonicotinamide	0·58	48	—	—

Vessel components: 1 ml. of pigeon liver extract (corresponding to 60 mgm. acetone powder); 60 μM potassium phosphate buffer (pH 7·4); 60 μM acetate; 60 μM citrate; 6 μM adenosine triphosphate; other additions as indicated: Exp. 1, 2·92 μM isoniazid; 2·61 μM sulphanilamide; exps. 2 and 3, 2·33 μM sulphanilamide; 2·33 μM isoniazid; 3 μM p-aminosalicylate; 3 μM 6-aminonicotinamide. Total volume 3 ml.; 90 min. incubation at 37° C.

composed of 0·09 *M* potassium fluoride and 0·06 *M* potassium chloride in the proportion of 60 mgm. powder per ml. of extraction medium. The supernatant obtained after centrifugation at 3,000 r.p.m. for 20 min. was used as the source of acetylating enzyme.

Sulphanilamide was estimated by the method of Bratton and Marshall[5]. A modification of the chlorodinitrobenzene method of Scott[6] was used for the estimation of isoniazid. Acetylated isoniazid, which does not react with the colour reagent, was determined as the difference between the control and incubated samples. This method will be described in detail elsewhere.

As shown in Table 1, isoniazid, when incubated with pigeon liver extract in the absence of adenosine triphosphate, was almost quantitatively recovered. This indicates that isoniazid is not destroyed by pigeon liver extract and that its disappearance, therefore, can safely be attributed to conjugation. The addition of acetate and adenosine triphosphate to the system resulted in the acetylation of 56 per cent of the isoniazid initially added. Citrate as an acetyl precursor[7] was less effective than acetate. The slight acetylation which takes place upon the addition of adenosine triphosphate alone is undoubtedly due to residual acetate or acetyl precursors in the crude extract. From the point of view of acetylation, isoniazid and sulphanilamide when present together are mutually inhibitory. Thus, when 2·92 μM of isoniazid and 2·61 μM of sulphanilamide were added to the system (Exp. 1 of Table 2), a lower amount of each was acetylated than when either was present separately. This suggests that the same enzyme may be involved in the acetylation of both compounds. The same suggestion may be found in the fact that *p*-aminosalicylate and 6-aminonicotinamide inhibit the acetylation of both isoniazid and sulphanilamide (Exps. 2 and 3, Table 2).

Hughes[2] has discussed the chemotherapeutic significance of isoniazid acetylation. The inhibition of isoniazid acetylation by *p*-aminosalicylate is of some interest in this regard. The apparent synergism which obtains when isoniazid and *p*-aminosalicylate are used in combination in tuberculosis therapy[8] may be due, partially, to the inhibition by *p*-aminosalicylate of isoniazid acetylation. When isoniazid and *p*-aminosalicylate are administered in combination to rabbits, the free-isoniazid blood-levels 4 hr. after dosage are twice as high as those attained when the same dose of isoniazid is given alone (unpublished results). Bernstein *et al.*[9] have shown that acetylisoniazid has less than one-five-hundredth the activity of the parent compound against the tubercle bacillus *in vitro*, while *in vivo* the parent drug is at least one hundred times more active than the acetyl derivative. It might be expected, therefore, that *p*-aminosalicylate would be instrumental in enhancing the *in vivo* activity of isoniazid against tubercle bacillus infections by maintaining elevated and prolonged therapeutic blood-levels of free isoniazid.

The technical assistance of Mr. Julius Gordon is gratefully acknowledged.

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Extraction of ACTH from Human Pituitaries

ACTH is prepared mainly from hog pituitaries for medicinal purposes, and Marshall[1] showed conclusively that it was localized in the basophil cells of the anterior hypophysis in that animal. So far as we are aware, ACTH has not been extracted previously from human pituitaries, although lyophilized pituitary tissue has been assayed[2].

Eighteen human pituitaries from cases with no evidence of a primary endocrine disorder were used for the extraction of ACTH, and all but two were removed within seven hours of death. In almost all cases a thin slice of the anterior hypophysis was taken for histological study and the posterior lobe removed. The bulk of the anterior hypophysis was then placed in deep freeze until sufficient material had been collected. The time in deep freeze of individual glands varied from a few days to six weeks.

The glands were then acetone-dried and finely powdered to give 1·30 gm. of dry powder. The powder was extracted with 75 per cent acetone at *p*H 2·0 and the active material precipitated with an excess of acetone, yielding 119 mgm. of ACTH with an activity of 2·24 I.U. ± 26 per cent per mgm.

Clearly this yield of ACTH from human pituitaries, namely, 205 u. per gm. of dry powder, is as good as that obtained from the best batches of pig glands despite the greater interval which elapsed between death and their collection. The histological changes produced in the basophils in Cushing's syndrome[3], as a result of cortisone therapy[4], in Addison's disease[5] and in conditions of stress[6], provide indirect evidence that in man, also, ACTH is formed in these cells of the anterior hypophysis. If this is the case, there is little doubt that the degranulation of the basophils occurring as a result of stress must have some influence on the yield of ACTH, and this problem is in the process of further investigation.

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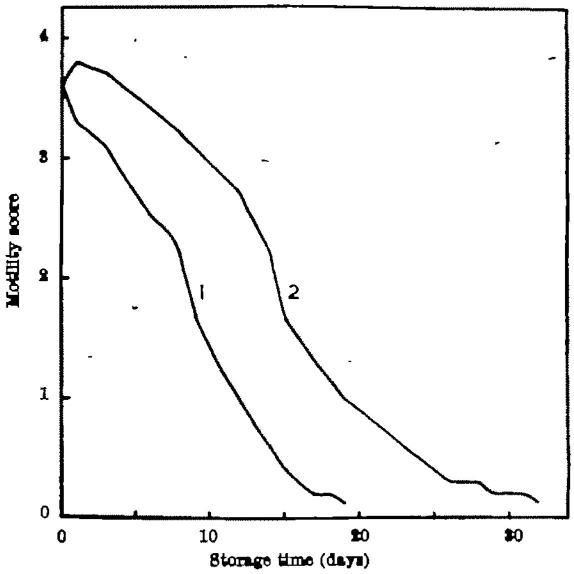
Effect of Glycine on the Survival of Bull Spermatozoa *in vitro*

Bull semen for artificial insemination is usually stored at 4° C. in media composed of equal volumes of either phosphate buffer (*p*H 7·4) or citrate buffer (*p*H 6·8) and fresh egg-yolk[1]. Under these conditions the motility and fertilizing capacity of spermatozoa decrease rapidly with time, and in practice samples are not used for insemination for more than three days after collection. Semen can be successfully stored for much longer periods at – 79° C.[2], but this technique has disadvantages for everyday use.

Since evidence has been obtained suggesting that bovine spermatozoa are adversely affected by phosphate and citrate buffers[3], attempts have been made to improve sperm survival at 4° C. by replacing these buffers (that is, the non-egg-yolk part of the diluent) with other solutions. In this connexion we have observed that sperm motility declines less slowly when the conventional citrate buffer (3·2 per cent sodium citrate) is replaced by Sørensen's glycine buffer (0·75 gm. glycine, 0·58 gm. sodium chloride, water to 100 ml.)[4]. Afterwards it was found that solutions of pure glycine, with equal volumes of egg-yolk, were more effective in bringing about this improvement and that sperm survival increased with increasing glycine concentration in the non-egg-yolk fraction up to levels of at least 4 per cent (0·53 *M*). Data illustrating the improved survival of spermatozoa stored in 3 per cent glycine–egg-yolk as compared with those stored in 3·2 per cent sodium citrate–egg-yolk are summarized in the accompanying figure. These results, mean observations on ten split ejaculates each diluted ten times, show that the decline of motility during storage is slower in glycine–egg-yolk and that the mean half-life of the spermatozoa in this diluent (as judged by motility) is increased by six days. The addition of electrolytes (sodium hydroxide, Ringer solution, 0·9 per cent sodium chloride, phosphate and citrate buffers) to the glycine–egg-yolk appears to have an adverse effect on sperm survival; on the other hand, there is evidence that the addition of small amounts of fructose and small amounts of arginine (which increases *p*H) individually increase sperm survival. In one instance a semen sample diluted with a glycine–fructose–egg-yolk medium appeared good enough for insemination after 50 days storage and still contained some progressively moving spermatozoa after sixty-five days. In all experiments, however, there has been considerable variation in sperm survival between semen samples.



Decline of motility of bull spermatozoa stored at 4° C. in (1) 3·2 per cent sodium citrate – egg-yolk, and (2) 3·0 per cent glycine – egg-yolk

Preliminary observations indicate that the survival of boar and stallion spermatozoa is also enhanced by glycine.

Tyler and co-workers[5] have shown that glycine prolongs the life-span of spermatozoa of the sea urchin, domestic fowl and bull. The mean half-life of bull spermatozoa at 38·6° C. was increased in their experiments from 5·9 to 7·2 hours by 0·038 *M* glycine in balanced saline, but there was no improvement at 4° C. and the effect of glycine in conjunction with egg-yolk was not studied. Tyler and Rothschild[6] found that the metabolism of sea urchin spermatozoa is affected by glycine although glycine is not metabolized to any measurable extent. They suggest that the beneficial effect of glycine is due to chelation of heavy metals, but if this were a complete explanation a maximal response would be expected at fairly low glycine concentrations. The present results show that maximal survival of bull spermatozoa is not obtained until the final glycine concentration, excluding that originally present in the egg-yolk, is at least 0·26 *M*, and that some property of glycine other than its chelating action must be at least partially responsible for its effect. Because electrolytes are known to stimulate the activity of mammalian spermatozoa and probably, therefore, shorten their survival, the favourable effect of glycine as compared with citrate buffer may be due to its low electrolyte content. It is also possible that as an essential precursor of certain biologically important substances such as sarcosine, creatine and adenosine, glycine plays an important part in maintaining the functional integrity of the sperm cell.

Experiments are now being carried out to determine the effect of glycine on the fertilizing capacity of bull spermatozoa.

One of us (A. R.), on leave of absence from the College of Veterinary Science, Mathura, India, is greatly indebted to Dr. John Hammond for the provision of research facilities and to the Nuffield Foundation for a Dominion Fellowship.

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Cultivation of *Pasteurella tularensis* in Chemically Defined Media: Effect of Buffers and Spermine

Pasteurella tularensis is generally considered to be a fastidious micro-organism, difficult to cultivate in artificial media[1,2]. Tamura and Fleming[3], in a preliminary report, briefly announced the cultivation of *P. tularensis* in a synthetic medium with cocarboxylase, adenylic acid, adenosine diphosphate or adenosine triphosphate as the critical growth factors.

With the strains at our disposal we were unable to demonstrate any growth-promoting effect of adenosine triphosphate when added to various basal media. On the other hand, we observed that addition of large amounts of acid hydrolysates of proteins such as hæmoglobin to a basal medium composed of glucose, cysteine, sodium chloride, salts *A* and *B*[4] and thiamine, enabled good growth of all the ten *P. tularensis* strains tested.

The growth-promoting effect of hæmoglobin was traced to the high histidine content of the globin moiety. In fact, graded amounts of histidine, added to a basal medium composed as above, with vitamin-free casein acid hydrolysate as source of amino-acids, produced, up to 5 mgm./ml., a nearly linear growth-response. Analogous results were obtained when casein hydrolysate was replaced by a mixture of amino-acids, similar to that described by Mills *et al.*[5], namely, *l*-arginine (200 μgm./ml.), *l*-aspartic acid (200 μgm./ml.), *l*-cysteine (100 μgm./ml.), *dl*-*iso*leucine (200 μgm./ml.), *dl*-leucine (200 μgm./ml.), *l*-lysine (200 μgm./ml.), *dl*-methionine (200 μgm./ml.), *l*-proline (1 mgm./ml.), *dl*-serine (200 μgm./ml.), *dl*-threonine (1 mgm./ml.), *l*-tyrosine (200 μgm./ml.), *dl*-valine (200 μgm./ml.) (Fig. 1).

dl-Histidine as well as *d*-histidine were found to be as effective, on a quantitative basis, as *l*-histidine, provided that the medium contained a minimal amount of *l*-histidine (50–100 μgm./ml.). This result suggested a dual function of histidine: as an essential metabolite active in its *l*-form only, and by its physico-chemical properties independent of the optical configuration.

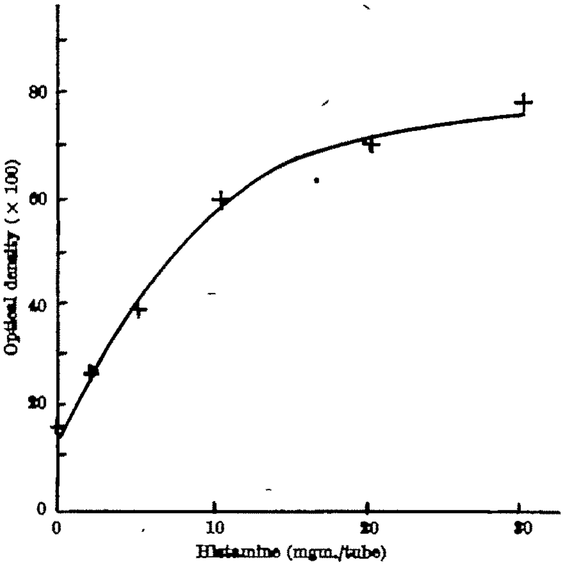

Fig. 1. Growth response of *P. tularensis* to graded amounts of histidine

Since histidine is known as a potent chelating agent, it was first assumed that its physico-chemical effect on growth may be ascribed to a metal-binding mechanism. The finding that other metal-complexing substances such as histamine and even chemically unrelated compounds like glycylglycine and sodium pyrophosphate exhibited similar growth-promoting activity appeared to lend support to this assumption (Table 1). On the other hand, it was difficult to reconcile with this hypothesis the fact that other known chelating compounds such as citrate, tartrate and versene (ethylene diamine tetraacetate) failed to sustain growth. Changing the mineral composition of the medium did not significantly affect growth.

While looking for an alternative and a more satisfactory explanation, it was noticed that all the active compounds had in common the property of being strong buffers with a *pK* value of about 8–9. This suggested the trial of other buffers of the same *pK* range such as tris [tris (hydroxymethyl) aminomethane], and diglycylglycine[6], substances which apparently do not possess any significant metal-complexing capacity. Tris and diglycylglycine proved to be nearly as effective as histidine in sup-

Table 1. Effect of Buffering Agents on the Growth of *P. tularensis* (Strain 176) in a Chemically Defined Medium

30 mgm. of each buffering agent was added to 5 ml. of basal medium. The basal medium is composed of the thirteen amino-acids mentioned in the text (histidine in amount of 100 μgm./ml.), thiamine 2 μgm./ml., 1 per cent glucose, 0·9 per cent sodium chloride, salts *A* and *B* (ref. 4). Growth was measured in terms of per cent transmission in a Coleman spectrophotometer at 550 mμ

Buffering agent added	Growth (48 hr.)
None	85
Histidine	15
Histidylhistidine	20
Histamine	15
Glycylglycine	28
Diglycylglycine	28
Sodium pyrophosphate	20
Tris	26
Salts *A*	50

porting growth of *P. tularensis*. Moreover, by increasing the concentration of the phosphate buffer (salts *A*) a definite improvement of growth was achieved (Table 1). Additional proof in favour of the buffer hypothesis was furnished by the observation that good growth could be correlated with maintenance of a constant pH of the medium at about 7–7·5, while poor growth was accompanied by a rise of alkalinity to a pH value of about 8.

The growth curve in the chemically defined media exhibited a prolonged lag period as compared with a proteose peptone broth, the final yield being equal in both media. In the search for this 'lag shortening factor' it was found that addition of minute amounts (5 μgm./ml.) of spermine or spermidine eliminated the lag and thereby abolished the observed difference between the synthetic and peptone medium. In addition, the presence of spermine reduced the amount of histidine needed. With spermine added, optimal and rapid growth could be secured by merely increasing the concentration of the phosphate buffer to 0·02 *M*. Putrescine, cadaverine and agmatine were also active, but to a smaller extent.

The mechanism by which spermine exerts its effect is being investigated. Results will be presented in a detailed report.

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Neutralization of Silkworm Jaundice Virus by Human Serum

It is well known that immunized rabbit serum neutralizes the virus of silkworm jaundice, but there seems to be no information on the effect of human serum. Human sera were obtained from people working on silkworm jaundice virus and from others. Supernatant fluid from the infected larval blood was used as the virus solution. Usually the pupae injected with about 5–1,000 ml. of 10^{-6} diluted infected larval blood all died from jaundice. The diluted virus solution and an equal volume of the serum or distilled water were mixed and maintained at room temperature for 30 min. After this treatment, about 5–1,000 ml. of the mixture was injected into healthy silkworm pupae, which were observed for 10 days[1].

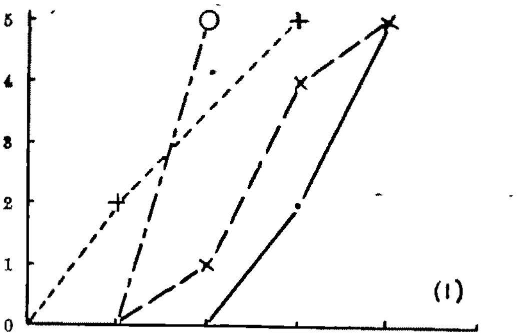
The results (Table 1) show that there is scarcely any difference in the neutralizing titre between sera of people engaged in work on silkworm jaundice virus and others.

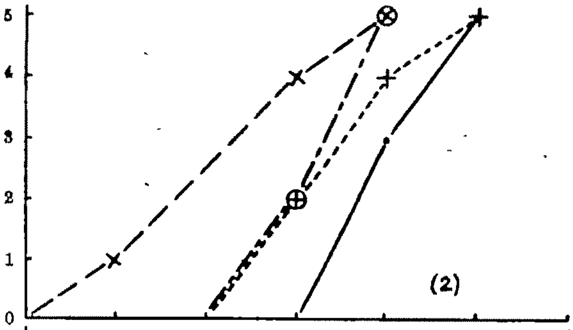
But it was found that the latent periods of the pupae injected with the serum were shorter than that with the distilled water in each virus dilution as shown in Fig. 1 (final dilution of the virus is $\frac{1}{2} \times 10^{-4}$), Fig. 2 ($\frac{1}{2} \times 10^{-5}$) and Fig. 3 ($\frac{1}{2} \times 10^{-6}$). The latent period of the silkworm jaundice virus depends upon the virus multiplication[1]. Hence, in the case of injecting the virus with human serum, the virus

Table 1. Neutralization Reaction of Jaundice Virus by Human Serum

Final dilution of virus	Distilled water	Serum of person working on silkworm jaundice virus		Serum of person not working on silkworm jaundice virus
		A	*C*	*I*
$\frac{1}{2} \times 10^{-4}$	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●
$\frac{1}{2} \times 10^{-5}$	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●	● ● ● ● ●
$\frac{1}{2} \times 10^{-6}$	● ● ● ○ ○	● ● ○ ○ ○	● ● ○ ○ ○	● ● ○ ○ ○

● Died of silkworm jaundice. ○ Alive





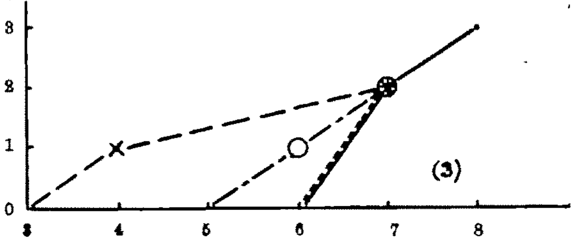


Fig. 1. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-4}$). Ordinate: total number of jaundiced silkworms. Abscissa: days after virus inoculation ——, Virus injected with distilled water; +···+, neutralization by *A* serum; O–·–O, neutralization by *C* serum; ×—·—×, neutralization by *I* serum

Fig. 2. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-5}$). Ordinate and abscissa, as Fig. 1

Fig. 3. Total number of jaundiced silkworms after virus inoculation (final dilution of the virus is $\frac{1}{2} \times 10^{-6}$). Ordinate and abscissa, as Fig. 1

increases more rapidly than that with the distilled water. Accordingly, it may be considered that the serum contains a viral growth factor.

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Electron-Track Autoradiography of Radioactive Frog Embryos

Beta-track autoradiographs offer advantages over other methods of autoradiography, especially when small quantities of weak emitters such as carbon-14 are used[1]. If, in addition, the autograph and tissue can be viewed as a unit, a further advantage is gained[2]. Such preparations permit detection of the characteristic tracks in the presence of heavy background fog; eliminate the problem of spurious interpretation due to the reduction of the silver grains by tissue constituents[3]; require far less radioactivity for detection than other methods of autoradiography; permit viewing at high magnifying power with consequent localization of radioactivity to small areas; and eliminate matching of tissue and autograph. Beta tracks, due to their tortuous path, do not permit determination of a point source.

Radioactive frog (*Rana pipiens*) ova and embryos were produced by injecting sodium formate-^{14}C into the gular lymph sac of females, which were then induced to ovulate by an intraperitoneal injection of pituitaries. Fertilized ova were permitted to develop, and specimens were fixed in absolute alcohol at various developmental stages[4], cleared in oil of wintergreen and embedded in paraffin. Serial sections were cut at 10 μ, floated on absolute alcohol on to slides coated with albumen, and dried.

For preparation of the autographs, the paraffin was removed with xylol and the slides dried at 40° C. on a warm plate. Several drops of Ilford *G*-5 emulsion gel, melted at 45° C., were placed on each warm slide, and the emulsion brushed over the sections with a camel's-hair brush held in a quill. The slides were cooled to room temperature to allow the gel to harden, placed in a lead-shielded dark receptacle for 23 days, and then developed in amidol for 15 min. (amidol, 1·5 gm.; sodium sulphite, 3·5 gm.; sodium bisulphite, 0·5 gm.; distilled water, 500 c.c.). This was followed by 5 min. in a stop-bath of 1 per cent acetic acid and then for 30 min. in hypo solution maintained at 5° C. The hypo was then gradually replaced with cold distilled water over a period of about 45 min. The slides were washed in running, cold tap water for several hours and dried overnight. The emulsion often adheres poorly to plain glass, so 5 per cent sodium sulphate should be added to the stop-bath to act as a hardening agent. However, if subbed-glass (gelatine-coated glass) is used, the hardening agent is not necessary. Subbed-glass can be treated just as plain glass slides are treated.

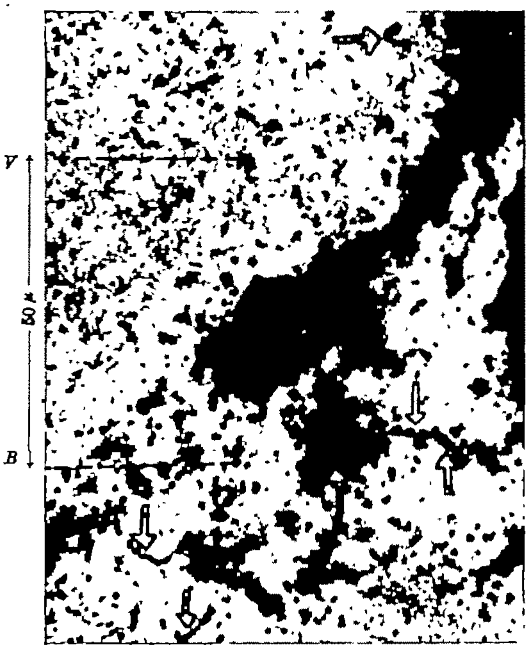

Fig. 1. Hind brain of a stage-21 larva of *Rana pipiens*, sectioned at 10 μ, showing electron tracks, some of which are indicated by arrows. *X* shows a cluster of tracks; the tissue can be seen in the background; *V* indicates the ventricle; *B* indicates the hind brain. (× 1,000)

The slides are best examined with an oil-immersion lens. Emulsion covering non-radioactive areas may show an occasional electron-track which is regarded as 'background', but emulsion covering the radioactive areas exhibits many tracks, and can thus be demarcated from non-radioactive areas.

Fig. 1 shows a portion of the hind brain and ventricle from a radioactive stage-21 larva. The tissue is out of focus, but can be seen in the background. The area in this photograph has at least forty tracks distributed in the emulsion over the tissue; but since the tracks arising from the tissue pass into the emulsion and lie in several planes, only a few can be seen clearly at any one plane of focus. One track can be seen in the ventricle at the periphery of the tissue; but beyond this area there are no electron tracks, and the radioactive area of tissue can be distinguished from the non-radioactive area of the ventricle. It is problematical that the group of tracks seen at 'X' come from a common source such as the same cell, but it can be assumed that they arose from cells in the immediate area of the field viewed.

The method of preparation outlined here loses the fatty substances of the tissue, and thus loses radioactivity. Other methods of preparation, such as freeze-drying, would preserve these and other soluble constituents. Thus, selective fixation and preparation might be used to demonstrate the presence of specified tissue substances.

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Properties of the Non-Calcareous Material in the Shell of *Anodonta cygnea*

THE shell in the Lamellibranchia consists of a number of distinct layers which show a fundamental similarity in structure in related regions of valve and ligament[1]. In *Anodonta*, all parts of the shell, except the periostracum and the fusion and outer layers of the ligament, are calcified and contain a non-calcareous matrix, termed conchiolin, which in sections possesses characteristic staining properties. Conchiolin of the inner layers of valve and ligament stains typically with basic dyes, outer layer conchiolin predominantly with acid dyes, and fully-formed periostracum and fusion layer usually remain uncoloured.

A number of histochemical tests have been carried out on the shell conchiolin which indicate that it consists mainly of protein (ninhydrin, xanthoproteic, arginine[2] and Millon tests), although lipoid material (sudan black stain) and possibly some polysaccharide (periodic acid–Schiff test[3]) may be present. The detailed results of these tests indicate that there is a similarity in the properties of corresponding layers of valve and ligament and also that, as reported by Trueman in *Tellina tenuis*[4], the conchiolin of the inner layers of valve and ligament differs in composition from that in the rest of the shell. The chitosan-iodine test for chitin[5] gives a slightly positive reaction with *Anodonta* conchiolin. The periostracum, fusion and outer layers give a more strongly positive reaction to the argentaffine test[6] than the inner layers, suggesting the presence of quinone-tanned proteins. Sections treated with a series of reagents devised by Brown[7] to determine the types of linkages in structural proteins dissolve almost completely only in the sodium hypochlorite solution, providing further evidence for tanning having taken place.

The amino-acid content of the conchiolin protein has been further investigated by paper chromatography. The shell was treated in four parts, namely, 'outer' layer valve (including periostracum as well as true outer layer), inner layer valve, 'outer' layer ligament (including fusion layer as well as true outer layer) and inner layer ligament. Acid hydrolysates of equal quantities of dried conchiolin from each region were run simultaneously on paper chromatograms, using phenol/water and butanol/acetic acid/water as solvents, and developed with ninhydrin. The results reveal that although the general pattern of the amino-acids produced from each hydrolysate is somewhat similar, there are some marked differences in concentration (Fig. 1). Tyrosine is relatively more abundant in the 'outer' layers of both valve and ligament and phenylalanine is more highly concentrated in the 'outer' layer of the ligament than in the inner. Arginine and certain other amino-acids, however, show relatively higher concentrations in both inner layers. These results, and, in particular, the striking similarity in amino-acid content of the 'outer' layers of valve and ligament (Fig. 1), agree in general with the responses observed to the histochemical tests for amino-acid groups.

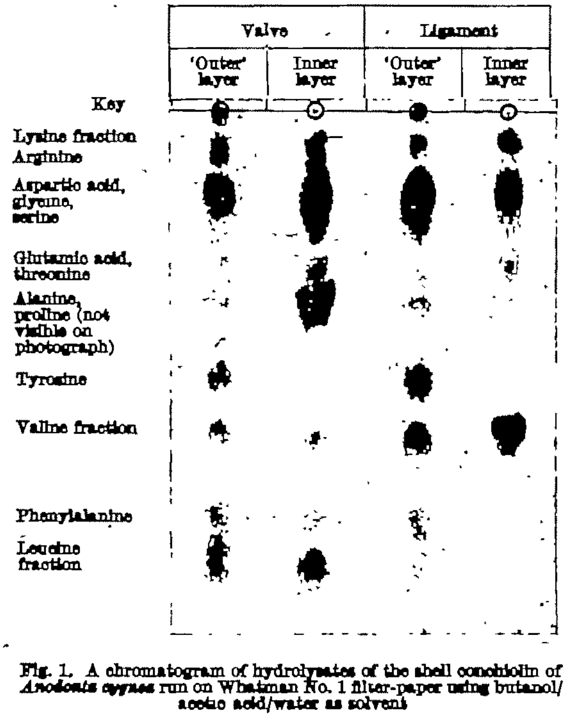

Fig. 1. A chromatogram of hydrolysates of the shell conchiolin of *Anodonta cygnea* run on Whatman No. 1 filter-paper using butanol/acetic acid/water as solvent

This work, which will be published in full later, appears to provide further evidence for the homology established on morphological grounds between the layers of valve and ligament. Moreover, the difference in composition between the conchiolin of the inner layers of valve and ligament and that in the rest of the shell, as indicated by its staining properties in sections, is reflected by the results of the histochemical tests and chromatographic analyses carried out.

I wish to thank Prof. P. G. 'Espinasse and Mr. E. R. Trueman for help and guidance and the authorities of the University of Hull for the research scholarship which has made this work possible.

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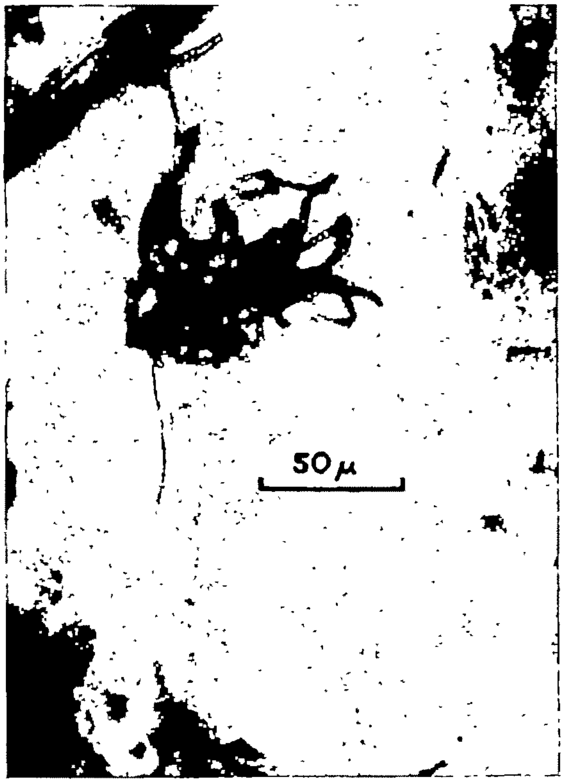
Examination of Soil Micro-organisms in their Natural Environment

PRESENT information on the distribution and growth of micro-organisms in the soil has been obtained almost entirely by plating dilute soil suspensions on to nutrient media, the Rossi–Cholodny[1] buried slide technique, Jones and Mollison's[2] soil suspension preparations and similar indirect methods. Kubiena[3] has developed methods of examining soil organisms *in situ* using reflected light, but his observations are necessarily confined to soil surfaces. So far as we are aware, the technique of preparing thin sections of soils and non-coherent rocks for microscopical examination by transmitted light has not previously been applied to the study of soil micro-organisms in their natural environment.

In the present method, standard soil sampling and rock slicing techniques have been modified with the object of keeping the soil and soil micro-organisms as nearly as possible in their natural state. This involves keeping the stresses acting on the sample small and the temperature low. Small soil samples are taken in a polythene tube fitted with a detach-



able metal shoe and are kept in the tube throughout the staining, drying and impregnation processes. Stains and wash liquids, if used, are soaked through the samples by capillarity. The sample is rapidly dried under vacuum and vacuum-impregnated at a low temperature by a drip method using a 'Marco Resin' mixture (an unsaturated polyester manufactured by Scott Bader and Co., Ltd.).

Once the resin has matured, the sample is hard enough to be cut by the usual rock-slicing techniques without disturbance and tough enough for slices 1 mm. thick to be removed using a fairly slow speed (140 r.p.m. for a ten-inch disk) and 'Carborundum' of about 100 grade. The slices are rubbed down to any desired thickness and polished using 'Carborundum' and water; they are mounted and covered with pure canada balsam.

When sampling and impregnation are carefully carried out, there is no detectable disturbance of the soil except for a little drag at the contact of the sampler and soil, and the samples are thoroughly impregnated. The accompanying photograph of a conidial head of *Aspergillus niger* van Tiegh. in an interstitial space shows that only slight disturbance of the conidial chains has occurred during sampling and impregnation.

Sections of sandy loam and sandy clay loam prepared by this technique have a moderate to high degree of translucency even at thicknesses of several hundred microns. Algæ, fungal hyphæ and fructifications, etc., in the soil pores and on the surfaces of the mineral particles are clearly visible. Fine hyaline hyphæ, difficult to see under conditions of bright-field illumination, can be seen more easily by phase-contrast microscopy. Preliminary trials suggest that staining of the soil sample before impregnation may increase the value of the method when fine hyaline mycelia and bacteria are to be studied.

The whole process from taking the sample to examining the finished slide takes two to three days—no longer than the standard biological technique of wax embedding and microtoming. The equipment required is simple and readily made up from standard laboratory materials. A more detailed description of the method will be appearing elsewhere.

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The Second Ecdysis of Infective Nematode Larvæ

ALTHOUGH the second ecdysis of certain species of nematodes which parasitize sheep is known to take place in the alimentary tract of the host, the actual site is not definitely known. In the horse, some knowledge of this subject has been gained by placing larvæ in fluid from various parts of the intestinal tract[1]; but this method has not always been successful with sheep. However, it has been reported that the abomasal fluid plays a part, at least in so far as *Haemonchus contortus*[2], *Trichostrongylus colubriformis*[3] and *T. rugatus*[3] are concerned.

At this laboratory the site of exsheathment of several species has been studied in the sheep. Infective larvæ were placed in the contents of the rumen, abomasum, duodenum and ileum, and incubated at 38° C. Larvæ in 'Cellophane' sacs were also placed directly into the rumen through a rumenal fistula, and after laparotomy, into the abomasum, duodenum and ileum.

Preliminary study of the results suggests that the infective larvæ of species normally parasitic in the sheep commence to exsheath in that portion of the intestinal tract which immediately precedes the region in which the adults are normally found. *H. contortus*, *Trichostrongylus axei* and *Ostertagia circumcincta*, parasitic as adults in the abomasum, were observed to exsheath in the rumen. *T. colubriformis* and *Nematodirus* spp., parasitic as adults in the small intestine of the sheep, failed to exsheath in the rumen, but exsheathed in the abomasum, although at different rates. Whereas after an hour 90 per cent of *T. colubriformis* were exsheathed, less than 10 per cent of *Nematodirus* were exsheathed.

Oesophagostomum columbianum, a parasite of the large intestine, was not observed to exsheath in the rumen, abomasum or small intestine, although Veglia[4] has recovered exsheathed larvæ of this species from the abomasum and small intestine of the sheep.

With the exception of *Nematodirus*, larvæ normally exsheathed very rapidly, and after an hour the process may be complete in more than 90 per cent. However, considerable variations were noted in the rate of exsheathment of *H. contortus* in the rumen.

Strongyloides papillosus, a contaminant in some cultures, was observed to die if retained in the rumen for more than half an hour. This species is a skin penetrator, and its inability to survive in the rumen suggests that the success of oral infestations may be dependent on the ability of larvæ to penetrate the epithelium of the mouth, or alternatively to pass through the rumen in less than half an hour.

It is possible that the second ecdysis plays a part in determining the region of the host's intestinal tract in which the worms develop. Thus, *T. axei* is the only member of this genus to live in the abomasum, and is the only member to enter that organ exsheathed. Differences in the rate of exsheathment between *T. colubriformis* and *Nematodirus* spp. in the abomasum may be a significant factor in the relative position of these species in the small intestine, since Tetley[5] has shown that the maximum numbers of *Nematodirus* spp. are always posterior to the maximum numbers of *T. colubriformis*. The relative inability of some species of nematodes to parasitize a host, in which another species of the same genus is commonly found, may possibly be determined by differences in the rate of exsheathment within the host. Further work to elucidate these and other aspects is in progress.

I thank Mr. H. McL. Gordon, of the McMaster Laboratory, for helpful advice, and Mr. F. J. Hamilton, also of the McMaster Laboratory, for assistance with the necessary surgical operations.

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Occurrence of *Paracentrotus lividus* (Lamarck) in Scotland

Paracentrotus lividus is a littoral sea-urchin well known in the Mediterranean and on the Atlantic coasts of Europe. In the British Isles it has been recorded only in Ireland, where it is common on the south and west coasts, and occasionally in Devonshire and Cornwall[1].

It is therefore of interest to place on record that three specimens were found in 1939 in the intertidal zone of the Isle of Muck, Inverness-shire. These came from two distinct localities and the animals were living in situations similar to those inhabited by *Psammechinus miliaris* in crevices and under stones. Possibly the rock is here too hard for the urchins to burrow as is their habit in so many other localities[2]. The spines, while of the typical purple colour, are shorter and stouter than in some Irish specimens in our collection. The animals resemble closely a specimen presented to one of us by the late Prof. J. H. Orton which he collected at Looe in Cornwall in 1913.

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Effect of Alpha-Particle Bombardment on Creep in Cadmium Single Crystals

BOMBARDMENT of stressed single crystals of cadmium by alpha-particles was found by Andrade[1] to cause a marked increase in the rate of glide under certain conditions. The crystals were stressed so as to produce a creep-rate of about 0·05 per cent per min., and increases in rate of up to five times were recorded on bringing up the alpha-particle sources during the early stages of the creep curve. The effect was attributed by Andrade to the initiation of new glide planes by the intense local disturbances produced in the surface of the crystal during the impact of the energetic alpha-particles.

The present creep tests were undertaken to throw further light on this hypothesis, and in particular to determine if the effect occurred on clean crystals or whether a thin oxide film was necessary. The apparatus is very similar to that used by Andrade with the exception that the strain is measured with an optical-lever device having a magnification of 200. A cylindrical polonium alpha-particle source with an initial strength of 140 mc. produces a maximum flux of 5×10^8 particles per sq. cm. per sec. at the surface of the crystal. The flux used by Andrade was about $1{\cdot}5 \times 10^8$ particles per sq. cm. per sec.

It has not proved possible to repeat the phenomena described by Andrade. Tests have been carried out on both standard (99·9 per cent) and spectroscopic (99·99 per cent) purity cadmium crystals, 1 mm. in diameter under a variety of surface conditions produced by oxidizing the clean 'as-grown' crystals in the atmosphere for various lengths of time at 240° C. Crystals have been tested with a range of orientation ψ, the angle between the glide plane and the specimen axis, between 10° and 45°. The effect of dissolved nitrogen has also been investigated. The majority of the specimens have been tested at 0·05 per cent per minute—the rate quoted by Andrade—but tests have also been made at various rates between 0·013 and 0·26 per cent per min. The bombardment was usually initiated after about 0·5 per cent glide and the sources were brought up and removed from the specimen several times during the course of a test. A small elongation of the crystal sometimes occurred on moving the alpha-particle sources; this was traced to vibration in the apparatus and could be reduced to a minimum by very careful handling.

In specimens in which marked geometrical softening occurred as glide proceeded, due to the rotation of the glide planes towards the specimen axis with a consequent increase in shear stress, it was observed that the elongation produced by vibration would sometimes cause an increase in the rate of creep. This behaviour was observed in specimens in which the angle ψ was large and also in annealed crystals containing dissolved nitrogen. The increase in creep-rate under these conditions was independent of the position of the alpha-particle sources. In the majority of the tests, however, no change in creep-rate was detectable on bringing up or removing the sources from either the clean or the oxide-coated crystals.

Bombarding for longer periods under no load has been found to harden the crystal slightly. In one case the creep-rate of a clean spectroscopically pure crystal was reduced from 0·08 to 0·05 per cent per min. after bombardment for 2 hr. It is possible that this effect is due to the oxidation of the crystal by the oxygen ions or ozone produced in the air by the passage of the alpha-particles.

A full account of these experiments is being published elsewhere.

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The 'Oxygen-Effect' in Ionizing Irradiation

It is a well-established fact that ionizing irradiation damages a variety of cells to a greater extent if the irradiation takes place in presence of oxygen than under anaerobic conditions. The mechanism of this 'oxygen-effect' is not yet fully understood. It is generally believed[1-4] to be due to the deleterious effect on cells by the strongly oxidizing radical HO_2 and, to some extent, by hydrogen peroxide, which are formed on X-ray irradiation in aqueous media containing oxygen, as compared with the less powerful OH radical which, in addition to reducing hydrogen atoms, is formed on irradiation in nitrogen. The exception, so far, is a bacteriophage, for which evidence has been adduced[5,6] that it has a far greater sensitivity to reducing than to oxidizing radicals.

In the work, which is reported here, bacteria representing strict and facultative aerobes and anaerobes, as well as some yeasts, were exposed to X-rays in order to study whether the 'oxygen-effect' requires the maintenance of normal respiration during irradiation and whether it bears any relation to a particular type of cellular metabolism.

Known concentrations of washed cells, suspended in phosphate buffer + glucose, were irradiated (190 kVp., no added filtration, dose-rate $6 \cdot 5 \times 10^3$ r./min.) at doses of $6 \cdot 5$–$26 \cdot 0 \times 10^3$ r. (1–4 min. irradiation). The liquid phase, during irradiation, was either free from dissolved oxygen (the gas space containing nitrogen or hydrogen) or it was in equilibrium with oxygen of decreasing percentage (100 per cent oxygen; 20 or 5 per cent oxygen in nitrogen). In some experiments with 20 per cent and 5 per cent oxygen the nitrogen was replaced by carbon monoxide. Immediately after irradiation a known amount of cells was transferred either into fresh buffer solution + glucose or into a nutrient medium in manometer flasks, and the rate of some metabolic processes measured for up to ten hours. These included: oxygen uptake, carbon dioxide production, aerobic and anaerobic fermentation or acid production and utilization of hydrogen (*Vibrio desulphuricans*). In a nutrient medium the increase, for example, in oxygen uptake or anaerobic acid production with time is proportional to the increase of dry weight of bacteria, that is, it is a true reflexion of growth.

None of the metabolic reactions measured was significantly affected by irradiation, when measured in washed non-growing cells, except aerobic fermentation of baker's yeast, which was slightly inhibited. All cells examined, however, when transferred into growth-promoting media, showed an 'oxygen-effect', that is, a stronger inhibition of growth on irradiation in presence than in absence of oxygen. The relative sensitivity for oxygen-treated as compared to nitrogen-treated samples was approximately threefold for aerobic cells, which agrees with data in the literature[1,3,4]. It was much greater, however, for a strictly anaerobic organism (*Vibrio desulphuricans*) and for spores of an aerobic organism (*B. subtilis*), which were not affected by irradiation of up to 26,000 r. in nitrogen, that is, they gave rise to vegetative forms at the same rate as the controls, while growth after irradiation in presence of oxygen (air) was strongly inhibited.

In the case of *Sarcina lutea* it has been possible to abolish almost completely the 'oxygen-effect' at doses up to 26,000 r., if cell respiration was inhibited by respiratory poisons during the irradiation. Thus, after removal of the poison, the cells behaved as if they had been irradiated in nitrogen, when judged by the degree of growth inhibition and subsequent rate of recovery. The effective inhibitors were carbon monoxide, potassium cyanide, hydroxylamine and sodium azide. Urethane did not diminish the 'oxygen-effect'.

The mode of action of the effective poisons in their role as respiratory inhibitors is known[7-9]. They all block hydrogen transfer through the respiratory enzymic system by combining with cytochrome a_3 and stabilizing the remaining respiratory enzymic chain in the reduced form. Taking this mode of action as a guide in advancing a possible explanation for the 'oxygen-effect' in irradiation, it is suggested, at least for this bacterium, that the enhancement of irradiation damage (1) involves the enzymic respiratory mechanism, (2) requires at least part of the enzymic respiratory chain to be in the oxidized form during irradiation. This makes it possible that the impedance has been caused by a reducing agent.

The results form part of a body of work which will be reported fully elsewhere.

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Effects of Crystallization on the Glass–Rubber Transition in Polyethylene Terephthalate Filaments

Multifilament yarn spun from polyethylene terephthalate polymer ('Terylene' polyester yarn) is non-crystalline and almost unoriented. After drawing, it becomes highly oriented and moderately well crystallized[1], and in this state at room temperature it has a high initial tensile modulus, and recovers almost completely from strains of up to 1 per cent[2].

It has recently been suggested[3] that the mechanical and electrical transitions in a number of substituted acrylic polymers are characteristic of the molecular structure: the results which are given here of our investigation into the tensile behaviour of polyethylene terephthalate filament yarn show, in addition, that the visco-elastic properties of a given polymer can be considerably modified by molecular orientation and crystallization. In particular, a con-

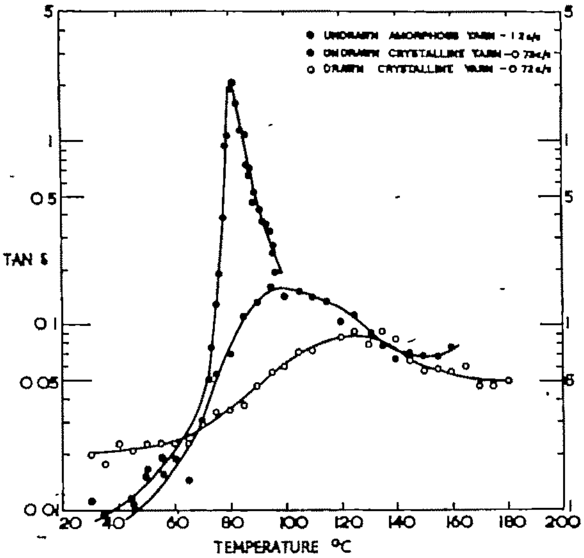
	Density (gm./c.c.)	Infra-red estimate of crystallinity[4] (per cent)	Birefringence	Transition temperature (° C.)	Half-width of loss peak curve (° C.)	Maximum value of loss tangent	Young's modulus (dynes/cm.² × 10¹⁰)	
							Below transition	Above transition
Unoriented amorphous	1·336	2	+ 0·00	81	10	2·0	1·9	0·012
Unoriented crystalline	1·383	48	− 0·01	100	70	0·16	2·6	0·29
Oriented crystalline	1·391	65	+ 0·22	125	45	0·09	12·1	3·5

siderable movement of the 'second-order transition point' has been noted.

A temperature-range of 20°–180° C. and frequencies from 10^{-3} c./s. to 10^{4} c./s. have been used, the frequency-range being divided into three sections to permit the use of convenient experimental methods. At low frequencies (10^{-3} c./s. to 10 c./s.) forced vibration was used for obtaining the load-extension hysteresis loop for strain amplitudes of up to 1 per cent. In the intermediate range (10 c./s. to 500 c./s.) the decay of free oscillations of a mass supported by the yarn is observed, while for still higher frequencies a longitudinal wave pulse propagation technique is employed. Since experimental limitations demand a decrease in amplitude with increasing frequency of vibration, it is not necessarily possible to make a direct comparison between the results from each frequency range; but there does appear to be reasonable agreement in regions of overlap.

The low-frequency range has been chosen for a detailed investigation of the effects of frequency and physical structure on the glass–rubber transition using a constant strain amplitude of 0·7 per cent. The load-extension loop is an ellipse, the slope of the major axis and the width being determined by the Young's modulus and the phase difference between the load and the applied extension (loss angle). The temperature dependence of these two quantities is used to determine the position and nature of the transition.

For all the yarns tested, the modulus decreases with increasing temperature, and the resultant tension becomes increasingly out of phase with the applied extension, until the foot of the sigmoidal modulus–temperature curve is reached, when the phase difference decreases again. In undrawn, amorphous filaments, this 'glass–rubber' transition is sharply defined by a drop of a factor of 100 in Young's modulus, whereas drawn crystalline filaments have a much broader transition with only a fourfold drop in modulus, occurring at a higher temperature.



The effect of increasing frequency is to increase the modulus and change the loss angle in the transition region, so that the maximum loss angle occurs at a higher temperature. For undrawn amorphous or slightly crystalline filaments this shift in loss peak is about 3·5° C. per decade, corresponding to an apparent activation energy of 170 k.cal./mole, whereas for highly crystalline drawn filaments the figures are 7° C. per decade and 90 k.cal./mole.

Increasing the crystallinity of undrawn yarn results in a broadening of the loss angle curve and a shift of its peak towards higher temperatures, together with a considerable reduction in its peak value, while the Young's modulus at temperatures above the transition region is considerably increased. The curves are further modified in a similar way in the more highly crystalline drawn yarn, the relative data being given in the accompanying table. This briefly summarizes the major influence of orientation and crystallization upon the physical properties; the two effects, however, cannot be completely separated owing to their close interdependence. The diagram shows the effect of crystallinity and orientation on the loss angle–temperature curves.

It is hoped to publish this work in more detail elsewhere.

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Magnetic Susceptibility of Vanadium Dioxide

We have found that the reduction of vanadium pentoxide (V_2O_5) as described below gives a form of vanadium oxide (VO_2) which has not the magnetic discontinuity (at 341° K.) reported in the literature[1,2].

Reduction of vanadium pentoxide, prepared from 'Analar' ammonium metavanadate, with hydrogen below 530° C. yields a blue-black powder. Oxide compositions in the range $VO_{1\cdot92}$ to $VO_{2\cdot3}$ have been prepared in this way and their magnetic susceptibilities measured in a nitrogen atmosphere. The compositions were checked from (i) the loss in weight on reduction from the pentoxide, (ii) the quantity of hydrogen used in reduction, and (iii) by titration with permanganate before and after measurement.

The oxides were examined in the range 20°–450° C. and the values of mass susceptibility χ_m of the vanadium oxide present, assuming them to be mix-

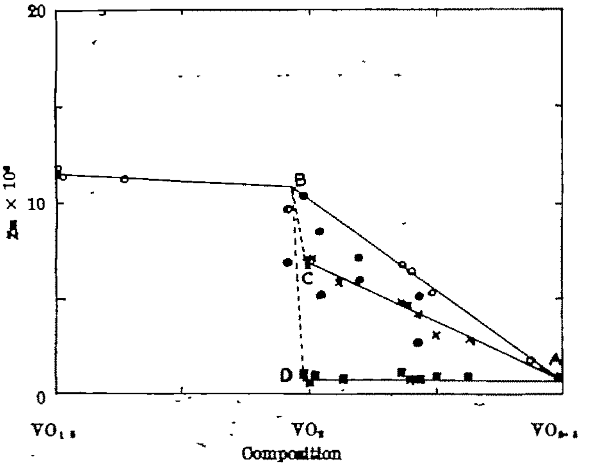

Fig. 1. Mass susceptibility of vanadium oxides. ○ (no discontinuity), at 340° K.; ● and ◑, at 335° K., 345° K., respectively (discontinuity at 340° K.). The line *AB* fits the points ○. Results for sintered oxides. □ (at 335° K.) and × (345° K.) for the various compositions. Lines *AD* and *AC* fit these points fairly well

tures of VO_2 and V_2O_5, were plotted for each oxide and above 345° K. were found to obey the Curie–Weiss law:

$$\frac{1}{\chi_m} = \frac{T - \theta}{C_M}.$$

Only slight discontinuities were noted at 340° K., and the values of θ and p_B (derived from C_M) for the V^{4+} ion were in the ranges $\theta = -350°$ to $-450°$ K. and $p_B = 1\cdot8$ to $2\cdot2$ Bohr magnetons for observations above 345° K. The results are plotted in Fig. 1.

These values were not inconsistent with the theoretical value of $p_B = 1\cdot73$ for the spin only state of V^{4+}.

The actual values of χ_m were generally too high (for example, $VO_{1\cdot90}$, $\chi_m = 9\cdot15 \times 10^{-6}$ at 335° K.; $11\cdot15 \times 10^{-6}$ at 345° K.; and $VO_{1\cdot8}$ $\chi_m = 13\cdot9 \times 10^{-6}$ at 335° K.) for these oxides to be mixtures of V_2O_3 and V_2O_5. They show no ferromagnetism.

When the oxides $VO_{2\cdot0}$–$VO_{2\cdot2}$ were fused at 750° C. in nitrogen, or V_2O_3 and V_2O_5 were fused together in the appropriate proportions at 750° C. in nitrogen, in a sealed silica tube, the resulting crystalline oxides had large discontinuities in susceptibility at 341° K. similar to, but more pronounced than, those reported by Perakis and Wucher[2]. The susceptibility curves were exactly reversible on cooling down again through 341° K. The V^{4+} ions in these oxides gave $\theta = -1,200°$ to $-1,400°$ K. and $p_B = 2\cdot8$–$3\cdot1$ Bohr magnetons, above 345° K. The value of $p_B = 3\cdot0$ corresponds to the presence of an unquenched orbital contribution in addition to the spin contribution. The values of χ_m for $VO_{2\cdot00}$ were $1\cdot2 \times 10^{-6}$ at 335° K. and $7\cdot75 \times 10^{-6}$ at 345° K. with the main discontinuity at 341 ± 2° K. The results for sintered oxides are plotted in Fig. 1.

The existence of a sharp increase in electrical conductivity and a decrease in thermoelectric e.m.f. (cold junction negative throughout), when the temperature rises from 330° to 350° K., has been noted for the fused $VO_{2\cdot00}$. No sharp changes in these properties have been observed for the powder form of this oxide.

These results suggest the existence of two different forms of VO_2, depending on whether the oxide has been sintered during preparation or not. This is in line with the results of Flood and Kappa[3] on vanadium oxide prepared by sulphur dioxide reduction of the pentoxide. We are unable to agree with these authors that VO_2 is formed in this latter process, as samples we have prepared at 480°–640° C. all analysed as $V_{12}O_{26}$ (allowance being made for any sulphur dioxide adsorbed on the final oxide). Rate measurements indicated that some sintering occurred between 600° and 640° C., however.

It would appear that oxygen can be removed from the V_2O_5 lattice until the composition VO_2 is formed; but the rutile structure is not attained unless the temperature is raised above about 620° C.

The results of Perakis and Wucher[2] suggest that the oxide they examined was a mixture of the two phases, and the non-reversible curve obtained on cooling after heating suggests either oxidation or a change in the proportions of the two phases. All our curves were reversible on cooling, except when the measurements were extended above 400–450° C. (in nitrogen).

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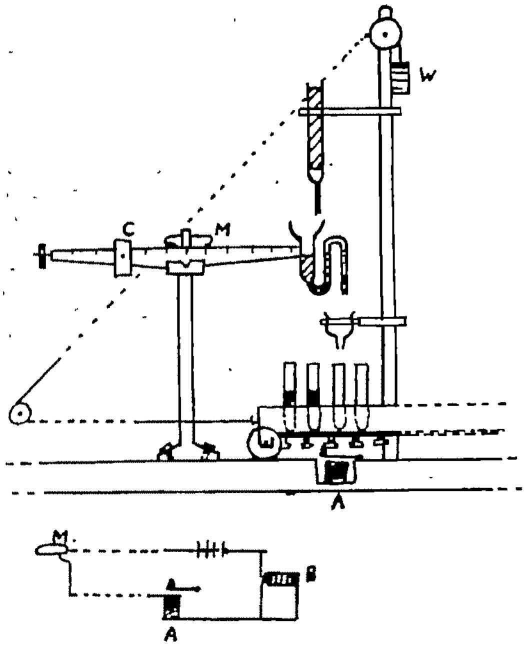
Simple Automatic Fraction Cutter

The automatic fraction cutter described below is of extremely simple design and inexpensive to make, and yet works as efficiently as any commercial model. In contrast to those which have been described previously[1,2], where a twisted string provided motive power, this cutter uses a descending weight, which is not only more dependable but also can be readily adjusted.



The column delivers into a small siphon attached to one end of a balance beam, and a counterweight C on the other side of the beam is used for adjustment. A mercury switch clipped to the top centre of the beam makes contact when the weight of liquid in the siphon tilts the beam. At the moment contact is made, a relay A underneath a trolley of test tubes is operated, and a lagged relay B, taking small current, switches this off very quickly afterwards. The trolley is moved along one division in this time by a weight, W, and pulley system. The siphon empties shortly after this, thereby releasing relay B; but this simply switches off the current and there is no movement of the trolley. During this time, and while the siphon is refilling, any last drips from the siphon are collected in the same tube.

The trolley in use has only sixteen holes drilled for test tubes spaced 1¼ in. apart. The design of the trolley may easily be modified to take more tubes or even flasks if a larger volume is required. Beneath the holes a strip of ¼-in. steel has been drilled and tapped for 16 6.B.A. 'cheesehead' bolts which connect with the catch of relay A.

The volume that the siphon delivers can be adjusted with glass beads, and the counterweight moved accordingly.

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Measurement of Small Differential Pressures at Low Absolute Pressures

In the course of a study of the flow of gases through powders at reduced pressures, it was necessary to be able to measure pressure differences of the order of 1–60 microns mercury in the absolute pressure range 1–100 microns mercury. Such small pressure differences have been measured by using two McLeod gauges, and the method has been reported elsewhere[1]. It was found that pressure differences of a small order could not be accurately measured using two separate McLeod gauges, even when a cathetometer was used for reading the mercury levels. Consequently, an alternative method and apparatus were developed and their principles are described here.

The apparatus (Fig. 1) consists basically of two McLeod bulbs connected on each end of a capillary oil manometer. The pressure difference applied between A and B is initially shown as a minute difference in the levels of the manometer filled with high-vacuum oil. Mercury contained in the reservoirs driven by the atmospheric pressure fills the bulbs and encloses the volumes of gas above the level YY. The final mercury level is reached at XX (approximate height of mercury 76 cm.). Thus the gas which originally occupied the bulbs and capillary tubes up to the level XX is compressed into the capillary manometer tubes above the oil. In the apparatus built in our experiments the compression ratio was about 20 : 1, thus increasing the observed differential pressure about twenty times, which was easily read with the cathetometer.

A simple theory of this apparatus is as follows. Let the actual pressure drop be $\Delta p = P_A - P_B$.

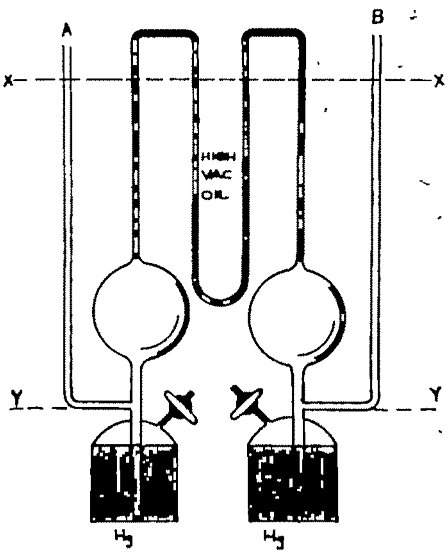

Fig. 1

Left-hand side : V_1 = volume of bulb + capillary between the levels XX and YY.

V_2 = volume of capillary between XX and oil level.

Right-hand side : V_3 = volume of bulb + capillary between the levels XX and YY.

V_4 = the volume of capillary between XX and oil level.

When the gas is compressed by raising mercury into the bulbs and up to the level XX, the following relation applies :

$$P_A\,(V_1 + V_2) = P_A'V_2\,;\ \text{that is, } P_A' = \frac{V_1 + V_2}{V_2}\,P_A$$

$$P_B\,(V_3 + V_4) = P_B'V_3\,;\ \text{that is, } P_B' = \frac{V_3 + V_4}{V_3}\,P_B$$

If $V_3 \approx V_2$ and $V_4 \approx V_1$ and $V_2 \ll V_1$;

$$\Delta p' \approx \frac{V_1}{V_2}\,\Delta p.$$

Hence the actual pressure drop Δp can be magnified by the ratio of the volumes of the bulb to that of the capillary manometer.

When $(V_3 - V_2)$ and $(V_4 - V_1)$ are not zero, then a plot of $\Delta p'$ versus Δp at different values of P_B will give the value of the expression :

$$\frac{(V_3 - V_2) + (V_4 - V_1)}{V_2}\,.$$

The differential pressures at low pressure may thus be obtained either from the final equation or from a graph and converted into the mercury readings applying the known density ratio of mercury to the oil.

In order to ensure complete pressure equilibrium, a period of ½–1 hr. was allowed to lapse between the compression of the gas and the final measurement of the oil levels. The method itself gives very reproducible results and is simple in operation.

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 18

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Electricity in the Future".

Physical Society, Acoustics Group (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. N. Fleming: "Techniques for Objective Noise Measurement".

Institute of Metal Finishing (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Dr. R. R. Kressman: "Ion Exchange in the Metallurgical Industries".

Royal Institute of Chemistry, London Section (at Dartford Technical College, Dartford), at 7.30 p.m.—Mr. W. S. Wood: "Manufacture and Uses of Hydrogen Peroxide".

Tuesday, October 19

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. H. E. Lewis: "The British North Greenland Expedition, 1952–54".*

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. H. Allen, Mr. W. A. Price and Sir Claude Inglis, F.R.S.: "Model-Experiments on the Storm Surge of 1953 in the Thames Estuary and the Reduction of Future Surges".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. M. Whitehead: Chairman's Address.

University of London, British Postgraduate Medical Federation (in the Beveridge Hall, Senate House, London, W.C.1), at 5.30 p.m.—Prof. A. V. Hill, F.R.S.: "Why Biophysics?" (From a series of lectures on "The Scientific Basis of Medicine".)*

Society of Chemical Industry, Plastics and Polymer Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. C. H. Bamford: "Recent Investigations in the Field of Vinyl Polymerization".

Institution of Mechanical Engineers, Steam Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Measurement of the Wetness of Steam".

Royal Society of Medicine, Pathology Section (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Prof. L. P. Garrod: "Chemicals versus Bacteria" (Presidential Address).

Wednesday, October 20

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. H. Harris: "Biochemical Genetics".*

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Sir Weldon Dalrymple-Champneys: "Non-specific Physiological Factors Controlling the Phenomena of Parasitism" (Presidential Address).

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. S. Chandrasekhar: "Infant Mortality in India, 1901–1951—a Demographic Revolution".*

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. J. N. McArthur: "A Contribution to Microscope Design".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 7.45 p.m.—Mr. Engel Lund and Mr. Ferdinand Rauter: "Folk Songs of Many Lands".*

Thursday, October 21

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. P. E. Hodgson: "Nuclear Disintegration".*

Physical Society and the Institute of Physics (at the Research Laboratories of the General Electric Co., Ltd., Wembley), at 2 p.m.—Joint Colloquia on "Modern Materials for Thermionic Cathodes".

Medical Research Council (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 5 p.m.—Dr. J. H. Hanks (Harvard Medical School, Boston): "The Application of Metabolic Study to Leprosy Research".

Institute of Refrigeration (joint meeting with the Low Temperature Group of the Physical Society, at the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. N. P. Allen: "The Properties of Metals at Low Temperatures".

University of London (at Birkbeck College, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. R. S. Krishnan (Bangalore): "Colloid Optics" (University Lectures in Physics. Further Lectures on November 24 and 25).*

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. B. S. Platt: "Protein Malnutrition". (From a series of lectures on "The Scientific Basis of Medicine".)*

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. P. M. Davidson: "The Manufacture and Applications of Glass in the Building Industry".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. R. B. Heisch: "Epidemiology of an Outbreak of Kala-azar in Kenya".

Textile Institute (at 10 Blackfriars Street, Manchester 3)—Symposium on Transactions Papers.

Friday, October 22

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. W. van Krevelen (Holland): "Heterogeneous Reaction Processes. 2: Gas-Solids Reaction Processes".*

Society for Analytical Chemistry, Physical Methods Group (joint meeting with the London Section of the Royal Institute of Chemistry, in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 7.15 p.m.—Dr. J. E. Johnston: "Assay Equipment for a Radiochemical Laboratory"; Dr. D. E. Palm: "The Determination of Gamma Isomer in Crude Benzene Hexachloride by a Carbon-14 Isotope Dilution Method"; Mr. R. H. Burns: "The Physical and Analytical Control of the Radioactive Effluent from A.E.R.E., Harwell".

Saturday, October 23

British Psychological Society, Education Section (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Mr. G. T. Sare: "Cybernetics and Teaching".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Kenneth P. Oakley: "Piltdown Man".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with an honours degree in mining and preferably with practical experience in the mining industry) in Mining Engineering—The Registrar, The University, Nottingham (October 23).

Mathematician (with a good honours degree, and preferably with some practical experience in the design of experiments), to design and analyse laboratory and small-scale plant experiments—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting TT/851 (October 23).

Scientific Officer (with a good honours degree in botany or agricultural botany) at the hill research farm of the Hill Farming Research Organization, Sourhope, Roxburghshire—The Secretary, Hill Farming Research Organization, Broomhouse Drive, Edinburgh 11 (October 23).

Assistant Experimental Officer (with a pass degree or at least the general certificate of education at advanced level) in the Plant Breeding Section—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (October 25).

Lecturer (with a good honours degree) in Physics, and a Lecturer (with a good honours degree) in Botany, at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 25).

Lecturers (2) (with a good honours degree) in Physics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (October 25).

Assistant Lecturer (with special qualifications in pure mathematics) in Mathematics—The Registrar, The University, Manchester (October 30).

Lecturer in the Department of Clinical Chemistry—The Secretary, The University, Edinburgh (October 30).

Lecturer (with a degree in engineering and preferably with experience or interest in some aspect of heavy power electrical engineering such as modern methods of system analysis or some aspects of electrical design) in Electrical Engineering, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London (Australia, October 30).

National Research Development Corporation Scholarship tenable in the Computing Machine Laboratory—The Registrar, The University, Manchester (October 30).

Lecturer in Anthropology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, October 31).

Assistant Lecturer in Bacteriology—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 1).

Assistant Lecturer (with an honours degree with good qualifications in agricultural chemistry, chemistry or biochemistry, and preferably with previous experience of teaching or research in soil science) in Agricultural Chemistry—The Registrar, The University, Reading (November 1).

Chair of Islamic Archæology—The Dean, Faculty of Arts, Cairo University, Cairo (November 1).

Chair of Animal Husbandry at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 6).

Senior Research Officer or Research Officer (with a degree in veterinary science and postgraduate research experience in bacteriology or immunology, or equivalent qualifications) at the Animal Health Research Laboratory, Commonwealth Scientific and Industrial Research Organization, Parkville, Victoria, to carry out researches on approved aspects of bovine contagious pleuro-pneumonia and to take over the supervision of bovine production—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 201/74 (November 6).

ASSISTANT LECTURERS (with special qualifications in physical chemistry) IN CHEMISTRY—The Registrar, The University, Manchester (November 13).

LECTURER (graduate with some experience of teaching, and preferably with a higher degree suited to the training of teachers) IN EDUCATION, at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, November 15).

SENIOR LECTURER IN PHYSICAL CHEMISTRY at Canterbury University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, November 15).

SENIOR LECTURER IN PHYSICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30).

BIOCHEMIST (Senior grade) (preferably with experience of recent methods used in general medical clinical biochemistry)—The Medical Superintendent, Morriston Hospital, Swansea.

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOW (with high qualifications in science) to undertake research in tinctorial chemistry, textile chemistry, or an allied subject—The Principal, Technical College, Bradford 7.

CHEMISTS (with an honours degree in chemistry, chemical engineering, A.R.I.C., A.M.I.Chem.E. or equivalent qualifications), at Windscale Works, Sellafield, Cumberland, to undertake experimental work on chemical and chemical engineering problems in connexion with the development of new chemical processes—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 676.

ELECTRONIC ENGINEER or PHYSICIST, to assist in installation and operation of an electronic digital calculator—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (graduate in physics or chemistry) required for the Soil Survey of England and Wales, to work on clay mineralogy by X-ray and thermal methods—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

HYDROLOGISTS (with an honours degree in applied science or engineering and at least two years postgraduate experience) in the Public Works Department, Kenya, for investigations of surface and underground water resources, including stream gauging, studies of rainfall and run off, and of ground water reservoirs, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.112/7/01/T.

JUNIOR LECTURER (graduate in science, agricultural science or horticultural science) IN INORGANIC CHEMISTRY AND SOIL SCIENCE at Massey Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

MECHANICAL ENGINEERS, AERODYNAMICISTS, PHYSICISTS, an ELECTRICAL ENGINEER, a CHEMICAL ENGINEER, and a MATHEMATICIAN (with a first- or second-class honours degree or equivalent qualification in an appropriate subject) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.272/54A.

METALLURGIST (with an honours degree in metallurgy, A.I.M., or equivalent, and with considerable industrial experience, preferably in both the ferrous and non-ferrous fields), to advise on all metallurgical problems arising in the design, manufacture and inspection of specialized plant, including nuclear reactors, and to maintain liaison between design offices, other headquarters groups, and various research and development laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 685.

PHYSICIST (with a first- or second-class honours degree or equivalent in physics) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for the design of high temperature electronic components for guided weapons, for use under severe vibration and climatic conditions—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 265/54A.

PHYSICIST (with a good honours degree in physics and at least two years research experience, and ability to extract information from laboratory records, repeat experiments and write suitable articles for the technical press)—The Delawarr Laboratories, Oxford.

RESEARCH ASSISTANT IN THE DEPARTMENT OF CHEMICAL ENGINEERING to investigate certain aspects of the inflammability of gases—Dr. J. H. Burgoyne, Imperial College of Science and Technology, London, S.W.7.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in physics, electrical engineering or mathematics) at the Royal Aircraft Establishment, Farnborough, Hants, for theoretical and experimental work on flight instruments for high speed aircraft, and investigations into stability and control of aircraft when flown with automatic pilots, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.264/54A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Parliamentary and Scientific Committee. Memorandum on Higher Technological Education. Pp. 16. (London: Parliamentary and Scientific Committee, 1954.) 2s. [267

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National Physical Laboratory. Automatic Digital Computation. (Proceedings of a Symposium held at the National Physical Laboratory on March 25, 26, 27 and 28, 1953.) Pp. vi+296 (13 plates). (London: H.M. Stationery Office, 1954.) 21s. net. [267

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the year 1952–1953. Pp. v+269. (Cmd. 9184.) (London: H.M. Stationery Office, 1954.) 7s. 6d. net. [267

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Other Countries

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien, Band 5, Nr. 2: Meridian Observations of Miscellaneous Stars—Observations of Stars contained in Boss' General Catalogue Stars Connected with Galactic Nebulæ, and Variable Stars, made with the Repsold Meridian Circle of the Lund Observatory during the years 1939–44, and reduced to the equinox of 1950. By Sven Cederblad. Pp. 34. (Stockholm: Almqvist and Wiksells Boktryckeri AB.; London: H. K. Lewis and Co., Ltd., 1954.) 5 25 kronor [207

Organisation of Applied Research in Europe, the United States and Canada. Report of Technical Assistance Missions Nos. 81–82–83. Vol. 1: A Comparative Study. Pp. 80. 6s.; 1 dollar; 300 French francs. Vol. 2: Applied Research in Europe. Pp. 192. 12s.; 2 dollars; 600 French francs. Vol. 3: Applied Research in the United States and Canada. Pp. 120. 8s.; 1.25 dollars; 400 French francs. (Paris: Organisation for European Economic Co-operation; London: H.M. Stationery Office, 1954.) [207

Sudan Government. Ministry of Agriculture. Bulletin No. 11: Commercial Horticulture in the Sudan. 2: Mango Cultivation. By L. B. Thrower. Pp. 66+6 plates. 25 p.t. Memoirs of Field Division. No. 3: Pasture Management in Uganda in Relation to Western Equatoria. By J. R. Catford. Pp. 5. No. 4: A Note based on Field Experience in Planning Hafir Excavation Programmes. By J. H. K. Jefferson. Pp. 22. (Khartoum: Agricultural Publications Committee, 1952–1954.) [287

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Western Australia. Report of the Government Chemical Laboratories for the year 1951. Pp. 12. (Perth: Government Printer, 1954.) [267

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POWER AND INFLUENCE IN THE MODERN STATE

THE autobiography which Lord Beveridge published last year under the title "Power and Influence"* is, like that of Lord Reith published earlier†, of historical interest. Both books fail to throw as much light as might have been expected on the developments with which their authors are most closely and enduringly associated: Reith, because his greatest achievement was to him of little interest compared with his brief career in ministerial office; Beveridge, in part, because the origins of the Beveridge Report were left to be told more fully in Lady Beveridge's subsequent book. They are, of course, authoritative in their particular fields, but through them both runs a note of disappointment and frustration. While this may sometimes lead the reader to ask questions about our ability to make use of talent, it also induces reflexions on the theme around which Beveridge in particular has written his book, and indeed about the whole nature of government, the way it works, the limits of autocracy and democracy, the place of the expert in democracy, the efficacy of discussion and persuasion and the adaptation of society to the new powers and influences to which it is subjected by technological change. It is not the frustration, which Reith and Beveridge are inclined to take tragically, that leaves the dominant impression, but the deeper issues that are opened up by the title Lord Beveridge chose for his book, and that lie at the root of the functioning of democracy in a world in which such immense concentrations of power are possible. To the questions of leadership in the modern State, the source of power and the process of influence, Lord Beveridge's book is highly relevant, and it may be surmised that if either he or Lord Reith were induced to lecture on leadership, they might contribute some dicta at variance with those hitherto enunciated in the Walker Trust Lectures.

The conceptions of leadership which find expression in these two books, to some extent complementary, are indeed imperfect or incomplete. Lord Beveridge does not seem to appreciate how closely this question of leadership is related to his theme. Power, as he uses the word, means ability to give to other men orders enforceable by sanctions, punishment or control of rewards, and—especially the power of government—the making and enforcing of laws, using the instrument of fear. He recognizes that if power is to be used for good, it must be guided by reason and accompanied by respect for other men, and that in any advanced society there is also the power of money, working through self-interest—greed rather than fear. By influence, on the other hand, he means changing the actions of others by persuasion and by appealing to reason or to emotions other than fear or greed; and to him the instruments of influence are words, spoken or written, while for influence to be for good it must rest on knowledge. Influence, in fact, is set in antithesis to power as the alternative means of getting things done. They are not seen as complementary. Influence, it is true, is not government, but Lord Beveridge suggests that the pursuit and exercise of power do not consort naturally with the pursuit of knowledge or the appeal to reason.

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* "Power and Influence". By Lord Beveridge. (London: Hodder and Stoughton, 1953.) 30s.

† "Into the Wind". By Lord Reith. (London: Hodder and Stoughton, 1949.) 25s.

Power as a means of getting things done appeals to that which men share with the animals, to fear and to greed; it leads those who wield it to desire it for its own sake, not for the service it may render, and to seek its continuance in their own hands. Influence, on the other hand, he argues, as a means of getting things done, appeals to that which distinguishes men from animals; and the way out of the world's troubles to-day is to treat men as men, to enthrone influence over power, and to make power revocable. It is no longer more knowledge that the world chiefly needs: power is now in the hands of men whose intentions, by any standard of respect for humanity, justice and freedom, are suspect.

Although Lord Beveridge considers the heart of the world's problem to-day is to find the right means of controlling the exercise of power and securing a place for influence, and asks some pertinent questions about democracy and the exercise of power in a democracy by particular groups, his antithesis between power and influence seems to lead him astray. It was one of his own staff at the London School of Economics who laid it down as a principle of legislation that the channels of assent could not be dug too deep, and the problem of the responsible exercise of power turns in part on this question of assent or persuasion and discussion.

Even more, it turns on personality, and this factor Lord Beveridge tends to discount or ignore. When he writes, "to use on administration the time of a great teacher or researcher is misuse of rare faculties; it is misuse which men of the highest gifts as a rule take care to avoid", he is directing attention to a danger to which scientists at least, as Sir Cyril Hinshelwood's address at the British Association meeting in Edinburgh testified, are increasingly conscious. But it is only one side of the truth. Harm and waste would equally result if no such men brought to the task of administration the imaginative insight which only their genius can confer. Government is more than administration, and administration is something more than the mechanical organization of work, the breaking up of complex tasks into simple processes, the assignment of responsibility and the provision of means for accomplishing the task assigned, to which Lord Beveridge appears to limit his conception.

In this mechanical aspect of administration Lord Beveridge himself excelled; but the government or leadership of men demands also something else, which John Buchan expressed so admirably in his lecture on Montrose and leadership and which, more prosaically, is embodied in Lieutenant-Commander A. H. Leighton's principles for the governing of men. This communication of purpose, this vision or contagion of greatness is the essence of leadership, and it springs from that indefinable personality in which Lord Beveridge is not interested as such, for all the affinity between his own definition of the art of leadership—"making common men do uncommon things"—with that of Buchan. That factor cannot be ignored in any study of government, of the relations between power and influence. Without it, integrity, intellectual ability and the capacity for sustained hard work can be ineffective—the tools of tyranny as readily as of freedom. Nor without it is experience alone likely to engender that sense of timing and of what is appropriate and possible which lies at the root of wise administration and government by consent. To arrive at a solution of this problem of power and influence, we must at least consider the processes by which such gifts are developed or acquired and also the conditions under which they are most effectively exercised. No reader of Lord Reith's "Into the Wind", for example, could imagine that the author was lacking in personality, or that he underrated the factor which Lord Beveridge discounts. The clue to Lord Reith's frustration is to be sought rather in the conditions in which personality is exercised, and his book might equally suggest an inquiry into the nemesis of power.

The right relations of power and influence turn as much on this question of personality as they do on the relations between knowledge and power. The task of government at any level to-day, from the international to the local level, involves increasingly the wise use of experts. Decisions and policy must be based on accurate knowledge and technical considerations, though not solely on these. If, however, such considerations are ignored, or the facts wilfully disregarded, disaster may well ensue.

The real challenge of the atom bomb or the hydrogen bomb comes into this context; only secondarily is it a moral challenge. Primarily it is a challenge to the hard thinking required to reshape institutions and policies to take full account of facts that do not consort with the form or practices in which ideas or prejudices have been expressed. If the expert is to be used effectively, he must himself give some attention to the expression of his ideas and to the persuasiveness with which he presents his conclusions as to the kind of policy that his expert knowledge suggests.

For this reason we require not merely experts, in spite of our need of more expert knowledge than ever; we also need men and women with personality, with faith and courage. It is curious that Lord Beveridge, who recognizes clearly enough that, behind his theme of power and influence lies this factor of change and the shaping of institutions and society to meet the needs of a new situation in which action and policy must be determined by knowledge and not prejudice, sees a somewhat false dichotomy between the scientist and the administrator or statesman. His view that the scientist is necessarily unpractical and indecisive will certainly be challenged, nor does it follow that those whose whole energies are spent in advocating some practical reform need be unscientific. The latter depends in part on whether the reform they advocate is based on knowledge rather than prejudice or whim, and in part on the outlook their training has given them. If, indeed, members of Parliament cannot be scientific and impartial, the prospects of democracy are indeed dim.

Lord Beveridge, it is true, insists that to acquire something of the scientific spirit is vital, and one remark he makes in relation to the chairmanship of the Unemployment Insurance Statutory Committee, which he held during 1934–44, is apposite: "In a world of regulations and controls it seems increasingly worth while to give to those subject to control a chance of expressing their views neither to a preoccupied Minister nor to a permanent official, but to a body of just men with time and independence and the right of making their judgments known". He sees, in fact, as the title of his epilogue tells us, that democracy, which has nothing to say about equality, but refers solely to power and the control of power, is a matter of mental climate. What he does not fully recognize is that the real issue is between two different tempers of mind—the spirit and temper of accommodation and the spirit and temper of intransigence; and his view of the way in which such climates of opinion are formed and changed is colourless and mechanical, lacking the vital quality of personality.

That quality is important, moreover, for yet another reason. The extent to which technical factors enter into sound political decisions means that the efficiency and even the possibility of government depend upon the removal of many such decisions from the range of popular choice. Even when the electorate is competent to make a sound choice, security considerations, as, for example, in the development of the hydrogen bomb and other atomic weapons or guided missiles, may make it impossible for the electorate to be given all the information required as a basis for wise decisions. To some extent that applies to its representatives in Parliament, and that is one reason for viewing with concern the growth in power of the political party system and the tendency to restrain Government policy and decisions within limits set by purely party bodies outside Parliament rather than on the corporate feeling of Parliament itself.

What has to be recognized is that any such removal of decisions from the control of Parliament exercising its corporate sense of the public interest is just as real a threat to liberty as the domination of Parliament by a single class or party. The distinguishing feature of the British constitution hitherto has been he practice of government by discussion between epresentatives who both possessed the confidence of he people and were free from their detailed control. f a new system is to be evolved or substituted in which decisions and policy are determined by technical considerations and expert knowledge, whether scientific or not, the implications must be faced and n attempt made to solve the problems of persuasion nd consent. Failure to do so will destroy the spirit f accommodation and lead to intransigence and tyranny just as surely as the attempt to make Parliament the instrument of a single class or section, sterilized against the conception of the public interest.

There is a further point also which Lord Beveridge has missed. Whether power is gained by accident or design and wielded brutally or responsibly, influence can only be won, and it is exercised continually by personal impact: it is dynamic not static, as so many professional associations forget. This point has a vital bearing on the responsible exercise of power and the place of the expert in government, and Sir Ernest Barker's analysis in his "Reflections on Government" goes much deeper than some current discussions on the adaptation of Parliamentary procedure and organization to the needs of to-day.

In the first place, we need to distinguish between the authority of the expert and that of the government itself. The first resides in the knowledge of the expert in the particular field in which he is qualified, and within which he has both the right and the duty to speak. It is an authority based on knowledge, and limited to that particular subject. The second resides in the competency of a person or body of persons to issue compulsory orders in the political field, and depends on the fulfilment of the conditions under which it was given and the cogency of those conditions in changing political circumstances. It depends accordingly to some extent on sound judgment, based on experience, rather than scientific knowledge, as to the continuing validity of the conditions under which the authority was originally given.

While the personal factor comes in at this stage on the political or government side, on that of the scientific expert it comes in at a different level. First, information, however authoritative in regard to even the most important particular field, must necessarily be compared with, and adjusted to, information in regard to other fields. No issue in politics falls within one field of science and one only. It is here, however, that the claim of the scientific expert is commonly misunderstood. It is not a claim as such to a place in the task or authority of government: it is a claim that those responsible for the task of government should be qualified and competent to assess the significance of particular scientific or technical factors, and to evaluate them along with the other factors involved in matters of public policy.

Second, not only is the information supplied by the expert in regard to his field confined on the whole to knowledge at that particular time: in the main it deals with measurable things, with questions of fact. It is quantitative and is not intended to solve problems of action, other than setting limits within which action is possible. The solution of such problems, which is the task of government, depends on more than the measurement of data and the results which such measurements can give. It may involve also the extrapolation of data to assess the probability of change within the time factor involved in political action. It involves at least a process by which the different but immeasurable claims of right and acknowledgments of duty are made sufficiently commensurable for adjustment to one another and are set to give information about themselves and in so doing to reconcile themselves to one another in a mutually acceptable solution.

Obviously, the scientist can only make his full contribution through those who possess not only an understanding of the way in which science works, but also sufficient knowledge to assess the validity of recommendations coming from within a particular field. Such persons must combine personality with their general or particular scientific knowledge, and they must also have a clear perception of the limits of scientific and technical knowledge and of the way in which the methods of open discussion and voluntary agreement function in a parliamentary democracy.

As Sir Ernest Barker points out, democracy which rests merely on the will of numbers rests merely on force. When, for example, a parliamentary government ceases to take account of public opinion or of parliament as a whole and reflects purely the views and wills of the party in a majority, it verges on the autocracy of a totalitarian regime. It ceases to be a democracy in the sense in which that word has hitherto been employed in Britain. The force which democracy can employ is inadequate merely as force, because democracy must consort with, as it is based upon, the free and full development of personality. It is not the majority, as a majority, that matters, but each human being as such; and the form of government which we have to find to-day is one which so far as possible elicits and enlists the thought, will, and general capacity, not of a majority but of every member. Such a government depends on mutual interchange of ideas, on mutual criticism of the ideas interchanged, and on the common and agreed choice of the idea which emerges triumphant from these processes. In such a government the influence of the scientific expert can be exerted in the way that is required and that consorts with the method of science itself. It will be a government which rests not on force or on numbers or even on knowledge, but on the spiritual quality of the processes by which it operates; and the effectiveness with which it works depends above all on the personality of those to whom the functions and authority of government are entrusted and the persuasiveness with which they can continuously enlist the understanding, goodwill and participation not of a minority—or even of a majority—but of all the governed.

DE BROGLIE ON QUANTUM THEORY

The Revolution in Physics

A Non-Mathematical Survey of Quanta. By Louis de Broglie. Pp. 310. (London: Routledge and Kegan Paul, Ltd., 1954.) 18s. net.

LOUIS DE BROGLIE has a unique place in the history of science as the man who in 1923 propounded the hypothesis of the wave character of material particles and thereby initiated the great movement of thought concerned in the passage from the 'old' to the 'new' quantum theory. His ideas also led directly to vital technical developments represented, in particular, by the invention of the electron microscope. Since then, besides carrying on his own scientific work, he has taken a leading part in scientific education and administration in France. In addition, he has attained eminence as a scientific writer. The present book is a translation by Ralph W. Niemeyer of one of his most notable expository works (with certain additions). Apparently the main text was written in 1936 and revised in 1946, and a few sections added in 1952.

The book may be described as an exposition, following the historical development, of the whole of quantum theory excluding (apart from brief references) the modern quantum theory of fields and modern nuclear theory. The treatment is strictly non-mathematical, but some descriptive indication is given of the mathematical structure of the theory. The work will appeal to several classes of reader. Presumably it is intended primarily for the general scientific reader, other than the mathematician or physicist, who seriously wants to understand the "revolution in physics" that has taken place in the present century. Such a reader will be well rewarded for the attentive study that the author's thorough explanations invite from him. But, since something like classical physics and something like quantum physics must always be necessary, not only for the sake of their appropriate applications, but also on account of the very nature of physical experience, it is essential to understand as well as may be the relation between these two systems; and since a special feature of the book is the statement of this relation as it stands at present, it should also be of much service to the present-day student of physics. Finally, in view of the central part played by the author himself, the book has special significance as a historical record. In this regard, it can be read as an interesting supplement to the recently published second volume of Sir Edmund Whittaker's "History of the Theories of Aether and Electricity", which also supplies the documentation not included in M. de Broglie's account.

Even in describing his own accepted contributions, M. de Broglie avoids the use of the first person singular. He reserves this form of expression for the statement of a few individual speculations and criticisms. These serve to remind us that, great as have been the successes of the theories described, the "revolution in physics" must never be assumed to have resulted in a settled régime.

W. H. McCrea

AN ASSORTMENT OF PROTEINS

The Proteins

Chemistry, Biological Activity, and Methods. Edited by Hans Neurath and Kenneth Bailey. Vol. 2, Part A. Pp. x+661. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 14 dollars.

THE nine articles that make up this third volume of a four-volume work are, for the most part, good; the information contained in them is well selected and the authors generally approach the statements they are reporting in a pleasantly critical manner. It is therefore more than usually important to consider what the advantage is of having all the articles bound together in one volume, for the consequent restriction on their distribution would matter less if it were not so obvious that much valuable time has gone into the writing. Papers appear higgledy-piggledy in scientific journals by tradition; because their classification would probably involve the editors in unnecessary argument; and because separate reprints are generally looked on by librarians as awkward things to handle. Some of the same arguments justify disorder in annual reviews and similar publications; their contents are united by their ephemeralness and little more is needed. The shortest article here runs to only twenty-five pages, which is perhaps too short to justify separate publication, but two of them run to more than a hundred pages and they would have made admirable books along the lines of the "Monographs on Biochemistry" that were such a valuable feature of the first third of this century. Had they come out in this form it is certain that they would have found more purchasers and probable that they would have found more readers.

Markham and Smith give a clear account of the history of research on the nucleic acids, nucleoproteins and viruses; and they point out how often apparently new methods had already been used by the older worker. Their criticisms of recent work are in the main valuable, though sometimes a little facile. The section on bacterial viruses is particularly good because it brings out the nature of the actual observations made; these have often recently been lost sight of in a fog of interpretations.

Work on the oxidizing enzymes has been more thoroughly integrated than any other part of biochemistry. Singer and Kearney classify it under the four main prosthetic groups, copper, pyridine nucleotide, flavine nucleotide and thiamine. They are careful to avoid the generalizations that loom so large in less specialized text-books and emphasize the importance of always mentioning the source of an enzyme in its name. Enzymes from different sources often have widely different properties though catalysing the same action, and the stress laid on this will help to focus attention on the nature of the minimum structure needed to bring about an action.

A straightforward, if pedestrian, article on respiratory proteins is followed by van Heyningen on toxic proteins. This is a well-planned account of an unusual subject; the main criticism of it is that some of the physiological and zoological jargon will not be comprehensible to chemically trained readers. He discusses critically the mode of action of these toxins, the evidence that they are useful to the organisms making them on account of the properties that we investigate, and the dangers underlying the assumption that, because a protein can do something, that is necessarily what it does do *in vivo*. McMeekin, on milk proteins, is less successful in resisting the allure of teleology. His article, and also the two on egg and seed proteins, brings out clearly the manner in which protein preparations, which appear to be homogeneous by two or three different criteria, are often shown to be inhomogeneous by the application of a third or fourth. The general recognition that homogeneity is not a property that can be demonstrated in proteins because it is, strictly speaking, only the absence of a defined type of inhomogeneity, is one of the most satisfactory aspects of research during the past decade.

Steward and Thompson have a completely different conception of the general character of the book from that shared by most of the other contributors. Their article is called proteins and protein metabolism in plants, but it is in fact a comprehensive and uncritical review of the greater part of the broader field of nitrogen metabolism in plants and much of it is only tenuously connected to proteins. If it makes more biochemists aware of the value that a plant's metabolic plasticity has in research, it will be useful.

Finally, Li describes the protein hormones in a straightforward and factual way. In the section on insulin he discusses species differences and the extent to which an activity can be shared by several different structures. It is a pity that this point, so well emphasized by Singer and Kearney, is not stressed for the other hormones too. There is generally no clear statement whether those made by different organisms are supposed to be identical or not.

The editors are to be congratulated on a book nearly free from printing errors, but they seem to have made little attempt to prevent overlapping or to put in cross-references where it does occur. There is, for example, more about the L-amino-acid oxidase of snake venom in the chapter on oxidizing enzymes than in that on toxic proteins, but neither mentions the other. To revert to the argument in the first paragraph of this review, one possible advantage of binding several articles in one volume has therefore been missed. Those who think of buying only one volume out of the four, because their tastes are catered for by the accidental grouping of articles in it, have been partly defeated by the editors. They have reserved the index for the last volume. The adequacy of the index cannot therefore be commented on.

N. W. PIRIE

THE WAY OF SEX

Sex and the Nature of Things

By Dr. N. J. Berrill. Pp. 256. (London: Victor Gollancz, Ltd., 1954.) 13*s*. 6*d*. net.

Reproduction and Sex

By Dr. G. I. M. Swyer. (Survey of Human Biology.) Pp. viii+280. (London: Routledge and Kegan Paul, Ltd., 1954.) 25*s*. net.

THESE two books are complementary and are both excellent expositions. Neither is meant for specialists, so biologists and endocrinologists should avoid them; but those whose subjects lie in other directions will find them enjoyable. Dr. Berrill's reminds one of those pleasant essays which Sir Ray Lankester published in the days of our youth, called "Science from an Easy Chair". However, his were on general biological topics, whereas Dr. Berrill's is really a history of the evolution of sex from the most primitive appearance of it as hermaphroditic reproduction in tunicates to the complication of placentals.

In some ways, Dr. Berrill disagrees with the usually accepted theory. For example, he believes that the giant reptiles, such as the dinosaurs, were exterminated by an increase in the temperature rather than by cold. It was this which caused the evolution of mammals by the shedding of reptilian scales, the development of sweat glands, and the growth of hair as an insulating medium, the production of heat by the muscles and the control of its loss by the nerve supply to the cutaneous blood vessels. He suggests that the first mammals were nocturnal animals because of their dull coloration and lack of colour vision, which contrasts with the birds and reptiles.

However, the book is not primarily concerned with such theories, interesting though they are, but with the evolution of sex, and he deals at length with the choice of a mate, mating behaviour, sexual dances of birds, and the sexual conduct of reptiles and mammals.

I have noticed only one tiny slip. On p. 128 Dr. Berrill suggests that a man's interest in the female disappears when he has insufficient male hormone; this is not necessarily true—it is, however, a triviality.

Dr. Swyer's book is not concerned with the evolution but with the manifestation of sex in the human. He gives first of all an outline and then goes on to describe reproduction in the male, the function of the adrenal cortex, and the female reproductive cycle. After this he deals with disorders of menstruation and the climacteric, and then with anomalies of sexual development. He describes conception, pregnancy and its special problems, childbirth and the problems associated with it, and breast feeding. He gives a chapter on fertility and infertility. Finally—most unusual in a book of this kind—Dr. Swyer devotes space to the psychological side of sexual behaviour and its development as well as the sexual anomalies and disorders. There are two appendixes: one on the anatomy of the reproductive organs and one on tubal patency.

There are innumerable popular books on the physiology of sex, but what makes Dr. Swyer's different from the usual 'outline' is that it is written by a specialist who is not only an endocrinologist, but also is consultant to the obstetric department of a large London hospital. He is thus able to approach the exposition of his subject with an intimate knowledge of both endocrinology and obstetrics, which the usual 'popularizer' lacks. The masterly way in which he explains the more complicated elements of female endocrinology in such conditions as menstruation, pregnancy and lactation makes his book well worth reading. Medical men who have lost touch with recent developments of sexual endocrinology could use his volume as a useful introduction; but it is so clearly written that it should be comprehensible to any educated person.

Once the subject of sex was regarded as scarcely a topic to be studied by the layman and not quite respectable. We have fortunately passed by such foolishness, and books such as these show that the ordinary man can be properly informed as to how sex was evolved and how it works. He will find the whole subject fascinating. CLIFFORD ALLEN

ASPECTS OF BIOCHEMISTRY

Essentials of Physiological Chemistry

By Prof. Arthur K. Anderson. Fourth edition. Pp. vii+480. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 40*s*. net.

Dynamic Aspects of Biochemistry

By Prof. Ernest Baldwin. Second edition. Pp. xx+544. (Cambridge: At the University Press, 1952.) 30*s*. net.

General Biochemistry

By Prof. Joseph S. Fruton and Prof. Sofia Simmonds. Pp. xii+940. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 80*s*. net.

It would be difficult to find three such dissimilar books dealing with the same branch of science. In the handling of the subject-matter and in the scope of presentation each book differs sharply from the others, but each has its own distinctive part to play in the biochemical literature.

Prof. Anderson's book is an elementary text of moderate size which first appeared in 1935 and which has now demonstrated its popularity, particularly in the United States, by reaching its fourth edition. It is essentially a book in which the beginner is introduced to biochemistry by the classical sequence of chemical structure of carbohydrates, lipids and proteins, their digestion, their metabolism and the excretion of the final products. The bias is heavily in favour of animal biochemistry, the physiological side is stressed—and rightly so in an introductory text—and the book is thus set to the level of the second-year medical student.

For the reader who has mastered Anderson—or its equivalent—Baldwin is the next logical step in his biochemical education, and the second edition of this remarkable book will be greeted with all the greater interest since the first edition achieved the unusual distinction of becoming a biochemical best seller. In spite of Prof. Baldwin's contention that this book is an elementary text-book, the reviewer cannot agree that it is an introduction to the subject, for the story does not begin at the beginning, and the reader who has not progressed to Baldwin from a more elementary text will soon find himself in difficulties. The book, moreover, does not attempt to cover the whole field of biochemistry, but deals briefly but comprehensively, at what is essentially an intermediate level, with the very body and bones of the subject—enzymology and metabolism, using the latter word in its broadest sense. The loose ends in the first edition have been tidied up and recent developments, including energetics, have been included with the same characteristic clarity and vigour of presentation as made the first edition so widely popular. In spite of the minor weakness due to the inadequate size of the bibliography, Baldwin's "Dynamic Aspects" has by now reached such an established place that no biochemical education is complete without it.

While Baldwin deals with aspects, Fruton and Simmonds cover the whole field, at what might be called a sophisticated level. As befits a text for advanced students, it plunges straight into the proteins before progressing through the enzymes and biological oxidations to a detailed study of intermediate metabolism. To attempt to write a comprehensive advanced treatise on a subject which is advancing and changing with disconcerting speed is a formidable task which few have attempted, but which has in this case been achieved with outstanding distinction. Of the two salient features of the book, one is its characteristic freshness of presentation; the authors have been fettered by none of the classical traditions which tend to stamp a pattern of uniformity on older books of a similar type, but have covered modern biochemistry in the way which seems to them—and to the reviewer—to be logical and systematic. The layouts of formulæ, figures and diagrams are entirely modern. The other characteristic feature is the wealth and breadth of documentation with chapter and verse given for each statement up to a remarkably recent date. Yet this comprehensive treatment of a big subject is compressed into 900 very readable pages. This book deserves to go through many editions—if the authors are prepared to face the formidable task o quinquennial, or even more frequent, revision.

J. N. DAVIDSON

THE ASSOCIATION OF APPLIED BIOLOGISTS (1904–54)

By R. W. MARSH
Research Station, Long Ashton, Bristol

ON November 8, 1904, Mr. Walter Collinge, of the University of Birmingham, called a meeting in the rooms of the Linnean Society, London. The seven workers interested in applied biology who attended agreed to the foundation of the Society that is now known as the Association of Applied Biologists. At this first meeting a total of twenty-seven original members was elected: they included Sir Ronald Ross, Sir Arthur Shipley, Prof. A. H. R. Buller, Prof. Maxwell Lefroy, Prof. F. V. Theobald and Mr. Cecil Warburton, now a centenarian and the only remaining survivor of the group of original members.

When the Association was inaugurated, applied biology was the pursuit of a few scattered workers, most of whom had other official duties. The first British appointments specifically for research in applied biology had been made within the previous two years at Rothamsted and Long Ashton. From 1905 until 1909 a major aim of the newly formed Association was to bring to the notice of government and university authorities the existence and potentialities of applied biology. To achieve this aim the Association became a peripatetic body, holding meetings in Birmingham, Liverpool, Cambridge, London, Edinburgh, Oxford, Manchester and Dublin. Among the subjects discussed in these early years were cereal breeding, the American gooseberry mildew, the Isle of Wight disease of bees, the larch sawfly, and the feeding habits of British birds. By 1909 the proselytizing activities of the Association had induced the enrolment of 132 members and had gained widespread recognition of the importance of applied biological research in the national economy.

This recognition was given tangible form in the constitution of the Development Fund by Parliament in 1909 with an allocation of £2,900,000 for aiding and developing agriculture and rural industries. In 1911 the Commissioners appointed to administer the fund adopted a scheme for the establishment of research institutes, the provision of technical advice, the support of research outside the institutes and the establishment of a scholarship scheme for training scientific workers. These provisions made a secure basis for the enlistment of a number of professional applied biologists, which, in its turn, was reflected in the increased activity of the Association.

By 1912–13 it was felt that the Association would function more satisfactorily if its headquarters were in London and if the existing arrangement whereby members published in the privately owned *Journal of Economic Biology* could be terminated. Stimulated particularly by the energy and vision of Prof. Maxwell Lefroy, the Association launched in May 1914 its own journal, the *Annals of Applied Biology*.

In its new role as a publishing society, the Association was almost immediately confronted with problems arising out of the First World War and its aftermath. With much difficulty, the publication of the *Annals* was maintained; but the other activities of the Association virtually ceased during the war period. The years 1918–21 were marked by recurrent financial crises threatening catastrophe, from which the Association was saved only by the resolute efforts of Prof. W. B. Brierley. He restored the stability of the Association and became editor of the *Annals of Applied Biology* in 1921. For the next twenty-five years, Prof. Brierley piloted the *Annals* to its position of unquestioned prestige.

A second period of major expansion in applied biology followed the 1921 repeal of the Corn Production Acts when, as a solatium to the farming industry, £850,000 was allotted to agricultural education and research in the ensuing five years. Within the agricultural research institutes and the advisory services many developments that had been held in abeyance since 1914 were thus facilitated, and the membership of the Association rose to 250 by 1925. During the next decade the expansion of the Department of Scientific and Industrial Research, the grants made by the Empire Marketing Board, and the attention paid to Colonial agricultural development all led to increases in the number of appointments in applied biology, reflected in demands for more meetings of the Association and for increased provision for publication.

In consequence, the activities of the Association from 1922 to the end of the inter-war period showed steady expansion. In addition to the four meetings or symposia held annually in London—where the Imperial College of Science and Technology has generously acted as host to the Association since 1917—one or more provincial and field meetings were arranged each year at centres throughout the British Isles. The *Annals of Applied Biology* was expanded from a volume of 359 pages and 14 plates in 1922 to one of 940 pages and 51 plates in 1937.

During the Second World War the expansion of the Association continued; but Prof. Brierley had to meet the problem of maintaining the publication of the *Annals* in spite of drastically reduced paper supplies and rising costs. He overcame these difficulties so successfully that at the end of the War it could be recorded that the *Annals of Applied Biology*, almost alone among British scientific quarterlies, had maintained the issue of four numbers a year in unbroken succession. During the War, the printing order for each issue remained restricted to seven hundred copies: this figure has now risen to 1,800.

Membership of the Association, now approximately seven hundred, includes on an equal footing research, advisory and teaching workers in government service and in industry, in Britain, the Commonwealth and Empire, and in many other countries throughout the world. The interests of the members, which are reflected in the *Annals of Applied Biology*, include all aspects of plant pathology (in its widest sense), the problems relating to stored products, plant and animal physiology and the application of statistical methods in biology.

Over the past fifty years the ever-increasing diversity of the elements making up applied biology has emphasized the need for bridging and integration in this field. The correlation of pure science with practice and the maintenance of the links between the interests included in applied biology has been and remains a major contribution made by the Association to the advancement of scientific knowledge.

JUBILEE CONFERENCE ON SEPTEMBER 13–17

THE Golden Jubilee of the Association of Applied Biologists was celebrated by a programme of lectures and symposia held at the Imperial College of Science and Technology, London, during September 13–15, followed by visits to research stations on September 16 and 17. Registered members of the Conference numbered 430, including 62 from twenty-one countries outside the United Kingdom.

At the opening meeting in the Jehangir Hall of the Imperial Institute, the president, Prof. William Brown, read the messages that had been sent to H.M. the Queen, to Prof. W. Brierley, and to Mr. Cecil Warburton, the only surviving original member of the Association. After giving a brief history of the Association, he welcomed the members and visitors. Dr. E. Gram (Denmark) responded on behalf of the visitors from Europe, and Dr. Starr Chester, replying for the North American visitors, conveyed the greetings of the American Phytopathological Society.

The inaugural address was delivered by Sir John Russell on "The Changing Problems of Applied Biology". Sir John recalled the early developments of the subject: the writings of Berkeley, Curtis and Miss Ormerod, the pioneer course in agricultural chemistry given by Prof. Liveing at Cambridge in 1891, and the establishment of Wye College under A. D. Hall in 1894.

In tracing the subsequent advances in applied biology, he attached major importance to the effects of the growth of technological organic chemistry that started during the First World War. Among the repercussions of this development were the far-reaching advances in all aspects of the work on crop protection products and growth-regulating substances. Another major impetus was given by the work of R. A. Fisher on the application of statistics to applied biology. The study of virus diseases of plants formed an outstanding example of advances in a field that was completely unexplored fifty years ago.

Sir John stressed the danger that specialists in applied biology may easily lose touch with each other, a danger that the work of the Association has done much to avert.

The guest lecturer on the evening of September 13 was Prof. E. C. Stakman, of the University of Minnesota. Taking as his subject "Progress and Problems in Plant Pathology", he emphasized the gravity of plant disease losses in an underfed world and listed the major contributions made by plant pathologists in reducing these losses.

Dealing with the control of black rust of wheat, Prof. Stakman showed that the eradication of 260 million barberry bushes in the United States between 1918 and 1941 had restricted the number of important races of the rust in North America to four. Wheat varieties resistant to these strains were bred and provided a satisfactory solution of the rust problem from 1938 until 1949, when the new race 15B attacked the hitherto rust-resistant varieties.

Prof. Stakman dealt with the possible means of origin of such new races from uredospore crosses. In maize smut, which can be grown in culture, mutant forms can be induced by using uranium nitrate, and these show a range of pathogenicity and of resistance to fungicides.

Prof. V. B. Wigglesworth (Cambridge) gave the evening lecture on September 14 on "The Contribution of Fundamental Research to Applied Biology". He attributed most practical advances to empirical attack, the function of fundamental research being to contribute fresh outlooks stimulating new methods of approach. A major difficulty in supporting basic research lay in the impossibility of determining which ideas would lead on to fruitful results. Karl Pearson, for example, writing in 1892, had selected the newly-described Hertzian waves—the waves of radio—as one discovery that could never be of any practical value.

The increasing cost of research work has made universities more and more dependent on the funds provided by the research councils, which are naturally aiming at practical objectives. There is therefore a danger of the neglect of fundamental research in biology, with the consequent loss of the source of new ideas. Prof. Wigglesworth commended the suggestion of Prof. Paul Weiss in the United States, that organizations supporting applied research should devote a fraction of their budgets to the cost of completely unfettered fundamental studies.

The closing lecture was delivered by Dr. K. W. Neatby, director of the Canadian Department of Agriculture Science Service, on "The Application of Biological Research to Canadian Agriculture and Forestry". In a survey of the history and organization of applied biology in Canada, he stated that the preponderating contributions were made by workers in government service—applied biology is still a relatively neglected subject in Canadian universities.

After dealing with problems of insect balance in orchards and climatological factors in tree diseases, Dr. Neatby described a method used at Ottawa for accelerated wheat breeding, enabling three generations a year to be raised in controlled-temperature chambers. The baking quality of small amounts of the newly-bred wheats can now be rapidly assessed by measuring the expansion of balls of fermenting dough in weak salt solution, and milling properties are to be tested in a micro-mill which is being constructed to produce flour from less than an ounce of wheat.

The remaining papers presented at the Conference were grouped into ten symposia. The topic of "International Co-operation in the Field of Crop Protection" was introduced by Mr. W. C. Moore (Plant Pathology Laboratory, Harpenden). As an example of progress already made, he referred to the International Plant Protection Convention, sponsored by the Food and Agriculture Organization in 1951 and now accepted by forty countries undertaking to collect and exchange phytopathological information, to carry out plant health inspections and to issue export certificates conforming to an agreed standard. The European Plant Protection Organization has since 1950 studied and recommended means of restricting the spread of pests and has organized the campaigns against the Colorado beetle.

These campaigns were described by Dr. V. E. Wilkins (director-general of the European Plant Protection Organization). He recounted the early devices for arousing public interest and showed the benefit derived by Britain from the reduction of infestation in the Cotentin peninsula and in the Pas de Calais. Eradication of the musk rat in Holland is also being attempted by the Organization. The fall webworm (*Hyphantria cunea*) spread in 1951 from Hungary to Yugoslavia, where it caused defoliation of fruit and forest trees. By 1953 the control campaign had averted the threatened spread of this pest to the rest of Europe.

Dr. E. Gram (State Plant Pathology Institute, Denmark) surveyed the problems of preventing the introduction of pests and diseases on plants sent from one country to another. He considered that air transport of plants and the world trade in grain need more supervision by plant health authorities. Dr. Gram advocated an extension of pest and disease surveys, of field inspection services and of fumigation before shipping. Improvements in these matters should make it possible to simplify some of the present quarantine procedures.

In the symposium on "Insect Pests of Stored Products", Mr. F. R. Cann, of the Infestation Control Division, Ministry of Agriculture and Fisheries, spoke on the biological aspects and economic problems of the entomology of stored products in temperate countries. He divided these pests into three groups—hose endemic in Britain, pests introduced from other temperate countries, and those arriving from the ropics. The 'temperate group' increases very rapidly in the warmer months and their attacks can be reduced by cool storage (40–50° F.). Some introduced tropical species, such as Pharaoh's ant, can continue to breed in bakeries and other heated buildings.

Dr. E. A. Parkin (Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough) reviewed progress in the control of insects infesting stored foodstuffs. After stressing the importance of cleanliness and order in the food-store, he surveyed developments in fumigation by ethylene oxide, methyl bromide and chlorinated hydrocarbons; he then dealt with the use of contact insecticides—pyrethrum, DDT, 'Gammexane' and inert mineral dusts. Concerning future developments, Dr. Parkin considered that the biggest gain would come from focusing attention on the biology and behaviour of a particular insect in specific products.

Dr. D. W. Hall, from the same Laboratory, dealt with problems of food storage in tropical countries. Here, major difficulties arise from the unsuitability of the traditional types of storage and the lack of rained staff. After only five years work, considerable advances have been made in Africa in developing methods of storing grain in sealed pits and in silos. Fumigation under gas-proof sheets has been successully applied to groundnuts in Nigeria since 1949 and is now being adopted for maize in Tanganyika and Nyasaland. Efficient storage techniques in the tropics are essential as a defence against malnutrition nd famine.

A symposium on "Plant Viruses and Virus Diseases" was held on the morning of September 14. Dr. Kenneth Smith (Agricultural Research Council Plant Virus Research Unit, Cambridge), surveying past nd present trends in plant virus research, said that two outstanding advances have been the recognition f latent infections and the proof of virus multiplication within the insect vector. Since 1935 the focus has been on the virus itself, facilitated by the electron microscope. Progress is now being made in determining the part played by nucleic acid in virus multiplication.

Prof. E. van Slogteren (Laboratory for Bulb Research, Netherlands) spoke on serological diagnosis of plant virus diseases. He described the development of the methods used in Holland and gave details of the organization and techniques used for the large-scale examination of potatoes to test their freedom from virus infection.

Dr. F. O. Holmes (Rockefeller Institute for Medical Research, New York), in a paper on additive resistance to virus diseases in plants, took as his principal example the susceptibility of *Nicotiana* spp. to tobacco mosaic. Plants of *N. glutinosa* can be readily infected, but permit little spread of virus in the tissues and show very low capacity for virus liberation. Crossing *N. glutinosa* with *N. tabacum* gives hypersensitive plants which do not act as sources of infection and so provide a means of controlling mosaic in the field.

Mr. F. C. Bawden (Rothamsted Experimental Station), speaking on the spread and control of plant virus diseases, made the point that the nearest relatives to viruses are normal nuclear proteins. Genetic crosses may conceivably give rise to completely new viruses. In the past fifty years, control measures based on inspection and certification schemes have gone far to free the British potato crop from leaf roll and virus Y. Insecticides have not prevented insect transmission of viruses: what is needed is a 100 per cent effective repellant. Infection by the contact-spread mosaic of tomato can be inhibited by a protectant spray of skim milk. Isolation cannot be considered a trustworthy means of maintaining virus-free stocks of plants until the host range of the relevant viruses is established.

The symposium on "Plant Growth-regulating Substances" opened with a paper by Prof. R. L. Wain (Wye College, University of London) on a new approach to selective weed control. He gave an account of his fundamental investigations on the breakdown of the side-chain of members of homologous series of certain ω-phenoxyalkylcarboxylic acids within plant tissues. He presented chemical, biological and chromatographic evidence showing that β-oxidizing enzyme systems capable of degrading specific acids of this type may be present in the tissues of certain plant species and not in others. From this finding, Prof. Wain developed his new approach to selective weed control based upon enzyme make-up. The results of preliminary experiments along these lines are so promising that it now seems certain that various γ-phenoxybutyric acids, for example, have a part to play in controlling weeds in such crops as celery, parsnip, carrot, clover, lucerne and peas, and have little or no phytotoxic effect.

Dr. W. G. Templeman (Jealott's Hill Research Station), speaking on the uses of plant-growth substances, gave an account of their employment in rooting of cuttings, inhibition of bud-growth, production of parthenocarpic fruits and prevention of fruit-drop. The date of pineapple harvest in Hawaii can now be accurately regulated by a single application of α-naphthylacetic acid to induce flower primordia formation. Dr. Templeman recorded the detailed sequence of the British and the

American discoveries of growth regulators as selective herbicides.

The activity of plant-growth regulators was discussed by Prof. H. Burström (University of Lund). He said that the effects of certain *iso*butyric acids that have been termed anti-auxins might be expected to be the reverse of those of the auxins (β-indoleacetic acid, etc.). However, in certain circumstances these anti-auxins behave like the auxins in increasing cell multiplication, enhancing cell-wall extensibility and, when in high concentrations, inhibiting root-growth. He suggested that the auxins, the herbicides and the anti-auxins all form one group characterized by the ability, present to a varying degree, to induce specific formative effects.

Prof. L. J. Audus and Mr. K. V. Symonds (Bedford College, University of London) reported further studies on the bacterial breakdown of hormone weed-killers in soils. Using a perfusion technique to examine the persistence of 2 : 4-D, they showed that the herbicidal effect of the soil perfusate remains unchanged for twenty days but then disappears completely in 48 hr. An organism of the *Bacterium globiforme* group was isolated and was shown to utilize 2 : 4-D as a carbon source. They suggest that the bacteria during their early period of proliferation gradually convert 2 : 4-D to another phytotoxic intermediate. Meanwhile, the bacteria are producing an adaptive enzyme system which, at the end of the twenty-day lag phase, destroys the intermediate. This hypothesis is supported by chromatographic studies.

The first paper in the symposium entitled "Problems in Applied Zoology" was by Dr. J. Carmichael (Boarded Barns Farm, Ongar, Essex) on insects of veterinary importance and Colonial development. He pointed out that the tsetse fly, because it transmits trypanosomiasis, denies to man and his domestic animals the use of vast areas of potential cattle-country in Africa. Attempts to eradicate tsetse are being made by selective forest clearing and by aircraft application of DDT and BHC, with and without the use of defoliants. The other important group of insects concerned with the development of the livestock industry in the Colonies are ticks, which transmit many serious diseases. Ticks are being controlled by dips containing arsenic, DDT, BHC and toxaphene.

Dr. T. H. C. Taylor (Anti-locust Research Centre) discussed the biological control of insect pests. He emphasized that the control of pests by introduced natural enemies is, at its best, superior to all other methods in cheapness, efficacy and permanence. However, there have been relatively few examples of completely satisfactory control by this method. It has been most successful on tropical islands: it cannot, as a rule, be combined with chemical methods. There is still an urgent need for studies of the biological and other factors causing fluctuations in insect numbers. Our aim should be to acquire the knowledge needed to ensure that the conditions we create for crop production do not unduly favour potentially harmful species.

The address by Prof. J. B. Cragg (University of Durham) on the natural history of sheep blowflies in Britain gave an account of the species responsible for sheep myiasis and discussed their movements and breeding sites. In describing oviposition studies, Prof. Cragg showed that attractants in traps gave different results from those on sheep, and he postulated that sheep wool provides an olfactory stimulus specific for female *Lucilia sericata*. He reviewed the experimental data on the micro-climate of egg masses in fleece.

"Soil-borne Pests and Diseases" were discussed in a parallel session. Dr. S. D. Garrett (University of Cambridge), surveying a century of investigation of root diseases, recorded that the phase of etiology, starting a hundred years ago, continued into the early years of the twentieth century, to be followed by a phase of environmental studies. With the discovery, around 1930, that other micro-organisms are the paramount factor in the environment of a root-disease fungus, the phase of microbial ecology began. Complete epidemiological analysis of a root disease is essential before biological control can be established on a scientific basis, or integrated with other measures of good crop husbandry.

Dr. J. Rishbeth (University of Cambridge) dealt with root diseases in plantations with special reference to tropical crops. He showed that field observations and experimental work with root-infecting fungi have indicated some possible methods of control. Thus, with tea, ring-barking forest trees before felling considerably restricts subsequent damage from *Armillaria mellea* and, with conifers, painting or creosoting stumps directly after felling reduces infection by air-borne spores of *Fomes annosus*. Stump extraction has also proved valuable, especially with rubber.

Dr. J. Doeksen (Netherlands Central Institute of Agricultural Research) spoke on the development in research and control of some important soil-borne pests. He stressed the importance of maintaining the balance of beneficial and noxious insects in the soil and issued a caution against the indiscriminate use of soil insecticides.

The opening contribution to the symposium on "Education and Extension Services in Applied Biology" was by Dr. L. M. J. Kramer (City of London School). Speaking on the subject of the applied biologist, the child and society, he claimed that present school biology contains insufficient ecology to show how applied biology is essential to maintain the contemporary scale of human society. Investigation of examinations, social phenomena and the education of Civil servants and members of Parliament indicates the potentialities of biology. There are sufficient senior pupils to provide the applied biologists needed, and evidence suggests how they may be guided.

Prof. W. Brown (University of London) pointed out that as biological research becomes more and more physiological the need for training in physics and chemistry increases. Pre-university training in biology is desirable to make good citizens, but may be detrimental to the prospective biology specialist if it is given at the expense of chemistry and physics. At the university the student in pure science (botany or zoology) should be given as good an introduction as possible to the applied branches: this can be achieved by vacation work in farming or horticulture. Such experience is particularly valuable for those who would be taking up administrative or advisory work.

Sir William Slater (secretary, Agricultural Research Council) spoke on biological education for agricultural research. This service needs men trained for research in the laboratory and in the field, and the requirements for both are equally high. Agreeing that the undergraduate being trained for biological research must have physics and chemistry as well as biology, Sir William made a plea for a limitation of the mass of facts now to be memorized in university courses—a burden that is smothering enthusiasm and imagination. A mastery of principles and methods should be the aim of undergraduate training, leaving the detailed study of a specialized branch of biology to the early postgraduate years.

Mr. R. Rae, director of the National Agricultural Advisory Service, described the work of that Service. He summarized its organization, gave details of its work and noted some of its principal achievements since its inauguration in 1946.

The symposium on "Crop Protection" began with an address by Dr. Hubert Martin (Science Service Laboratory, London, Ontario). In considering some basic problems in the application of chemistry to crop protection, Dr. Martin pointed out that the subject of insecticides has extended beyond the confines of chemistry and entomology. It now delves deeply into enzymology and electrophysiology. The possibility that toxicants may act on nuclear proteins, thus inducing phenomena comparable to mutations, is of great significance when highly potent crop-protection chemicals are added to the soil.

A paper by Dr. A. E. Dimond and Dr. J. G. Horsfall (Connecticut Agricultural Experiment Station) was entitled "Fifty Years of Fungicides". In the relatively dry summer climate of the United States, the replacement between 1944 and 1950 of Bordeaux mixture by thiocarbamates as potato sprays was followed by a doubling of yield. Future achievements would probably be in internal therapy of plant diseases. The *Fusarium* wilt of carnations is already being controlled commercially in Connecticut by internal therapeutants.

Dr. W. E. Ripper (Pest Control, Ltd.) discussed the development of methods of application for crop protection chemicals. He showed the importance of size of spray droplet and reviewed the existing types of spray machinery and techniques, with special reference to helicopter and aeroplane applications.

Dr. E. Holmes (Technical Department, Plant Protection Ltd.) spoke on the contribution of commerce to plant protection. After giving examples of fundamental chemical and biological studies made by industry and their contributions of new insecticides, fungicides and weed-killers, he dealt with the cost of developing new products and the economic benefits that their use had conferred on agriculture.

"The Forecasting and Assessment of Plant Diseases" formed the subject of the symposium that was opened by Dr. K. Starr Chester (Battelle Memorial Institute, Ohio), who spoke on scientific and economic aspects of the appraisal of losses due to plant disease. He stressed the advantages that would accrue to the agencies and industries serving agriculture if accurate information on losses due to disease were available. He noted the progress made by North America and Western Europe in plant disease surveys and assessments, and described international co-operation in this field now being developed through the Commission on Plant Disease Losses and the World Reporting Service of the Food and Agriculture Organization.

Mr. E. C. Large (Plant Pathology Laboratory, Harpenden), dealing with methods of measurement and forecasting of plant disease in Great Britain, outlined the methods devised for assessing losses due to tulip fire, apple scab, choke of cocksfoot, common scab of potatoes and potato blight. For the last-named he demonstrated the accuracy of present forecasting methods and showed maps giving accurate measures of regional losses from potato blight in England in a dry season (1952) and in the wet season of 1953.

Dr. D. Hille Ris Lambers (Bladluisonderzoek, T.N.O., Netherlands) spoke on potato aphids and virus diseases in the Netherlands. Seed potatoes in Holland must be lifted by a date that is determined each year by the onset of aphis-spread virus infection. The relation of this date to the yearly fluctuations in aphid population was discussed.

A session on "Plant Nematodes" opened with a paper by Dr. B. G. Peters (Rothamsted Experimental Station) entitled "Nematology in Retrospect and Prospect". He showed that the first small nematodes to be described, free-living in the seventeenth century and plant-parasitic in the eighteenth, are identifiable only from their peculiar habitats; taxonomy came relatively late because adequate optical equipment was a prerequisite. In the study of the free-living and plant-parasitic nematodes, the development of two aspects of taxonomy, figure drawing and mensuration, can be traced in the work of five founders, all of whom were living in 1904: Bastian, Bütschli, de Man, Cobb and Goodey. Possible future developments in the identification of species and strains, the investigation of host–parasite relationships and the training of nematologists were briefly discussed.

Mr. F. G. W. Jones (School of Agriculture, Cambridge) spoke on quantitative methods in nematology. He reviewed the techniques of extracting and counting soil nematodes and discussed methods of assessing the errors in laboratory sampling. In field sampling, there is still little information on which to select the best depth, size and number of samples. Mr. Jones described recent developments in assaying the egg contents of eelworm cysts and egg viability. He emphasized the need for further study of nematological techniques to find how time and effort could be saved without loss of accuracy.

The third paper in this symposium was contributed by Dr. P. Bovien (State Plant Pathology Institute, Denmark), who discussed host specificity and resistance to plant nematodes. He considered that there are degrees of resistance, often specific to host variety. The situation is further complicated by the existence of biological races of eelworms, each with a different host-range. Eventually, non-morphological characters may have to be accepted as defining eelworm species.

A conversazione was held on the evening of September 14 in the Main Chemistry Laboratories of the Imperial College. The ninety-five exhibits were grouped into the following twelve sections: growth and soil investigations, plant breeding and crop improvement, methods in applied biology and taxonomy, medical and veterinary zoology, agricultural zoology, forest entomology and ecology, pests of stored products and of timber, horticultural and agricultural entomology, plant pathology and virology, helminthology, chemical methods of plant and animal protection, and apparatus. The attendance at the conversazione, which was not restricted to members of the Conference, exceeded five hundred.

LOW-TEMPERATURE PHYSICS

EACH year at the meeting of the British Association, the increasing specialization of science is deplored and the perennial half-truth that knowledge advances only at the border of subjects is proclaimed. It was refreshing, therefore, that a whole day at the recent meeting at Oxford could be devoted to low-temperature physics, a specialized subject and one of which the frontiers have steadily retreated from their original position on the edge of chemistry.

It was appropriate that this should happen in Oxford, one of the great centres of low-temperature research, and that the four speakers should be drawn from the Clarendon Laboratory.

The first address, by Sir Francis Simon, surveyed the whole of current low-temperature research and explained why the properties of matter at very low temperatures are of such peculiar interest.

As the temperature of a material system is reduced, its state becomes progressively more ordered; thermodynamically, this is described as a decrease in entropy. Order can be increased and entropy decreased not only by a change in temperature but also by other external influences. The simplest case of this is the isothermal compression of a gas. This change of entropy by mechanical or other non-thermal means is the basis of every method of obtaining lower temperatures; and in general, if a substance possesses entropy which can be lowered by compression, magnetization or any other method, then it can be used as the working substance of a cooling process.

Classical thermodynamics, however, was faced with a dilemma, for the law of equipartition of energy predicted that the specific heats of all substances should be finite at absolute zero. Thus their entropies would be undetermined to the extent of an arbitrary infinite quantity, and the concept of an absolute zero lost much of its usefulness. This dilemma was only resolved by the advent of the quantum theory, which predicted that all specific heats would tend rapidly to zero at low enough temperatures as exemplified by Debye's famous T^3 law.

Sir Francis then stressed the fundamental role of the third law of thermodynamics and its corollary the principle of the unattainability of absolute zero in low-temperature research, remarking in passing that the existence of substances with frozen-in entropy does not constitute a true exception since these are not in equilibrium states.

Sir Francis traced the progressive stages by which entropy is removed as a substance is cooled. First the gas liquefies, then the liquid solidifies. The entropy of the solid will be largely due to lattice vibrations, although in certain substances free rotation of the molecules in the crystal may contribute. In non-magnetic substances the entropy due to all these causes will be almost completely removed at 1° K. In certain magnetic substances, however, the entropy associated with the disordered orientations of the elementary magnetic moments will persist to very much lower temperatures of the order of a few thousandths of a degree. Since this entropy can be influenced isothermally by a magnetic field, this can be made the basis of a method of cooling.

This method of isothermal magnetization and adiabatic demagnetization, first employed by Giauque in 1933, has now been successfully used in a great many laboratories. The lowest temperature attainable by this method is determined by the strength of the interactions between the atomic magnetic moments which are responsible for the ordering of the magnetic system at the lowest temperatures. By a choice of suitable substances in which this interaction is weak, temperatures of the order of 0·001° K. have been reached both at Leyden and Oxford.

Apart from the entropy associated with the atomic moments in paramagnetic substances, there is also the entropy associated with the nuclear magnetic moments. Since the magnitude of these moments is some thousand times smaller, their interactions are very much weaker and it is to be expected that the nuclear entropy will persist to very much lower temperatures—of the order of one-millionth of a degree. In order to make use of nuclear magnetic moments in a cooling process, it is necessary to be able to influence their entropy by the application of a magnetic field. Very large fields of the order of 100 kilogauss applied at very low temperatures of the order of 0·01° K. will be needed. The technical problems this poses have not as yet been surmounted.

Sir Francis Simon concluded by showing how these experiments throw new light on the concept of temperature itself. The naïve association of temperature with kinetic energy clearly becomes untenable when, for example, we consider a 1-mm. cube of diamond at 0·01° K. which contains on the average only one quantum of thermal energy. The concept of temperature is, in fact, inextricably linked with those of order and entropy. A substance which has lost all its entropy is effectively at absolute zero. The temperatures reached by adiabatic demagnetization are perhaps unique in the whole universe. In interstellar space, matter exists at low temperatures but also at very low densities, so that its entropy is large. In stars, on the other hand, while the density is high so is the temperature, and the entropy is again large. It is only in the laboratory that condensed matter at very low temperatures is found.

Sir Francis Simon's introduction was followed by Dr. K. Mendelssohn, who dealt in a picturesque and vivid way with the properties of superconductors and liquid helium, which he tentatively described as a new state of aggregation.

Since the discovery by Kamerlingh Onnes that the electrical resistance of pure mercury vanishes at temperatures below 4° K., a great many other elements, mainly those in Groups IV*a* and V*a* and II*b*, III*b* and IV*b* of the Periodic Table, have been shown to be superconducting. The resistance has been found to be not only small but, in fact, effectively zero, as evidenced by the possibility of obtaining persisting currents in rings of superconductors which showed no diminution in their intensity after periods as long as a week. An empirical law relating the occurrence of superconductivity to the atomic volume of the element has been traced, and this has led to the production of superconducting alloys between two non-superconducting elements, one having too large, the other too small, an atomic volume. These alloys are, in many ways, analogous to the ferromagnetic Heusler alloys.

No completely satisfactory theory of superconductivity exists, although the phenomenological theory, mainly due to the late F. London, has done much to clarify the experimental facts. Superconductivity is a function of the metallic free electrons, and the existence of a specific heat anomaly at the superconductive transition temperature indicates that the entropy of, at any rate, part of the free electrons is considerably reduced in the superconductive state. They may, therefore, be considered to exist in an ordered state the nature of which is unlike anything we would normally consider to be ordered since they are still free to take part in electrical conduction. Superconductivity has as yet found no practical application, although extremely sensitive bolometers have been made using superconductive elements. A photograph of Prof. D. H. Andrews, of Johns Hopkins University, taken by his own infra-red radiation using a superconductive bolometer as the sensitive element, was shown; its relation to a conventional photograph was as that of a Paul Klee to a Vermeer.

Liquid helium also exhibits behaviour in many ways analogous to superconductivity. At 2·2° there is a discontinuity in the specific heat, the coefficient of thermal expansion and the thermal conductivity. The latter is most strikingly shown when helium is cooled by evaporation. As the temperature is reduced below 2·2°, all bubbling ceases and the liquid becomes perfectly still. This is because the thermal conductivity increases more than a millionfold at the transition temperature. The viscosity of liquid helium measured with an oscillating disk shows no marked discontinuity; yet if an attempt is made to measure the viscosity by studying flow through a fine capillary, it is found that the flow is independent of the pressure head and the apparent viscosity is less than that of any gas, let alone liquid. These phenomena by no means exhaust the peculiarities of liquid helium, and Dr. Mendelssohn went on to describe and illustrate the fountain effect, the mechanocaloric effect and the existence of film-flow, which he likened to the emission of α-particles from nuclei.

In all these ways helium exhibits a similarity to superconductors, for in both cases the underlying phenomenon is transport without friction. Moreover, there is a striking resemblance between the entropy – temperature curves for both classes of substance. This suggests that in both cases the transition from the normal to the superfluid state is associated with the same type of increase of order. Since helium below the λ-point is a liquid, this cannot be spatial order but may rather be pictured as order in momentum-space. This, although not a particularly simple idea, might be visualized by considering the order introduced into traffic moving along a road by the introduction of a speed limit: in the absence of the limit the relative positions of vehicles change with time; after the introduction of the limit, they all move with the maximum permissible velocity, and although the scenery past which they move changes, their relative positions remain the same.

At present there is no complete theory of liquid helium, although the fact that the odd isotope helium-3 does not show superfluidity indicates that part of the explanation of the superfluid behaviour of liquid helium-4 must be that it obeys Bose–Einstein statistics.

Dr. Mendelssohn concluded his address by some remarks of a more speculative nature. Perhaps the cold stars might be regions in which matter exists in the superfluid state, and since we have in superfluidity a new state of matter, may there not be yet another state of matter appropriate to living organisms?

The concluding part of the morning's proceedings was opened by Dr. A. H. Cooke, who described how paramagnetic resonance and relaxation measurements contribute information of great value to low-temperature research.

Prior to the Second World War, most of our knowledge of paramagnetism came from the measurement of the static magnetic susceptibility. The susceptibility is, however, only an average effect due to all the paramagnetic constituents of the substance. Since in even the simplest substances containing only one paramagnetic element the different atoms are often subjected to different internal fields, resulting in a difference in their contributions to the susceptibility, the interpretation of susceptibility measurements in terms of the magnetic properties of individual atoms was an undertaking of considerable difficulty. The method of paramagnetic resonance, on the other hand, studies the properties of each group of atoms separately and makes it possible to give an unambiguous theoretical interpretation of the paramagnetism.

The principle of the method was illustrated using a small gyroscope. When a magnetic field is applied to a magnetic ion, it precesses about the direction of the magnetic field at a frequency which depends on the strength of the field and the ratio of the magnetic and angular momenta of the ion. If an oscillatory magnetic field is applied at right angles to the steady field, the ion will make transitions, from one orientation to another, which absorb energy from the oscillatory field. This absorption can be detected, and thus a measurement of the field and frequency at which absorption occurs allows the determination of the ratio of magnetic to angular momentum. Since the latter is usually known from other evidence and is in any event an integral multiple of $\frac{1}{2}\hbar$, the measurement determines the magnetic moment.

In the demonstration the gyroscope represented the paramagnetic ion, and the magnetic field was applied by means of a length of elastic. When an oscillatory elastic field was applied at right angles, most convincing transitions from one orientation of the gyroscope to another were produced.

Knowing the magnetic moments of the paramagnetic ions in a substance makes it possible to predict many of its magnetic and thermal properties. Paramagnetic resonance experiments, however, give information only indirectly about the strength of the interaction between the magnetic ions, and it is these interactions which determine the behaviour of the substance at the lowest temperatures.

Due to these interactions, there is a contribution C_M to the specific heat which is proportional to $1/T^2$ and is therefore negligible except at low temperatures, where it rapidly assumes a dominant role. For many substances C_M is of the same order as the lattice specific heat at temperatures of a few degrees. Paramagnetic relaxation experiments enable us to determine this magnetic specific heat independently of other contributions to the specific heat.

When a system of spins is magnetized, heat of magnetization is generated, and this has to be lost by the spin system to its surroundings, that is, the crystal lattice. At high temperatures the heat of magnetization is small and the contact between the spin system and the lattice is good, so that this is a very rapid process. At temperatures below 20° K., however, this transfer may take an appreciable time; thus after the field is put on, it may take a fraction of a second for the spin system to lose its heat of magnetization and attain its equilibrium magnetization. Therefore, if the susceptibility is measured using a rapidly oscillating magnetic field, the quantity observed will be the adiabatic susceptibility of the spin system. A measurement with a static or slowly varying field will yield the isothermal susceptibility. From these two quantities a simple thermodynamic relation leads directly to the magnetic specific heat.

Thus the method of paramagnetic relaxation complements the resonance experiments. Since the magnetic specific heat is a measure of the strength of the interaction between the magnetic ions, and this determines the lowest temperature available in adiabatic demagnetization, relaxation measurements give a useful guide to the choice of substances for demagnetization. For example, iron ammonium alum, with $CT^2/R = 0{\cdot}014$, needs at 1° K. the application of 30 kilogauss to reduce its temperature to 0·01° K., whereas cerium magnesium nitrate, with $CT^2/R = 7{\cdot}5 \times 10^{-6}$, reaches 0·003° K. from a field of 15 kilogauss.

The final paper was given by Dr. N. Kurti and dealt with the low-temperature aspects of nuclear orientation.

The object of this address was the description of methods that have been, or could be, used for orienting atomic nuclei in solids. Normally the elementary nuclear magnets point at random in all directions. Under favourable conditions and at very low temperatures, it is possible to establish preferential orientations with respect either to an external magnetic field or to a crystal axis.

Nuclear orientation was originally conceived as a possible method of producing temperatures of the order of one-hundred-thousandth or one-millionth of a degree absolute. The lowest temperature that can be obtained by means of the adiabatic demagnetization of paramagnetic substances (in which the electron spins are the elementary magnets) is of the order of a few thousandths of a degree. This lowest temperature is determined by the magnitude of the interaction forces between the electronic elementary magnets. With nuclei, which have a thousand times smaller magnetic moments, one could expect to reach much lower temperatures because the interaction forces are smaller. In order to carry out such a nuclear demagnetization experiment, the nuclear paramagnetic substance (say, a metal the nuclei of which possess magnetic moments) has first to be magnetized in a field of between 50 and 100 kilogauss at 0·01° K. This presents great difficulties, and no successful nuclear magnetic cooling has been carried out as yet.

At 0·01° K. and in a field of 100 kilogauss, the nuclei would be directed preferentially along the magnetic field. Such oriented nuclear systems can be of great use to nuclear physics. If we have a radioactive substance which emits γ-rays, then, even if the intensity of emission from one individual nucleus is anisotropic, the total radiation emitted from a piece of material will be isotropic in ordinary circumstances because of the random distribution of the nuclear axes. The behaviour of an assembly of oriented nuclei, however, would approximate more and more to that of an individual nucleus. Details of the importance of such experiments were given in Dr. Grace's paper later in the session.

If one wants to produce oriented nuclei for radioactive experiments, some experimentally simpler methods are also available. Instead of using an external magnetic field of 100,000 gauss, one can make use, in suitable cases, of the strong magnetic fields (of the order of half a million gauss) which the electron spin produces at the nucleus in paramagnetic ions. In such cases the nuclear spin sets itself parallel to this local magnetic field if the temperature is low enough (a few hundredths of a degree absolute). If, moreover, the electron spins which are responsible for these local fields are oriented parallel throughout the specimen, a high degree of nuclear orientation will result. The ordering of the electron spins is brought about either by the action of the electric field of the crystal lattice or by a relatively modest external magnetic field of the order of 1 kilogauss.

The former method was used in the first conclusive demonstration of nuclear orientation in an experiment carried out by Drs. Daniels, Grace and F. N. H. Robinson in September 1951 at the Clarendon Laboratory in Oxford. The anisotropy of the γ-rays emitted by radioactive cobalt-60 which was incorporated in a paramagnetic crystal and cooled to one-hundredth of a degree was clearly shown. Since then many more experiments have been carried out with both methods in Oxford and elsewhere, and in one of the Oxford experiments a degree of orientation of nuclei of more than 90 per cent was attained.

Although at present most of these experiments yield results of main interest to nuclear physicists, the situation will undoubtedly change when nuclear magnetic cooling experiments get under way and, possibly, temperatures of 10^{-5} or 10^{-6} degrees will be reached. It has been suggested, for example, that at these temperatures one might observe 'nuclear ferromagnetism'.

Dr. Kurti concluded by asking whether it is wise and indeed justified to classify these results according to whether they belong to nuclear physics or to low-temperature physics. It is more important, he said, to realize that they are the outcome of a combination of two fundamentally different and distant branches of physics.' F. N. H. ROBINSON

OBITUARIES

Prof. F. Wood Jones, F.R.S.

WITH the death of Dr. Frederic Wood Jones at the age of seventy-five on September 29, there passed an anatomist who was well known not only for his numerous contributions to human and comparative anatomy and anthropology, but also for his unusual versatility (his interests extended far beyond the confines of pure morphology) and his vigorous expositions of Lamarckian and teleological conceptions.

Wood Jones was born in London on January 23, 1879, studied medicine at the London Hospital, and graduated in 1903. During 1905–7 he was stationed on one of the Cocos-Keeling Islands as a medical officer of the Eastern Telegraph Co., and it was here that his scientific career may be said to have derived its initial inspiration. For, as he relates, his medical duties were so nominal as to allow him to spend much of his time exploring coral reefs and making observations on the local fauna. In 1910 he published a book on "Coral and Atolls" in which he ventured an original interpretation of atoll development, an interpretation which, even if it did not gain general acceptance, aroused considerable interest because of its very novelty. It was as a result of these studies that he was awarded the degree of D.Sc. of the University of London.

In 1907 he joined the late Sir Grafton Elliot Smith in anthropological studies on behalf of the Egyptian

Archæological Survey of Nubia, and in 1909 he was appointed lecturer in anatomy in the University of Manchester. His subsequent academic career was varied as well as distinguished, for he occupied chairs successively in the Universities of London, Adelaide, Hawaii, Melbourne, Manchester and the Royal College of Surgeons, and also (for one year) acted as director of anatomy at the Pekin Union Medical College.

A man of many and varied experiences, Wood Jones was imbued with a restless curiosity which found expression in several books of essays on a great diversity of subjects. His pleasing literary style and descriptive powers, combined with a certain originality of approach, made his writings singularly attractive and stimulating; this was particularly so with his lighter essays, but it was also true of his more serious expositions, even though the intrusion here and there of his personal prejudices against some of the well-established principles of evolution occasionally proved exasperating to those who allowed themselves to be too easily exasperated by such expressions of 'unorthodoxy'. In one of his earliest books, "Arboreal Man", published in 1916, Wood Jones elaborated in a series of anatomical essays the thesis (which he continued to emphasize in many of his later works) that, compared with other Primates, man is fundamentally primitive in many details of his anatomical structure. Indeed, it was this general conception which led him to suppose that man has occupied a rather unique position in the evolutionary series, for he argued that the retention of these primitive features could only be explained on the basis of a very prolonged period of evolutionary independence. In a more comprehensive work on "Man's Place among the Mammals", published in 1929, he further elaborated these ideas, contending with considerable dialectical skill that man's relationship to other Primates is far more remote than is suggested by the evidence of comparative anatomy and palæontology. It is fair to say that, although the more extreme views put forward by Wood Jones made but little impact on biological thought, he certainly provoked his contemporaries by the very persuasiveness of his literary style to give more critical attention to the validity of the evidence on which he relied.

Apart from his essays and books, Wood Jones's most important contributions to anatomy are embodied in numerous papers which have appeared from time to time in the *Journal of Anatomy*, the *Proceedings of the Zoological Society*, and elsewhere, and which consist mainly of descriptive studies in the field of comparative anatomy. But he also made important contributions in the allied fields of embryology, physical anthropology and palæontology. All these papers are characterized by a refreshing originality and by illuminating interpretations of the relationship between structure and function. His most systematic study (and in some ways one of his best works) was his comprehensive survey of the mammals of South Australia, published in the series of handbooks issued during 1923–25 by the South Australian Branch of the British Science Guild. Like all his published works, these are illustrated entirely by his own drawings, which display particularly well the unusual skill and attractive style of his draughtsmanship. In his two books on human anatomy, "The Principles of Anatomy as seen in the Hand", first published in 1920, and "Structure and Function as seen in the Foot", published in 1944, Wood Jones showed a profound knowledge of topographical and morphological detail, and at the same time gave abundant evidence of the exceptional powers of observation which enabled him to contribute so much original information beyond the scope of the standard text-books of anatomy. They also display his intimate acquaintance with the history and literature of anatomical discovery, for he makes constant reference in them to observations of the older anatomists which seem too often to have been forgotten.

In temperament, as well as in his scientific work, Wood Jones was an individualist, and he was sometimes impatient of new orientations in anatomical teaching and research. But it would be difficult to over-estimate the service which he has done to his subject by his insistence on the comparative and functional approach to anatomical studies, by the cumulative importance of his many original observations, and by the inspiration which he gave to his contemporaries and his students through his lectures and essays.

Prof. Wood Jones is survived by his widow, Gertrude Clunies, daughter of the late George Clunies-Ross, governor of the Cocos-Keeling Islands.

W. E. LE GROS CLARK

Sir Roderic Hill, K.C.B.

SIR RODERIC HILL, rector of the Imperial College of Science and Technology, London, died on October 6 at the age of sixty.

In 1948, the Governing Body of the Imperial College appointed a committee to select a new rector, and also invited representative members of the academic staff to consult among themselves and make suggestions. The result was unexpected: both groups independently suggested Air-Chief Marshal Sir Roderic Hill. Seldom can an appointment have been so acceptable to all concerned or have proved so happy in its outcome.

From the moment he took office, it was clear that the new rector would prove a powerful leader, and that his personality and example would stimulate those who came in contact with him to give of their best to the College. A humanist by education, he had, during his long career in the R.A.F., showed judgment and experience in technological matters which many professional engineers and scientists might well have envied, and the appreciation by his colleagues that he possessed such ability lent added weight to his view, so often expressed, that the education of technologists must be broadened if they were to exercise their functions with a full sense of responsibility. His concern with this aspect of education led him to initiate general lunch-hour lectures twice a week throughout the session, covering a wide range of subjects, a particular example being the encouragement of College musical activities by the appointment of a distinguished musician as special lecturer and adviser.

The general scheme, of which this was part, was given the title 'Touchstone', which will remain one of many reminders of the ideals of its originator. Under this scheme, also, week-end study circles were held at Silwood Park, the College Field Station near Ascot, at which students, members of the staff, and experts from outside the College met to discuss social and political questions of the day.

While this and much more was being developed, Hill carried a heavy burden in connexion with the projected expansion of the Imperial College at the behest of the Government. The opportunities thus presented appealed to his imagination and he threw himself into planning and directing with that energy which he always gave so lavishly.

It was a great joy to him when, in 1953, he was elected vice-chancellor of the University of London, a post which his father, Prof. M. J. M. Hill, had held many years earlier. Some of his friends feared that the responsibilities of this post added to those he already carried might prove too great a strain and, in fact, his health obliged him to resign the vice-chancellorship before the completion of his year of office.

His career before he joined the Imperial College will be recorded elsewhere, and it is only possible to say here that the ability, enthusiasm, capacity for hard work, and keenness in everything he did, which produced an outstandingly distinguished R.A.F. officer, were all brought to the service of the College and the University. All these qualities and one other, which will be remembered most by all of us, that of charming friendliness, combined to give the College a rector who will always be remembered with deep affection. A. J. Sutton Pippard

Prof. Carl I. Cori

The death occurred in Vienna on August 31 of Carl I. Cori, emeritus professor of zoology in the German University of Prague. Born almost ninety years ago in Brux, Bohemia, he studied zoology and medicine at the ancient German University of Prague and after graduation became assistant and lecturer at the Zoological Institute under Hatschek. In 1898 he was made a professor and director of the Zoological Station of Trieste, where up to 1914 he organized biological and marine research. Pupils from many countries came to his station, and the cruises of the research vessel *Adria* which Cori himself had helped to design, and of which he was the master, are still remembered by many biologists. After the First World War, which he spent in charge of a malaria unit, he found his station closed down and he returned to Prague, where in 1919 he became professor of zoology. Three times elected rector of the German University, he retired in 1936 and had lived in Vienna since 1946.

Cori's most important publications concerned the Phoronids and Bryozoa. The chapters in Bronn's "Klassen und Ordnungen" referring to these two groups, as well as to the Brachiopoda and Entoprocta, were also written by him. Further important papers dealt with segment formation in annelids and vertebrates, the circulatory system of *Ammocoetes* and with the fauna of the Adriatic. Cori also contributed in many ways to marine and limnological research techniques. Of several books, one, "The Naturalist's Introduction to the Adriatic Littoral", appeared in several editions.

Prof. Cori is survived by a son, the well-known biochemist, C. F. Cori, of St. Louis, Nobel Laureate in 1947 for medicine, and by two daughters, one of whom is married to the Viennese geneticist, F. Mainx

The institutions at which Cori was prominently working have been destroyed by two world wars but his teaching and personality will be remembered by his pupils in many countries. H. Kalmus

NEWS and VIEWS

European Organization for Nuclear Research

President of Council : Sir Ben Lockspeiser, K.C.B., F.R.S.

At the first session of the European Organization for Nuclear Research, held in Geneva on October 7, Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research in Great Britain, was elected president of the Council of the Organization, in succession to M. Robert Valeur. M. Valeur, who has been director of the Interim Council of the Organization since 1953, is a member of the French Diplomatic Service and has recently been appointed director of the Information and Cultural Services of the French Embassy in Washington. Sir Ben has from the beginning taken an active part in the work of the Interim Council of the Organization as a delegate of the United Kingdom and as chairman of the interim finance committee since 1953. After holding successively a number of key appointments in Britain in the field of aeronautical research, he became chief scientist to the Ministry of Supply in 1946, and, in 1949, secretary to the Department of Scientific and Industrial Research (see *Nature*, 163, 314; 1949). He thus brings to his new post a wealth of experience both as a research worker and administrator.

Deputy Director-General : Prof. E. Amaldi

The new deputy-director-general of the European Organization for Nuclear Research is Prof. Edoardo Amaldi, who was born in Piacenza in 1908. He has spent much of his time working at various laboratories throughout the world. Though he has studied the spectroscopy of atoms and molecules, his main work has been devoted to nuclear physics, particularly the diffusion and absorption of neutrons and the radioactivity induced by neutrons; in collaboration with Enrico Fermi he published a study of slow neutrons which has proved to be of fundamental importance for research in this whole field. During the past few years he has worked mainly on cosmic rays, especially the properties of mesons of high energy, the tau and kappa mesons and hyperons. He became professo of experimental physics in the University of Rome in 1937, director of the Institute of Physics in 1950, and is a member of the Accademia Nazionale dei Lincei. Prof. Amaldi is one of the pioneers of the European Organization for Nuclear Research. A secretary-general of the Organization since its creation in 1952, he has been responsible to the Council fo the work of the Executive Group, which prepares the plans and the budget for the future. The energ with which he has applied himself in the service o the Organization has been an important factor in it growth to a fully fledged body.

Director : Prof. F. Bloch

The post of director of the European Organization for Nuclear Research has been filled by Prof. Féli Bloch, who took up his duties on October 1, on leav of absence from Stanford University, California. Pro Bloch was born in Zurich in 1905 and started h university career there as a student of engineering at the Eidgenössische Technische Hochschule. Very soon however, partly inspired by Schrödinger's lectures, he changed over to theoretical physics, and in 1927 moved to Leipzig, where as a pupil of Heisenberg he was awarded his doctorate for a dissertation on the quantum mechanics of conduction electrons. After working successively under Pauli, Heisenberg, Bohr and Fermi, he went to Stanford in 1934 as associate professor of physics, where in 1939, in collaboration with Alvarez, he made the first measurement of the magnetic moment of the neutron, using the cyclotron at Berkeley. In 1946 Prof. Bloch published the theory and, together with a number of collaborators, the experimental technique of measuring very accurately nuclear magnetic moments by the method of 'nuclear induction'. For this he was awarded the Nobel Prize for Physics in 1952 jointly with Prof. E. M. Purcell, who had done independent work in the same field (see *Nature*, 170, 911; 1952).

Director of the Synchro-cyclotron Division : Prof. C. J. Bakker

PROF. CORNELIS JAN BAKKER has been appointed a member of the Directorate and director of the Synchro-cyclotron Division. Prof. Bakker was born in 1904 and studied physics under Zeeman in Amsterdam, taking his doctorate in 1931 for work on the Zeeman effect in the spectra of the noble gases. After this he spent a year in London at the Imperial College of Science and Technology continuing his work in the field of spectroscopy. He then joined the scientific staff of Philips at Eindhoven, where he did research on certain physical problems in relation to radio. However, his interests turned to nuclear physics and during the Second World War, in collaboration with Prof. Heyn, he started designing a cyclotron for Philips. In 1946 he succeeded Gorter as professor of physics and director of the Zeeman Laboratory of the University of Amsterdam and also became director of the Institute of Nuclear Physics, the focal point of Dutch nuclear research, sponsored by Fundamenteel Onderzoek der Materie (F.O.M.), by the city of Amsterdam and by Philips. There he and his team of assistants work with the cyclotron which was designed and built by him for Philips. Prof. Bakker is a member of the Dutch Reactor Committee and, as such, a member of the Joint Dutch–Norwegian Committee, which operates the joint reactor at Kjeller in Norway; he is also secretary of the Joint Committee on Spectroscopy of the International Union of Pure and Applied Physics and the International Astronomical Union. He was one of the original eight experts invited in 1951 to draw up plans for the future of the European Organization for Nuclear Research, and since 1952 he has been director of the Synchro-cyclotron Group; with about fifteen staff members and consultants he has been carrying out the engineering studies on the synchro-cyclotron. The new Division has begun moving to Geneva, but at the moment Prof. Bakker is only spending part of his time with it.

College of Aeronautics : Prof. J. A. J. Bennett

THE Board of Governors of the College of Aeronautics has appointed Dr. J. A. J. Bennett to be professor of aerodynamics in succession to Prof. A. D. Young, who has taken the chair of aeronautical engineering at Queen Mary College, University of London (see *Nature*, January 9, p. 64). Prof. Bennett, who holds the degree of D.Sc. of the University of Glasgow and the diploma of the Imperial College of Science and Technology, London, is an international authority in the field of helicopters. He has been a member of the Helicopter Committee of the Aeronautical Research Council since 1945 and has served on a number of British missions devoted to rotary-winged aircraft. He was the originator of the Gyrodyne, which established an international speed record in 1948. A very considerable number of papers on rotary-winged aircraft have appeared under his name in technical journals both in Great Britain and abroad. Prof. Bennett is a founder member of the Helicopter Association and a member of the Council, and a founder member of the American Helicopter Society. For the past two years he has been engaged on helicopter research at Hiller Helicopters, California, and, prior to this, he was for seven years head of the Helicopter Branch of Fairey Aviation Co., Ltd.

H. W. B. Roozeboom (1854–1907)

HENDRIK WILLEM BAKHUIS ROOZEBOOM, who is remembered in the history of physical chemistry for having demonstrated the industrial importance of the phase rule, was born in the historic town of Alkmaar on the North Holland Canal, a century ago, on October 24, 1854. His interest in chemistry began in his school-days; but he was too poor to go to a university. In 1875 he was offered a position as assistant analyst by J. M. van Bemmelen, and three years later he became an assistant in the chemical laboratory of the University of Leyden. He obtained the Ph.D. of this university in 1884, and in 1890 was appointed lecturer in chemistry. In 1896 he succeeded J. H. van 't Hoff in the chair of inorganic and physical chemistry in the University of Amsterdam. In 1875 the American physicist, Josiah Willard Gibbs, contributed to the *Transactions of the Connecticut Academy* his classic "On the Equilibrium of Heterogeneous Substances", which established the phase rule for chemical equilibrium and change. Roozeboom made careful studies of melting points and solubilities, while investigating the equilibria between solid and liquid phases in various systems, and in 1904 began publication of "Die heterogene Gleichgewichte vom Standpunkt der Phasenlehre". Completed in 1918, after his death, by his pupils, this work, particularly on the composition of the salt hydrates, showed the practical value of Gibbs's rule. Roozeboom died on February 8, 1907, at the age of fifty-three.

Scientific Instruments from the Thirteenth to the Nineteenth Century

ASTROLABES, armillary spheres, portable sundials and other antique scientific instruments constitute a valuable source for the historian of science. They afford evidence which is complementary to the printed and manuscript material, and they may provide information unobtainable in any other way. Besides all this, they are frequently beautiful objects in themselves—products of a happy marriage of scientific design and the art of the metal-worker and engraver. The most important private collection of such instruments, that of Mr. J. A. Billmeier, of London, is described in the October issue of *The Connoisseur* by Dr. C. H. Josten, curator of the Museum of the History of Science, Oxford. The greater part of the collection was recently acquired from M. Henri Michel, of Brussels, well known for many years as a leading authority and connoisseur in this field. The 153 choice instruments which have now come to Britain, together with the museum collections at South Kensington, the National Maritime Museum, the British Museum, the Whipple Museum at Cambridge and the Museum of the History of Science at Oxford, constitute a tremendous national heritage. Nowhere else in the world is such an aggregate of fine collections available for study. Dr. Josten's article is well illustrated with photographs of many of the instruments, including six of the twenty-one astrolabes and an interesting selection of sundials. A fuller account has been given in a printed Catalogue of the Billmeier Collection, which was exhibited in May 1954 by Messrs. Frank Partridge and Sons, London.

Mycorrhizal Uptake and Translocation of Phosphorus

In investigations of the uptake of phosphate by excised mycorrhizal roots of the beech, J. L. Harley and J. K. Brierley have obtained evidence of the active transport of this nutrient from the fungal sheath into the host tissue (*New Phytol.*, 53, 2, 240; 1954). They point out that movement of substances from the external solution might be by way of the inter-hyphal spaces, or the walls of the fungal tissue, or through the living hyphæ themselves. In critical experiments, excised mycorrhizal roots were allowed to absorb radioactive phosphorus during the first phase while, during the second phase, the distribution of the radioactive phosphorus in the fungal and host tissue was determined after known time periods under conditions in which the rate of metabolism was varied. The rate of movement of phosphorus-32 from fungus to host was at first rapid, but became slower after 10–15 hr.; it was sensitive to temperature and oxygen supply. In low oxygen concentrations and in anaerobic conditions especially, phosphorus-32 was lost from the roots into the washing solution at normal temperatures. No such losses occurred at low temperatures in either aerobic or anaerobic conditions nor at normal temperatures in air. The loss of phosphorus-32 from roots in anaerobic conditions was entirely from the fungal tissue and resulted from a process which had a high temperature coefficient. In roots which had been returned to normal temperatures after a period of washing at low temperatures or returned to aerobic conditions after a period of washing in anaerobic conditions, transport of phosphorus from fungus to host, temporarily prevented, was resumed at an undiminished rate. The authors conclude that active transport of phosphorus from fungus to host occurs in mycorrhizal beech roots. The mechanism of transport is dependent upon aerobic metabolic processes in the fungal tissue as well as upon the absorptive processes of the core. The phosphate which is lost from roots kept in low oxygen concentrations is entirely released from the sheath and results from temperature-sensitive anaerobic processes occurring in that tissue. (See also *Nature*, October 9, p. 684.)

Abnormal Plant Growth

The Brookhaven National Laboratory, Upton, New York, has rendered a useful service to botany by bringing together a number of leading research workers interested in the phenomena of abnormal and pathological plant growths and their causation ("Abnormal and Pathological Plant Growth", Brookhaven Symposia in Biology No. 6; pp. 303, Office of Technical Services, Dept. of Commerce, Washington 25, D.C., 1954; 2.10 dollars). While the subject itself is not new, it is evident from a reading of this report that the application of recent and new techniques has resulted in the acquisition of many new and interesting facts and in a persistent analytical approach to the underlying causation of the several manifestations of abnormal growth. The symposium covers a wide field, and abnormal growth developments induced by physical, chemical and biological agents are described and discussed with special reference to their genetical, physiological and morphological aspects. In this diverse assemblage of new information the reader may read at large or he may read selectively, paying special attention to such major topics as differentiation and organogenesis, tissue culture and tumour formation as induced by genetical, bacterial, virus or insect agencies. Some of the investigations are reported in considerable detail, special reference being made to the method of induction of the abnormal development and to the related nutritional aspects. The substance of the discussion on each of the papers is also given.

Notes on Nuclear Science

A set of notes on nuclear science, mainly factual and explanatory, providing reliable data and references suitable for lecturers and teachers has been compiled by the Atomic Sciences Committee of the Association of Scientific Workers. The notes, which are in loose-leaf form, are in three sections, of which Vols. 1 and 2, dealing with scientific and industrial aspects, and the military aspect, respectively, have recently been issued; and Vol. 3, on international control, is to be issued shortly. In order to keep the notes up to date, it is intended to issue annual supplements to the respective volumes as the necessity arises. Vol. 1 is of a general nature and summarizes the basic elements of nuclear science, the large-scale release of nuclear energy, nuclear energy programmes in different countries and the production and uses of radioactive and stable isotopes. Vol. 2 deals with the effects of atomic weapons, in particular with the physical and biological effects of the bombs dropped on Japan in 1945, and with the problem of civi defence. A very detailed bibliography is a feature of this volume, and an addendum brings the information and data, on thermonuclear bombs, for example up to the date of publication, September 1953.

South African Museum: Report for 1953–4

The report of the South African Museum, Cape Town, for the year ended March 31, 1954 (from the Museum; pp. 28), records that, with the prospective legislation repealing the South African Museum Act of 1857 and the proposal to include museums and other organizations as State-aided institutions, it is hoped that the future of the South African Museum will be as progressive as it has been in the past. A preliminary survey of the site for the extension of the east wing has been made, and the trustees hope for the erection of this long-deferred addition. It is intended that it shall provide extra space for the larger mammals and also for historical objects. In Britain all strandings of whales are immediately reported by the coastguards to the British Museum (Natural History). Unfortunately, in South Africa there are long stretches of coast where such occurrences are never seen or reported, and the Museum is taking active steps to remedy this position Research is now considered to be a major functio of museum staffs, and the impressive list of publications, including those in the *Annals of the South African Museum*, bears witness to extensive activity in this direction.

Radiation Hazards in Industry: Conference in London

THE third conference of the British Occupational Hygiene Society will be a one-day meeting on "Radiation Hazards in Industry", to be held in the London School of Hygiene and Tropical Medicine on November 1. The conference is open to non-members (on payment of a fee of one guinea) as well as to members of the Society. The chair will be taken by the president of the Society, Prof. E. J. King, professor of chemical pathology in the Postgraduate Medical School, University of London. Four papers will be presented as follows: the health of workers exposed to ionizing radiation, by A. S. McLean, principal medical officer, Department of Atomic Energy; radiation safety in the Industrial Group of the Department of Atomic Energy, by D. R. R. Fair, head of the Health Physics Division, Department of Atomic Energy, Windscale Works, Sellafield; protection against X-rays and gamma-rays in the industrial field, by W. Binks, Radiological Protection Service, Ministry of Health and Medical Research Council; and safety criteria in atomic energy, by F. R. Farmer, assistant director (production), Department of Atomic Energy, Industrial Group Headquarters, Risley. There will be a short discussion after each paper. The conference will be reported, in due course, in the *British Journal of Industrial Medicine*. Those intending to be present should complete and return by October 25 the appropriate form, obtainable from the honorary treasurer, Mr. D. E. Hickish, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Biology and a General University Education

A RESIDENTIAL conference is being arranged by the Institute of Biology in co-operation with members of the staff of the University College of North Staffordshire on the place of biology in a general university education. The meeting will take place at the University College of North Staffordshire during December 19–21. Part of the programme will revolve around the place of biology in a general science course at university-level, while the remainder of the programme will be concerned with the place of biology in a university education which is not primarily scientific. Among those expected to take part will be Dr. J. Hutchins, professor of physiology in the University of Chicago, who has been closely concerned with the planning and teaching of a course in biology for arts students, Prof. S. Zuckerman, Prof. A. R. Gemmell, Dr. C. Gordon, Mr. L. J. F. Brimble, Mr. W. B. Yapp, Prof. J. F. Danielli, Prof. T. A. Bennet-Clark and Prof. F. W. Rogers Brambell. Further information can be obtained from the Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Fourteenth International Congress of Pure and Applied Chemistry, Zurich

THE dates of the Fourteenth International Congress of Pure and Applied Chemistry and the Eighteenth Conference of the International Union of Pure and Applied Chemistry, both of which will be held in Zurich, are July 21–27 and July 20–28, 1955, respectively (and not the other way round, as given in *Nature* of September 25, p. 588). Papers will be limited to twenty minutes and summaries not exceeding 250 words should be submitted via the appropriate national organization. The final dates of acceptance vary for the different countries from December 15 and January 31, but in any event the summaries must reach the Congress secretary-general by February 15.

Announcements

THE Committee of Privy Council for Agricultural Research and Nature Conservation has appointed Mr. Frank Rayns to fill a vacancy in the membership of the Agricultural Research Council, caused by the retirement of Prof. K. Mather. Mr. Rayns is director of the Norfolk Agricultural Station, Sprowston; he is chairman of the Experimental Husbandry Committee of the Agricultural Improvement Council for England and Wales and serves on the governing body of the National Institute of Agricultural Engineering. Prof. S. Zuckerman has been appointed a member of the Agricultural Research Council for a further term of office.

DR. NICOL GROSS, managing director of S.A.G. (Pty.), Ltd., Johannesburg, has been appointed to the University of London readership in production engineering tenable at the Imperial College of Science and Technology.

MR. IVOR BOWEN has retired from the post of principal director of Equipment Research and Development (Air) in the Ministry of Supply, and is taking up an appointment with the General Precision Equipment Corporation of the United States; his new post will be in London.

THE Third International Congress on Vitamin E will be held in Milan in September 1955. The following topics will be discussed: vitamin E and metabolic processes; influence of vitamin E on the hæmato-vascular system; vitamin E and the neuromuscular system; correlation between vitamin E and other vitamins and hormones. Further information can be obtained from Prof. Emilio Raverdino, via Pietro Verri 4, Milan.

THE Rockefeller Foundation has made a grant of 7,500 dollars to the University of Glasgow towards the expenses of three small working conferences of European scientists interested in genetical problems. The conferences will be held during the next five years, one probably in or near Glasgow and the others in localities to be decided.

THREE postdoctoral fellowships in statistics are being offered for 1955–56 by the University of Chicago. The purpose of these fellowships (of value 4,000 dollars each) is to acquaint established research workers in the biological, physical and social sciences with the role of modern statistical analysis in the planning of experiments and in the analysis of empirical data. Application forms can be obtained from the Committee on Statistics, University of Chicago, Chicago 37, and must be returned by February 15, 1955.

ERRATUM. In the communication "Seasonal Regulation in British Dragonflies" by P. S. Corbet in *Nature* of October 2, p. 655, the labelling of the axes of the graph should be interchanged; thus the ordinates indicate percentage of yearly population emerging per day, and the abscissæ successive days of emergence.

ORGANIZATION OF APPLIED RESEARCH IN EUROPE

THREE reports have been prepared by the Organization for European Economic Co-operation*, the first two of which embody the results of a study of the organization of applied research in various European countries, including the United Kingdom, made during October 6–November 15, 1951, and in the United States and Canada during April 21–June 11, 1952, by two Technical Assistance Missions, the comparative observations and general conclusions of the two Missions being collected in the first report. The third report, dealing at length with applied research in the United States and Canada, though undertaken at the request of the Organization for European Economic Co-operation, was prepared as a project of the National Research Council of the United States National Academy of Sciences, in co-operation with the Mutual Security Agency. To a certain extent it has since been superseded by studies carried out by the National Science Foundation, so far as applied research in the United States is concerned, with which roughly a hundred out of its hundred and twenty-five pages deal. Nevertheless, the broad sketch of American practice in the organization, administration and finance of applied research and of the methods used to facilitate the translation of research results into practice provide a most useful supplement to the earlier publications of the National Resources Planning Board, "Research—A National Resource", and to the Steelman report, "Science and Public Policy". It is supported by a brief but well-chosen bibliography, and the much slenderer survey of industrial research in Canada is equally well-balanced and appropriate to the purpose.

The volume on applied research in Europe contains much more material that is either fresh or—except perhaps in respect of that supplied for the United Kingdom or contained in papers presented to the international symposium sponsored by the Department of Scientific and Industrial Research in London in November 1951—not so conveniently accessible. The symposium was included in the programme of the first of the two missions, and a brief account of the symposium is included in the Mission's report, which emphasizes the value of comparing methods used in the various countries for the organization of research, particularly for the adaptation of new ideas to varying conditions, and the value of international collaboration in the effective distribution of technical information. More attention should be given to the application of research results and to the improvement of means of communication. Generally, in Europe the trend has been in favour of the co-operative research organization as opposed to the sponsored research institute; but both types are regarded as necessary, and there appears to be no reason why they should not work in harmony.

In Austria, the Federal Government, which is the chief supporter of basic research, provided 390,000 dollars for this purpose at the universities and technical colleges during 1952 as well as other contributions for basic and applied research and technical development to a total of 1,960,000 dollars, but only 58,600 dollars was provided for basic research from industry or other private sources. There are some three hundred and fifty experimental research stations in Austria, employing eight hundred graduate and nearly five hundred other staff, and two centres for disseminating technical information: the Documentation Centre for Technology and Economy and the Economic–Technological Service of the Austrian Productivity Centre.

Since the Second World War scientific research in Belgium has been organized mainly by the National Scientific Research Board, with an income during 1949–50 of 306,000 dollars (187,000 dollars from State grants) and the Institute for the Development of Scientific Research in Industry and Agriculture with an income, from the State, in 1951 of 1,895,000 dollars. About 65–75 per cent of the industrial and agricultural research programme supported by the latter body is carried out at the universities or higher educational institutions, but for industrial research a higher proportion is carried out in the laboratories of the research associations.

Technical research in Denmark is mostly built up around the institutes of higher learning, but there are several research institutes established by the Government, and the Academy of the Technical Sciences makes grants totalling 192,000 dollars to various technical institutions, while the Government contributes 1,442,000 dollars for technico-scientific research, as well as 50,000 dollars for the Research Council of the Technical Sciences and 36,000 dollars for scientific research. The General Scientific Foundation has recently been established to distribute a State grant of 288,000 dollars annually for research in basic science and in the agronomic and veterinary sciences.

Applied research in France is carried out chiefly in laboratories controlled by the State, the nationalized industries and private enterprise. The National Centre of Scientific Research, with an expenditure of 8,580,000 dollars during 1951, as well as 1,720,000 dollars on equipment, is concerned mainly with fundamental research but devotes some of its activities to practical applications. Some branches of industry have organized corporate research centres, but the structure of these bodies varies widely.

In Germany the Kaiser Wilhelm Society has been replaced by the Max Planck Society for the advancement of the sciences, which has already some sixteen institutes dealing with applied research, and had an income for 1953 of 4,240,000 dollars. The German Research Association, which functions chiefly through grants to individual research workers, had funds in 1953 amounting to 2,600,000 dollars, while the Fraunhofer Society for the Advancement of Applied Research, founded in 1949 and which is still being built up, has distributed about 714,000 dollars for applied research. Research associations have been formed for some industries, to which the League of Benefactors for German Science has contributed some 238,000 dollars for fundamental research, while Federal Government contributions to industrial research totalled 6·25 million dollars.

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* Organization of Applied Research in Europe, the United States and Canada. Report of Technical Assistance Missions Nos. 81–82–83. Vol. 1: A Comparative Study. Pp. 80. 6*s.*; 1 dollar; 300 French francs. Vol. 2: Applied Research in Europe. Pp. 192. 12*s.*; 3 dollars; 600 French francs. Vol. 3: Applied Research in the United States and Canada. Pp. 120. 8*s.*; 1.25 dollars; 400 French francs. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.)

The main government organization for sponsoring research in Italy is the National Research Council, with an income for 1952–53 of 3 million dollars, while it is estimated that about 2·3 million dollars a year is spent on research in the universities, another 2·7 million dollars by government departments and nearly 250,000 dollars by the learned societies, professional associations and scientific foundations. Estimates are given of the expenditure on industrial research by individual firms—for example, 924,000 dollars each by the Montecatini Co. on chemical research and by the Fiat Co. on mechanical engineering research—but not for industrial research organizations as a whole.

In the Netherlands the Central National Organization for Applied Scientific Research has been responsible since 1932 for the direction of applied research in accordance with national needs and had a budget for 1951 of 3·4 million dollars, of which 2·37 million dollars came from the government and the remainder chiefly from industry. In Norway, where the universities themselves come under the Ministry of Education, most scientific and technical research, apart from that at the Christian Michelsen's Institute, Bergen, and that of the Society for Industrial and Technical Research at the Norwegian Technical College, Bergen, is carried out directly, under the government or with government assistance, which provided about 8 million dollars for research and development during 1952–53. The Royal Norwegian Council for Scientific and Industrial Research is responsible for the furtherance of fundamental research as well as for planning technical research in accordance with the needs of industry. Expenditure on scientific and technical research in 1952–53 is estimated at about 8·2 million dollars, of which 1·8 million was in universities and technical colleges, 2·1 million in public research institutes, 680,000 in institutes under the Council for Scientific and Industrial Research, and about 2·5 million dollars in industrial laboratories, with a research staff of about nine hundred, of which 290 are in the universities and technical colleges and 182 in public research institutes.

Information on research expenditure in Sweden is much less complete. The Royal Swedish Academy of Science received government grants amounting to 243,000 dollars during 1951–52 for research work at the Nobel Institute for Physics and Chemistry, the Stockholm Observatory and other institutes under its control. The Royal Swedish Academy of Engineering Sciences received a government grant of 25,000 dollars and also support from industry. Of the four State Research Councils, that for Technical Research had a budget for 1951–52 of 212,000 dollars, the Committee for Building Research 67,500 dollars and the Atomic Energy Committee 367,000 dollars. Applied research is carried out to some extent by various government laboratories which have a total budget of nearly 1·3 million dollars, while the combined budgets of the Forest Products Research Laboratory, the Textile Research Institute, the Metallographic Institute and the Food Preservation Research Institute are 776,000 dollars, of which 235,400 dollars are provided by the State. A survey of thirty-seven of the larger industrial research laboratories indicated that they employed a scientific and technical staff of 340 out of a total of 2,300, and the total expenditure on industrial research is estimated at about 10 million dollars a year. The interchange of information between research workers and industry is facilitated by the Researchers Contact Organization.

In Switzerland applied research is organized at the national level through the Society for the Promotion of Research at the Federal Technical College, the Commission for the Sponsoring of Scientific Research, the Swiss Research Council for Atomic Energy and the Swiss National Foundation for Scientific Research. No comprehensive data are available for Federal expenditure on research, but 936,000 francs were allocated for scientific research by the Federal Council in 1945, and the Swiss Federal Institute of Technology in 1951 received Federal credits amounting to 2 million dollars, the Swiss National Foundation for Scientific Research was to receive Federal grants increasing to 936,000 dollars in its third year, while some 3·25 million dollars were expended in 1951 on research and development by the Division of War Technology of the Federal Military Department. It is estimated that the firms of Ciba and Sandoz spend about 5·85 million dollars a year on research, and Brown Boveri about the same amount. The Aluminium Foundation was established by the Aluminium Industrie A.G. of Nordhausen to support promising investigations in applied chemistry, particularly electrochemistry and electrometallurgy, and a number of other Swiss firms and industrialists have established foundations for scientific research in medicine, biology, etc.

BRITISH INDUSTRY AND SCIENTIFIC MAN-POWER

THE first part of the address of Sir Harry Pilkington, president of the Federation of British Industries, to the annual meeting at Reading, on September 21, of members of the Southern Region of the Federation, stressed the importance of the export trade to the British economy and indicated that we are on the eve of another big effort by the Federation in this field, the Trade Fair at Baghdad. He said that we are the people in the whole world whose future, safety and survival most depends on the growth of international trade, and on the credit side that means the export of manufactured industrial products. We must constantly improve our productivity, attempt to increase our share of world trade, but still more expand the total of world trade and develop the purchasing power of growing markets overseas, including the raising of the standard of living of those people whose standards are far below our own.

Sir Harry said that the new industrial revolution under way completely overshadows that of the nineteenth century, and means a demand for more, and more highly qualified, scientists. The Federation's Education Committee is concerned here both with recruitment and training, including the shortage of science teachers. We shall not obtain the rise in productivity we require, he thinks, unless we have more people with a good scientific background—not merely more outstanding inventors, but more people competent to carry out the ordinary analytical work and team-work of development. Sir Harry then emphasized the high cost of invention to-day. This is now the result of team-work and leadership, and often involves enormous sums before inventions are developed to a commercial stage. He does not believe that Britain or any other country can afford to allow all its best scientists to work in isolated compartments on the same problem, without access at least to other people's mistakes. Broad views of the advantages of pooling resources of inventiveness, or of pooling results, are of the utmost importance to Britain and to mankind as a whole. He therefore urged industrial firms to re-assess the work of their research departments, and where research institutes or associations for the whole of the industry do not exist, to try to devise other means for pooling with their neighbours or their competitors results of their development work.

Sir Harry remarked that some of our man-power resources are still being used wastefully, and touching on the question of taxation said that to abolish de-rating would give a great shock to industrial confidence in Britain and undo all the good resulting from the encouragement given last April to investment in plant and machinery. He urged member-associations and individual firms to make their own cases showing what would be the effect, industry by industry, of a re-introduction of full rating on top of revised valuations.

Although Sir Harry complained of the high level of employment in the Civil Service, he welcomed the endorsement by the Government and the Civil Service as a whole of the findings of Sir John Wood's Committee in the Crichel Down case, and said that it is equally important that private citizens, and especially industry, should show like consideration to Civil servants.

BRITISH PHARMACEUTICAL CONFERENCE, 1954

THE ninety-first British Pharmaceutical Conference was opened at Oxford on September 13 and nearly five hundred members attended.

Dr. H. Davis, in his chairman's address, discussed the impact of National Health Service on pharmacy and outlined how the changing pattern of prescribing and dispensing demands from the pharmacist of to-day less manipulative skill but a more detailed scientific knowledge of drugs and processes than was formerly required. This changing demand is reflected in the research papers read at the Conference.

Two of the papers are of general interest. The first, on demineralized water, shows that with correct technique demineralization of tap water by mixed anion and cation exchange resins produces a water of purity at least equal to that of distilled water B.P. The second general paper was a discussion of entrainment of liquid in distillation. It was shown that when the flow of vapour in the still-head was in streamline flow, the amount of entrainment increased with diameter of still-head and was proportional to Reynolds number.

Research of specific interest to practising pharmacists included a study of the pH of the castor oil soap in the preparation of a solution of chloroxylenol in an attempt to obtain a constant product. The increased use of newer emulsifying agents is reflected in the report on polyethylene-glycol esters of cetostearyl alcohol, in which it was shown that when used alone the lower members of the series (two or four ethylene oxide units) are more effective in emulsifying arachis oil. Also in the emulsion field, an interesting point was that the addition of bentonite to certain cream bases will permit them to be autoclaved without creaming or separation of the oil.

Stability of preparations of drugs is always an important subject in pharmaceutical analysis. A quick iodometric method for estimating the hydrolysis of succinylcholine chloride, confirmed by chromatographic and biological assays, has shown that increased temperature (20° → 37° C.) greatly increases the instability of this drug. Since ferrous iron is more readily adsorbed than ferric iron, oxidation of ferrous gluconate solutions should be prevented; it has been found, by suitable formulation and storage in light, that the ferrous iron content of such a solution may increase slightly, but this is accompanied by some deposition from the solution. The most stable solution is a 10 per cent solution stored in small, completely filled containers, stabilized with 7·5 per cent dextrose monohydrate and stored protected from light.

It is interesting to find that the sugar coating of tablets of penicillin intended for oral use not only masks the bitter flavour but also protects the contained penicillin from external moisture, and so increases the stability that they can then be stored for two years at 25° C.

The instability of tincture of digitalis has been a puzzle, since the frog lymph sac method of assay showed loss of potency on storage whereas the cat intravenous method did not. Fresh light has been thrown on this subject by two workers who, using a frog intravenous method, have shown that this method also indicates a drop in activity on storage and so the disagreement between the two methods of assay is not due to differences in absorption. They suggest that on storage the primary glycosides in the tincture are hydrolysed to secondary glycosides but not down to the genins.

The correlation shown between three methods of measuring pyrogenic activity—temperature rise, fall in percentage of small lymphocytes and fall in average number of lobes per neutrophil—will give pharmacologists a double confirmation of the results of pyrogen tests.

A very neat method of studying the percutaneous absorption of substances from ointment bases has been devised. Injection of acetylcholine into a rat causes secretion of reddish-brown tears; this effect is increased by eserine, and the response can be used for an assay of the eserine. By incorporating the eserine in an ointment base and rubbing on the skin of the rat, the amount absorbed can be ascertained.

A number of papers on the analytical aspect of research were presented, including biological and chemical assays.

In a new type of apparatus it has been shown that the rate of disinfection of solids by formaldehyde vapour is dependent on the amount of vapour permeating the solid rather than the concentration of formaldehyde in the vapour.

The adsorption of phenol on activated charcoal, or on a precipitate caused when ferric chloride was added to the bacteriological medium used for detecting survivors from a phenol–*Bact. coli* mixture, showed no apparent effect on the survival-rate.

An infusion of raspberry leaves has a traditional use in giving easy and speedy parturition. Preliminary investigation into the active principles which may be responsible for this effect have led to the separation of three fractions, one a spasmolytic factor which may antagonize the stimulant effect of the other two factors, and might explain the negative results of clinical trials of raspberry leaf extracts. A standard method for the purification of such extracts should lead to more definite results from them.

The comparison of two types of assay for tincture of digitalis, the 18-hr. frog method and a chemical method using 3 : 5-dinitrobenzoic acid, has shown that the biological assay of this material is still the only sure way of ascertaining potency. Search for a means of characterizing sulphonamides by examination of their benzaldehyde and salicylaldehyde derivatives not only achieved the required results but also led to a rapid colorimetric method for the assay of sulphadimidine.

Two papers were read dealing with spectroscopy, one a general outline of infra-red techniques and the other on the determination of vitamin D.

The diverse chemical nature of synthetic analgesics led to a review of their stereochemistry, when it was found that the more analgesically active isomer of optical enantiomorphs has a spatial configuration related to that of D-(−)-alanine. The isolation, purification and identification of the constituents of the petrol extract of serpentary formed the basis of one paper, which illustrated the vast amount of work that still remains to be done before the true nature of many of the drugs in common use is elucidated.

Two new assay techniques were reported, one for benzathine penicillin and the other for quaternary ammonium compounds.

It was argued on statistical grounds that some of the present standards for surgical dressings given in the British Pharmaceutical Codex need review, in that in some cases the exacting specifications take no account of variations which are bound to occur in manufacture and can easily be measured and limits imposed.

With the increasing use of the tablet as a convenient method of dispensing solid drugs, it is not surprising to find the symposium session of the Conference devoted to tablets, when the preparation, standardization and dispensing of them were fully discussed.

GIOVANNI MARIA LANCISI (1654–1720)

ANATOMIST, pathologist, epidemiologist, sanitarian and clinician, and one of the most advanced thinkers in the history of the medical sciences, Giovanni Maria Lancisi was born in Rome three hundred years ago, on October 26, 1654. He studied medicine at the Collegio di Sapienza, where he obtained his doctor's degree at the age of eighteen. After serving for two years as assistant physician at the Santo Spirito Hospital, he was made a canon of the Church of San Salvatore College in 1678 and devoted himself to studying the medical classics. In 1684 he was appointed professor of anatomy at the Collegio di Sapienza and thirteen years later professor of the theory and practice of medicine. A great admirer of Boerhaave, he introduced his clinical methods into medical teaching. He was physician to three successive popes: Innocent XI, Innocent XII and Clement XI. It was at Clement's request that in 1707 he wrote his monumental treatise "De subitaneis mortibus", in which he carefully records the pathological lesions of the brain and heart observed at autopsy, gives the first description of syphilis of the heart and of growths on the valves, and lists hypertrophy and dilatation of the heart as a cause of sudden death.

Lancisi's book, "De motu cordis et aneurysmatibus" (1728), is another landmark in the history of heart disease, for it stresses the significance of heredity, syphilis and violent emotions as causes of aneurysm. In his work "De noxiis paludum effluviis eorumque remediis" (1717) he showed remarkable insight into the theory of contagion and the possible transmission of malaria by mosquitoes. He described the natural history of the mosquito, suggested repeated examination under the microscope of the blood of malarial patients, recommended with poetic fervour cinchona bark as a remedy, and pointed out the connexion between stagnant water and mosquitoes as vectors of the disease. For the prevention of malaria he advocated the draining of marshy lands and their drying up by conservation of forests. He also wrote on equine and bovine pest.

Appreciating the relation of anatomy to sculpture and painting, Lancisi, in 1691, persuaded Bernardino Genga, professor of anatomy and surgery in Rome, to publish for the use of students his studies of anatomy made from the works of the ancients, and he himself published and edited in 1714 the "Tabulae anatomicae" of Eustachius, which had lain unused in the Vatican Library for more than 150 years. In the following year he wrote "A Correct Curriculum of Medical Studies", in which he emphasized the need of a preliminary education and the value of regular visits to other medical clinics. His library of twenty thousand rare books and manuscripts (Biblioteca Lancisiana), which he presented to the Santo Spirito Hospital in 1711 for the use of young physicians and surgeons, and for the maintenance of which he left a generous legacy, represents one of the first public medical libraries.

Paradoxically, Lancisi, whose signature is writ large on so many pages of anatomy, is eponymously commemorated solely by Lancisi's nerves—striae longitudinales on the upper surface of the corpus callosum.

A small man with lively expression and exuberant spirits, affable and diplomatic in company, Lancisi was a tremendous worker of amazing versatility, who carried on an extensive correspondence with the most famous scientists of his day. He died in Rome on January 21, 1720, at the age of sixty-six. In the tercentennial year of his birth he is gratefully remembered chiefly for having laid the foundation for a true understanding of the pathology of the heart.

W. R. Bett

SOCIETY FOR VISITING SCIENTISTS

ANNUAL REPORT FOR 1953–54

THE annual report for 1953–54 of the Society for Visiting Scientists, the seventh report of the Society, opens with an account of the financial state of the Society, which though it is disappointing is by no means hopeless, and under the energetic direction of the honorary treasurer, Prof. A. Haddow, fresh appeals will be made to the scientific industry to support the Society (preferably by deed of covenant) and to individual scientific workers to become members.

The Society's library and lounge are available to scientific societies on payment of a small fee, and it is hoped that in future more use will be made of these facilities. The premises were redecorated during the year, and they have a very pleasing appearance. As a result of the financial stringency, a certain amount of economy in the activities of the Society has had to be enforced during the year, but receptions were arranged for the delegates to two conferences—one on nucleic acids, organized by the Faraday Society, and the other by the General Assembly of the International Union of Pure and Applied Physics—and members of the Bureau of the International Council of Scientific Unions were also received on the occasion of their meeting in London in the spring. Of the three evening meetings held during the year, one consisted of scientific films on the petroleum industry, and another was a lively discussion on "The Science of Clothing". The third gathering was prompted by the occasion of the meeting in London of the Executive Committee of the International Geographical Union, and a discussion was arranged on "World Population".

The Overseas Science Students Association, which was started two years ago with the help of the Student Department, Student Welfare Department and the Science and Engineering Department of the British Council, has continued to hold its regular weekly meetings.

Although there were few 'major' occasions, the principal function of the Society—to act as a day-to-day centre in London for all scientific workers, both from overseas and those resident in Britain—was maintained, for which no little credit is due to the secretary, Miss E. Simpson. The officers of the Society are: *President*, Prof. A. V. Hill; *Honorary Secretaries*, Prof. F. J. M. Stratton and Mr. A. Lang Brown; *Treasurer*, Prof. A. Haddow; *Chairman of the Programme Committee*, Mr. G. A. McMillan; and *New Member of Council*, Sir Lawrence Bragg.

BUILDING RESEARCH STATION

REPORT FOR 1953

THE report for 1953 of the Building Research Board, to which is attached the report of the director of building research, Dr. F. M. Lea, this latter taking up the major part of the publication (pp. 66. London: H.M.S.O., 1954; 3*s*. 6*d*. net), is chiefly impressive for the very great amount and variety of research that has been undertaken at the Building Research Station, Garston, near Watford. Perhaps this is not altogether surprising, since the staff at the Station numbers more than four hundred, half of whom are officers in the scientific and experimental grades.

The director's report is divided into seven sections entitled: materials; design and performance of structures; soil mechanics; building operations; efficiency of buildings; the Scottish Laboratory; and Colonial housing and building research. In materials alone, the problems are becoming exceedingly varied and complicated as more and more different sorts of materials are invented and developed. But, of course, building research does not end with materials. There are the various types of building, from small dwelling-houses to large industrial premises, and it is with regard to the latter that many interesting developments are taking place, particularly in such media as prestressed concrete. Then, too, there is the question of building methods, productivity and costs, and the development of mechanical aids in building, of which the rail-operated tower crane is a case in point. The scope of building research extends to such problems as flooding, sea-defence banks and dams.

The Scottish Laboratory is more and more providing a means of extending investigations at the main Station, though there are particular Scottish problems, such as the utilization of local stone. In Colonial research, the work revolves around the activities of the Colonial liaison officer, who has been making extensive tours, mainly in Africa, looking into problems and arranging for the right organization to work on them. As yet, the only body in Africa engaged exclusively on building research is the South African National Building Research Institute, but plans are being laid for building research to be undertaken in British West Africa, the French African Territories and the Belgian Congo, as well as a certain amount of work on materials in Kenya and Southern Rhodesia.

Finally, mention must be made of the Building Research Board's concern at the reduction in finance during 1953, which severely curtailed long-term and short-term research, leaving the resources more concentrated on advisory work and the practical application of research. The Board feels strongly that its function is to promote not only work of immediate use but also that which will yield returns in the more distant future, and it is to be hoped that the recent lifting of financial restrictions on the Department of Scientific and Industrial Research will be reflected in the allocations to building research.

PLANT CULTIVATION IN SALINE AND BRACKISH WATER

THE raising of plants under saline conditions is a common problem in arid areas, where there is little leaching of the soil by rainfall and where the water available for irrigation has often a high salt content. In the fourth volume produced under the Unesco Arid Zone Programme*, the utilization of saline water is dealt with in three reviews, which not only provide a useful summary of existing information, but also, by emphasizing the gaps in our knowledge, serve as pointers to further research.

The first review, by Georges Grillot, of the Centre de Recherches Agronomiques, Rabat, Morocco, is based on research carried out in Africa, Europe and the Middle East. It deals with the biological problems presented by the growth of plants in saline or alkaline environments, and includes a particularly thorough section on the use of saline water for irrigation. Some of the important data are concisely set out in nine appendixes, among which is a table of natural halophytes "indicative of the corresponding cultivability of domestic species". One of the principal conclusions of the review is that both research and actual practice show that irrigation by saline water is not necessarily harmful. Certain types of soil, however, may be impoverished by even slightly saline water; but since vegetation is tolerant of higher degrees of salinity, the problem is one for the soil chemist rather than directly for the biologist.

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* Arid Zone Programme. Reviews of Research on Problems of Utilization of Saline Water Pp. 96. (Paris: Unesco; London: H.M.S O., 1954.) 1 75 dollars, 500 francs, 10*s*. 6*d*

The second review is by Dr. H. E. Hayward, director of the United States Salinity Laboratory, Riverside, California, and covers research in the Americas, Australia and India. The practical problems encountered in the various geographical regions receive a comprehensive treatment; but more space is allotted to an interesting general account of basic physiological problems. Subjects discussed include the physiological basis for salt tolerance, the physiological basis for alkali tolerance, the effect of saline and alkali soils on plant growth, toxic effects of specific ions and salt tolerance in relation to germination. It is concluded that one of the main effects of moderate levels of soil salinity is to limit water supply to the plant by increasing the osmotic pressure of the soil solution. This effect is intensified by an increase in soil moisture tension, and the combined effect, total soil moisture stress, conditions the growth of plants. Over and above the osmotic effect, each component of the saline solution may have some specific toxic effect which may vary among various genera, species and varieties of agricultural crops. Because of this specificity in salt tolerance, it is important to make a proper selection of crops for use on lands that are marginal because of salinity.

The third review, by Dr. Everett D. Howe, of the Faculty of Engineering, University of California, is restricted to a consideration of methods of purification of salt and brackish waters. The development of an economically feasible method of carrying out such a purification on a large scale is clearly of the greatest importance, but has evidently not yet been achieved.

The reviews are clearly written and although their main value will be to those engaged in the agricultural development of saline regions, they have much of interest for many readers, particularly for the plant physiologist or ecologist.

A. ALLSOPP

HOUSEFLIES RESISTANT TO A GROUP OF CHLORINATED HYDROCARBON INSECTICIDES

By DR. J. R. BUSVINE

London School of Hygiene and Tropical Medicine

IN general, DDT has been the subject of far more research than other chlorinated hydrocarbon insecticides and, in particular, this is true of investigations of insecticide-resistance in houseflies. It seems that resistance to the insecticides γ-BHC, chlordane, dieldrin, aldrin and toxaphene is quite distinct from DDT-tolerance. These compounds must have some factor in common, since selection by exposure to one of them raises the resistance of a fly strain to the others. Questions which now arise are: Is there a single defence mechanism which protects resistant flies from all these compounds; and what is the common factor which defines this group of insecticides?

As regards DDT tolerance, there is evidence of at least two defence mechanisms, which may be more or less developed in different strains of fly, and thereby modify the type of resistance displayed. This has been exemplified by two strains of DDT-resistant flies, which showed marked differences in relative susceptibility to a range of DDT analogues[1].

It seemed possible that a similar type of investigation might reveal whether resistance to the γ-BHC–chlordane group of chlorinated compounds was equally heterogeneous. The method used was to determine the exact degrees of resistance, to a series of related compounds, shown by four strains of flies from very different sources. The strains of houseflies used were: (1) Sardinia strain. Previous history in the field: DDT house-spraying throughout the island during 1947–50; chlordane added to the spray from 1948; laboratory colony started in November 1950. (2) England strain. Previous history in the field: from a refuse tip at Egham, treated with DDT during 1947–49; during 1951–53 treated with BHC; laboratory colony started in September 1953. (3) Omdurman (Sudan) strain. Previous history in the field: all pit latrines and other breeding sites near the town dusted with BHC during 1949–52; in 1950, many houses sprayed with DDT; laboratory colony started in March 1953, through the kindness of Dr. D. J. Lewis. (4) Uruguay strain. Previous history in the field: widespread use of BHC and DDT; laboratory colony started in 1951; a subcolony kindly sent to me by Mr. Newman, of Imperial Chemical Industries, Ltd., in January 1954. (5) Normal strain. Reared in the laboratory for many years and believed to be normally susceptible to insecticides.

Samples of males of the above strains were collected and, on the fresh specimens, the ratios head width/frons width were calculated, with the following results: Sardinia, 6·81 ± 0·44; England, 5·98 ± 0·38; Omdurman, 10·94 ± 1·45; Uruguay, 5·17 ± 0·46; normal, 5·14 ± 0·46. The Omdurman strain is clearly of the *M. domestica vicina* type, while the England, Uruguay and normal colonies are of the *M. domestica domestica* form. The Sardinia ratio is a little high, but approximates to the latter. These figures agree with those of Sacca[2], though I find the difference between colonies of *domestica* and *vicina* to be more constant than he suggests. Thus, after a year in my laboratory, the Omdurman ratio was found to be 11·14 ± 1·40, so that it had not changed appreciably.

Measurements of relative resistance. Purified samples of the following seven compounds were kindly supplied by the Shell Co., Ltd.: α- and β-chlordane (1, 2, 4, 5, 6, 7, 8, 8-octochloro-4, 7-methano-3a, 4, 7, 7a-tetrahydroidane); it is believed that α- and β-chlordane differ in regard to the position of chlorine atoms on carbons 1 and 2, α being a *trans*-

Table 1. MEDIAN LETHAL CONCENTRATIONS OF VARIOUS INSECTICIDES TO DIFFERENT STRAINS OF HOUSEFLY

Fly strain	Median lethal concentration (per cent)							
	Chlordane alpha	Chlordane beta	Isodrin	Endrin	γ-BHC	Aldrin	Dieldrin	DDT
Uruguay	30	9	0·5	0·3	0·8	7	3	0·35
Omdurman	18	4	0·35	0·2	0·5	2	1·5	0·6
Sardinia	3·5	0·3	0·1	0·05	0·09	0·4	0·25	1·8
England	2·0	0·4	0·09	0·06	0·1	0·22	0·14	1·0
Laboratory	0·04	0·018	0·015	0·009	0·008	0·007	0·006	0·08

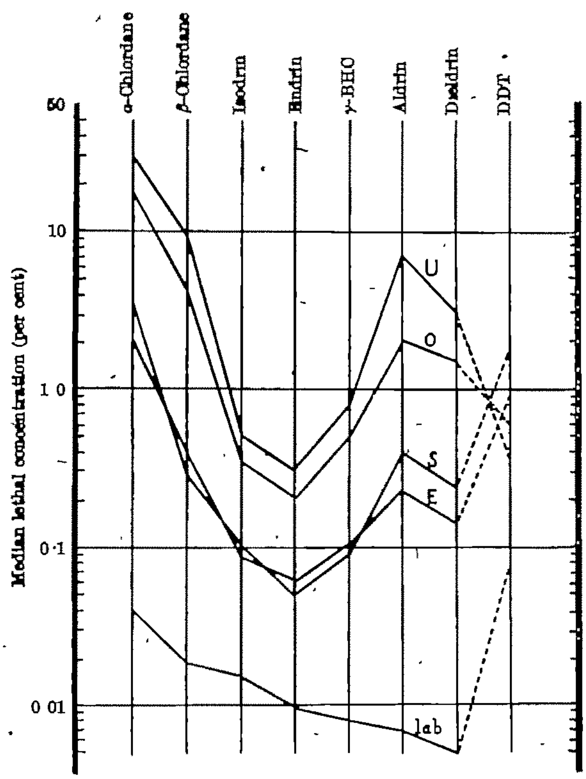

Fig. 1. Relative resistance to chlorinated hydrocarbon insecticides in houseflies. The logarithmic scale on the left indicates the median lethal concentration of various insecticides, which are shown as vertical lines. These, with the exception of DDT, are arranged in order of toxicity to the normal laboratory strain of flies (lab.). The irregular lines display the similar resistance 'pattern' of the following strains: U, Uruguay; O, Omdurman; S, Sardinia; and E, England

and β a *cis*-isomer; both are thought to be *endo* forms in respect of the isomerism about the 3*a*–7*a* carbon bond. Dieldrin and endrin (1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4*a*, 5, 6, 7, 8, 8*a*-octahydro-1 : 4, 5 : 8-dimethanonaphthalene); dieldrin is an *endo–exo*- isomer, whereas endrin is the *endo–endo*- form. Aldrin and isodrin (1, 2, 3, 4, 10, 10-hexachloro-1 : 4, 5 : 8-dimethano-1, 4, 4*a*, 5, 8, 8*a*-hexahydronaphthalene); aldrin is an *endo–exo*-isomer, whereas isodrin is the *endo–endo*- form. γ-BHC (γ-1, 2, 3, 4, 5, 6-hexachloro-cyclohexane).

These insecticides were dissolved in refined, high-boiling mineral oil (Shell risella oil), and their toxicities to the various fly strains determined by droplet applications, as in previous investigations[1]. The median lethal concentrations were estimated, the results being set out in Table 1 and illustrated by Fig. 1.

These results have certain interesting characteristics. It will be seen that the 'pattern' of resistance of the four fly strains is remarkably similar, despite their different histories and origin in such diverse geographical areas. All of them have developed highest resistance to α- and β-chlordane, dieldrin and aldrin. Resistance is intermediate to γ-BHC, and it is least developed against endrin and isodrin. Though three of the strains acquired resistance by the selective action of BHC used in the field, yet in all cases resistance to chlordane, dieldrin and aldrin is higher.

Possibility of a common defence mechanism. The results strongly suggest that the four strains depend on the same defence mechanism for dealing with insecticides of this type, though it may be more highly developed in some strains than others. From Fig. 1 it will be observed that the compounds aldrin and dieldrin, and the two isomers of chlordane, retain the same order of toxicity to the resistant as to the normal flies. In contrast, endrin, isodrin and γ-BHC, which are intermediate in toxicity to normal flies, are decidedly more toxic to resistant ones than the group mentioned above. This change is puzzling; but, indeed, the reasons for the original order of toxicity to normal flies is equally obscure. In a later paragraph it will be suggested that all these compounds have similar insecticidal action by reason of similar toxophores. If this is so, their individual levels of toxicity might depend on characters of the whole molecules, affecting such things as phase distribution or efficiency of absorption or diffusion. It is conceivable that these characters might have different effects at the high concentrations necessary for the resistant flies.

Another possible explanation could be offered if the resistance mechanism depended on detoxification; for this might well be more efficient with some compounds than others. Then, for example, one would expect dieldrin introduced into resistant flies to disappear faster than endrin.

The following tests were conducted. Batches of resistant females were injected with 0·1 per cent oil solutions of dieldrin or endrin. After various periods, the flies were ground up and extracted with ether and the insecticide remaining in the residue estimated

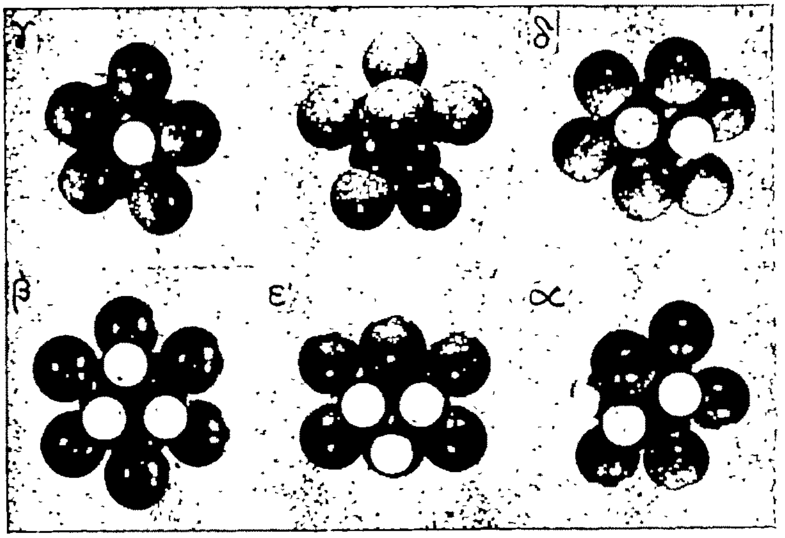

Fig. 2. Molecular models of α-, β-, γ-, δ- and ε-BHC and (top centre) end-view of a molecule of either chlordane, dieldrin, aldrin, isodrin or endrin, all of which have a somewhat similar pentagon. Key to the colours: black, carbon; white, hydrogen; grey, chlorine. It will be seen that for BHC the pentagonal arrangement of chlorine atoms occurs only in the γ form. (The bonding angles in the 6-membered carbon rings in these compounds are somewhat strained and the carbon balls have been slightly modified by Dr. S. L. Thomas to obtain a fit. In consequence, this model cannot be used for an accurate estimate of molecular dimensions.) The models were made by Messrs. Catalin, Ltd., according to specifications of Settatree, Thomas and Yardley (ref. 3)

Table 2 EXTRACTION OF DIELDRIN AND ENDRIN (μgm./fly): (a) FOR LIVING AND DEAD FLIES, RESPECTIVELY, AFTER 30 HR.; (b) LIVING AND DEAD FLIES TOGETHER, AFTER 0, 40 AND 70 HR.

	Living	Dead
(a) Dieldrin	0·21	0·24
Endrin	0·26	0·28

	0 hr.	40 hr.	70 hr.
(b) Dieldrin	0·26	0·24	0·19
Endrin	0·23	0·17	0·14

by bioassay, by wire-loop applications to susceptible male flies (Table 2).

These limited data suggest that the different degrees of resistance developed to these two compounds do not depend on relative ease of elimination.

Common factor of the γ-BHC–chlordane group. The second question mentioned earlier was the problem of the common factor of the γ-BHC–chlordane group of insecticides. The compounds chlordane, aldrin, dieldrin, endrin and isodrin have obvious similarity in part of their molecules; but γ-BHC appears quite different when represented graphically. When molecular models are prepared, however, it may be observed that five of the chlorine atoms of the chlordane group are arranged approximately symmetrically, with a sixth protruding from the centre. Models of the various isomers of hexachlorocyclohexane reveal a rather similar pentagon of chlorine atoms in the γ-form only (Fig. 2). It seems likely that this is the toxophore responsible for the high insecticidal activity of γ-BHC and the chlordane type insecticides. It may also explain the correlated resistance developed by flies to members of the group.

Additional evidence for this hypothesis was obtained by tests with a sample of octochloropropane, a highly chlorinated hydrocarbon not possessing a pentagonal arrangement of chlorine atoms. The median lethal concentration of this compound was found to be approximately 20 per cent for both the Omdurman and the laboratory strains. Thus, this substance is not highly insecticidal, nor does resistance to the γ-BHC–chlordane series alter the level of susceptibility to it.

Apart from chemical considerations, observations of the progress of intoxication in flies reveal similar features in γ-BHC and the chlordane group, which are quite different from signs of DDT poisoning. DDT causes continual, unco-ordinated movements; but until a late stage of intoxication, the wings can function normally. Flies poisoned by γ-BHC or by a member of the chlordane group frequently show 'fanning' movements of the wings, insufficient to cause flight. At a late stage of intoxication, the legs are all tightly contracted under the body and the wings are usually deflected downwards (cf. Weismann[4]).

It is interesting to learn that, in mammals, there is an analogous difference in signs of poisoning by DDT as compared with those due to the γ-BHC–chlordane group of insecticides. Dr. J. M. Barnes, of the Medical Research Council Toxicology Research Unit, kindly allows me to quote his observations, as follows: "When these insecticides are dissolved in 'Tween 80' (polyoxyethylene sorbitan oleate) and injected intravenously into rats, there are two types of effect. DDT and methoxychlor, like phenol, produce widespread muscular twitchings. The intensity of the tremors depends on the dose. In the case of DDT, convulsions are relatively minor in severity and come as a cumulation of the violent tremors. Death may not take place for 1–2 hours. With *gamma* BHC, aldrin, endrin, dieldrin and chlordane, fine muscular twitchings are not seen. The outstanding feature is convulsions, of sudden onset and extreme violence, often starting within a few minutes of giving a dose that is just lethal. Death may occur during convulsions, or after a period of unconsciousness following the convulsions. Death, if it occurs, usually takes place within 10–15 minutes".

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PHOTOLYSIS OF CHLORINE DIOXIDE AND ABSOLUTE RATES OF CHLORINE MONOXIDE REACTIONS

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THE absorption spectrum of chlorine monoxide was first detected in the photochemical reaction between chlorine and oxygen[1,2] and all direct studies of its reactions have so far been carried out on this system. The mechanisms of these reactions have been thoroughly elucidated, but[3] it has been necessary to express the absolute rates and concentrations in terms of an unknown constant which is numerically equal to the extinction coefficient of chlorine monoxide at a given wave-length. The evaluation of this constant would lead to absolute extinction coefficients of chlorine monoxide at all wave-lengths, absolute concentrations under any required conditions and absolute rate constants of the reactions of chlorine monoxide.

The extinction coefficient appears in these quantities because the observed parameter is an optical density, D_λ, of the reaction mixture at a given wave-length λ. We then have

$$D_\lambda = \varepsilon_\lambda c l,$$

where ε_λ is the extinction coefficient of chlorine monoxide at this wave-length, c is its concentration and l is the length of the absorption path. It is therefore possible only to measure the product $\varepsilon_\lambda c$ and not the separate quantities. Since the relative extinctions at two wave-lengths are easily obtained, all can be referred to a standard extinction, ε_s, at a wave-length of 2577 A., which is in the continuous region of the spectrum and is therefore insensitive to the exact wave-length and independent of the resolving power of the spectrograph.

The ClO radical is removed by the bimolecular process:

$$2ClO = Cl_2 + O_2; \qquad (1)$$

and the rate constant of this reaction is given by

$$k_1 = 7{\cdot}2 \times 10^4 \times \varepsilon_s \exp \frac{(0 \pm 650)}{RT} \text{ litre mole}^{-1} \text{ sec.}^{-1}.$$

To evaluate ε_3, the concentration of chlorine monoxide must be known and, in principle, this can be found by difference if the concentrations of the other species present are known. Thus, in the reaction between chlorine and oxygen, the only species which contain chlorine and which are present in significant concentrations are chlorine monoxide and chlorine, and the decrease in concentration of chlorine should lead directly to the concentration of chlorine monoxide. Unfortunately, owing to the low extinction of chlorine, this decrease of concentration was below the limit of detectability and it was therefore only possible to give a lower limit for ε_3 which was 310. Reasons were given for supposing that ε_3 was less than 3,000, but no further limits could be fixed by these experiments.

The extinction coefficient of chlorine dioxide is much greater than that of chlorine and is of the same order of magnitude as the above predicted values for chlorine monoxide. It follows that, if chlorine monoxide were detected during the photolysis of chlorine dioxide, the decrease in concentration of chlorine dioxide should be readily measurable. We have therefore investigated this reaction by the same experimental methods as were used to study the chlorine–oxygen reaction. The photolysis flash was operated with an energy of 250 *J* and had an effective duration of 100 μsec. Pressures of chlorine dioxide were ½ mm. mercury or less, and the experiments were conducted in the presence of up to half an atmosphere of inert gas (argon, nitrogen or carbon dioxide) in order to reduce the rise in temperature to a few degrees. Plate densities were measured by reference to calibrations made with a neutral step wedge.

It was found that a single flash decomposed about 90 per cent of the chlorine dioxide and that this spectrum was replaced by that of chlorine monoxide, which then decayed slowly in the same manner as had been observed in previous work. Spectra of other chlorine oxides were absent at all times, and microphotometric measurements at 2780 A. established that chlorine trioxide (ClO_3), which has an extinction coefficient of 1,210 at this wave-length[4], could not have been formed in an amount greater than 1 per cent of the total chlorine dioxide decomposed. This is different from the photolysis of chlorine dioxide at normal intensities, where chlorine trioxide is a major product[5], but the difference can be understood in terms of the following competing reactions:

$$O + ClO_2 = ClO_3 \qquad (2)$$

$$O + ClO = ClO_2 \qquad (3)$$

$$O + O + M = O_2 + M \qquad (4)$$

Since the ratio of the concentration of atomic oxygen plus chlorine monoxide to the dioxide is many thousand times greater in the flash experiments, the probability of reaction 2 relative to 3 and 4 will be correspondingly reduced.

The primary photolysis undoubtedly occurs by the process:

$$ClO_2 + h\nu = ClO + O\,; \qquad (5)$$

and therefore, if measurements are made before the chlorine monoxide has reacted to form chlorine, the concentration of chlorine monoxide will be given simply by the difference between the corresponding concentration of chlorine dioxide and the concentration originally present. Allowance was made for the chlorine monoxide which had reacted before measurement by carrying out a number of determinations at pressures of chlorine dioxide of 0·1, 0·2 and 0·5 mm. mercury, and extrapolating to zero concentration. The correction was very small, the observed value at the lowest chlorine dioxide pressure being only 4 per cent less than the extrapolated value, while the mean deviation from the mean at a given pressure was 7 per cent. The final value of the extinction coefficient at 2577 A. obtained in this way was 1,190 ± 100 litre mole^{-1} cm.$^{-1}$. Substituting this numerical value into the expression of Porter and Wright, we obtain:

$$k_1\ (20^\circ\ \text{C.}) = 8{\cdot}6 \times 10^7 \text{ litre mole}^{-1}\text{ sec.}^{-1}.$$

We have also measured the rate constant of removal of chlorine monoxide independently, using the same methods but preparing it by photolysis of chlorine dioxide. The mean value of the bimolecular constant obtained at 20° C. was $5{\cdot}7 \times 10^7$ litre mole^{-1} sec.$^{-1}$. The difference between these two values is probably within the combined errors of the two completely independent determinations, which used different density standards for plate calibration. It follows that chlorine dioxide, like chlorine and oxygen, has no effect on the rate of disappearance of the ClO radical.

It has been pointed out that reaction 1 has a low frequency factor and the reasons for this have already been discussed[3]. It is one of the simplest bimolecular radical reactions for which quantitative rate data and spectroscopic constants are now available for more detailed theoretical treatment.

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RESTRICTION OF INFLAMMATORY RESPONSE BY POLYSACCHARIDES

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THE suggestion that colloids from the blood plasma may coat the capillary endothelium and that the porosity of the latter may thereby be reduced was advanced more than a decade ago[1]. However, the possibility of utilizing this mechanism as a means of restricting inflammatory response has perhaps not been appreciated clearly. Water-soluble polysaccharides frequently occur on micro-organisms in the form of capsular envelopes. It is relevant to the mechanism of infection and of interest to learn whether such polymers also can act on blood vessels as wall-coating agents. In the experiments described here, we have attempted in particular to ascertain whether neutral and high-molecular bacterial polysaccharides, lævan and dextran, systemically administered, retard escape of blood colloids and cells across the capillary wall at sites of tissue injury.

The influence of the intravenous administration of high-molecular polysaccharide on the capacity for acute inflammatory responses to local irritants is illustrated by the results in Table 1. The saccharide used was native lævan of *Aerobacter levanicum* (3 per cent in saline), given intravascularly before the irritant in doses of 100 mgm./kgm. in rabbits and guinea pigs, and of 500 mgm./kgm. in mice. This preparation, though apparently non-toxic towards the mice and guinea pigs, evoked an untoward reaction (immediate diarrhœa and occasionally death) in a few rabbits. The irritants were: (1) peptone, 0·1 ml. of 10 per cent 'Difco' proteose peptone in saline; (2) turpentine, 0·005 ml.; (3) staphylococcus, 0·1 ml. of a suspension of a *Staphylococcus* sp. grown on an agar slant for 24 hr., washed and finally suspended in 5 ml. of saline. These findings show that inflammation throughout an area of injury can be markedly restricted or prevented both by a lævan and a dextran. The same effect was uniformly present in systems involving different irritants, tissues and hosts.

Table 1. INFLUENCE OF HIGH-POLYMER LÆVAN ON ACUTE INFLAMMATORY RESPONSES

Irritant	Route of irritant	Animal	Reactions no lævan	Reactions lævan
Peptone	Intradermal	Rabbit	+ (*a*)	—
Turpentine	Intradermal	Rabbit	+ (*a*, *b*)	—
Staphylococcus	Intradermal	Rabbit	+ (*a*, *b*, *c*, *d*)	—*
Staphylococcus	Intradermal	Guinea pig	+ (*b*, *c*)	—*
Staphylococcus	Intra-peritoneal	Mouse	+ (*e*, *f*)	—

* When the high-polymer dextran of *Leuconostoc mesenteroides* was used instead of lævan, the same gross result was obtained.

+ indicates the presence of the inflammatory responses listed in parentheses; — their absence or marked diminution.

a – local blueing reaction within 1 hr. when 5 ml. of 1 per cent trypan blue in saline was administered intravenously immediately before irritant;

b – local œdema at 4 hr.;

c – local erythema at 4 hr.;

d – diapedesis at 1 hr. as observed in histological preparations;

e – markedly increased number of leucocytes in peritoneal exudate at 4 hr.;

f – marked elevation of the amount of an agglutinin (*Salmonella typhi O* 901 rabbit antiserum) in the peritoneal exudate 4 hr. after the intravenous administration of the agglutinin.

A *Staphylococcus* sp. injected intradermally into normal guinea pigs and rabbits evoked skin lesions which were soon localized and became purulent within a day. In hosts with diminished inflammatory responsiveness, such skin lesions are known to be non-purulent and to show a tendency to spread[1]. When rabbits or guinea pigs received lævan or dextran systemically, the intradermal inoculation of the staphylococcus regularly evoked a spreading and necrotic rather than a purulent lesion (see Fig. 1). These findings have strongly supported the concept that the promoting effect of lævan and dextran on infection is mediated by the ability of the polysaccharides to arrest inflammatory responses[3].

Dr. E. Margoliash in this laboratory has also found that subcutaneous resorption of a foreign tissue (fragments of a transplantable mouse mammary carcinoma) in the rat can be greatly retarded by daily intraperitoneal injection of lævan: the resorption in the normal rats was advanced in four to five days; resorption was less marked after two weeks in the 'lævanized' animals. Thus it appears that the lævan can inhibit a presumably chronic process of inflammation and not only the acute inflammatory responses.

The question arises whether the polysaccharides prevent or simply mask the capillary injury. We observed that 1–3 hr. old skin lesions produced in rabbits by intradermal injection of turpentine show an almost instantaneous blueing reaction with intravenously injected trypan blue. When rabbits with the preformed skin lesions received lævan 30 min. before the injection of the dye, the blueing reaction at the injured sites was prevented or greatly diminished and delayed. This suggests that lævan effects the rapid masking of the capillary injury.

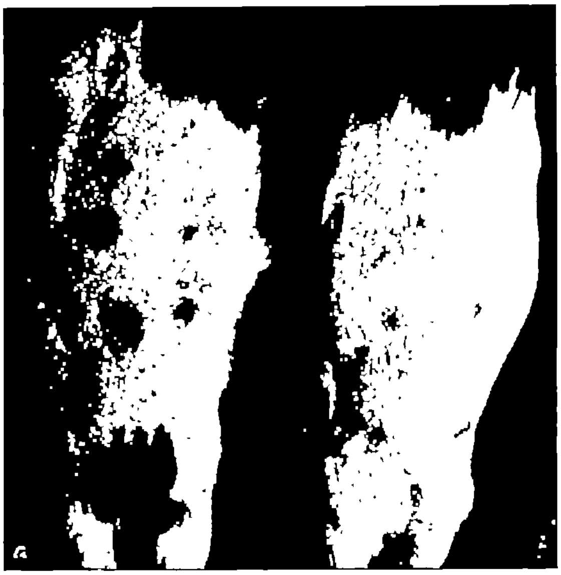

Fig. 1. Influence of high-polymer lævan on a cutaneous staphylococcus infection. guinea pigs infected intradermally at several dorsal sites. The inoculum was 0·1 ml. of suspension of washed cells of a *Staphylococcus* sp., the doses corresponding respectively in the lesions of the left and right rows to 1/50 and 1/500 of an agar slant. Lævan (150 mgm.) was administered intravenously. Photographs show lesions after six days. Lesions are purulent and localized in the non-lævanized control (*b*), whereas they are non-purulent, characteristically necrotic, and cover a relatively large skin area in the lævanized animal (*a*)

Both the ability to restrict inflammatory response and the attendant ability to promote infection are manifested by some shocking agents[2] and by cortisone[4] as well as by the polysaccharides. However, the mechanisms whereby these classes of substances affect the inflammatory response could, of course, be quite distinct. The activity of the polysaccharides was diminished greatly or abolished when molecular weight was reduced from greater than 10^6 to 10^4–10^5, which is the range acceptable in a plasma expander. Hence the activity is not determined solely by the structure of the polymer repeating-unit. The activity, however, could well be simply a function of capacity, dependent on molecular size, for adsorptive combination and resulting formation of an extraneous polysaccharide coat on the surface of the endothelium (cf. ref. 5).

A detailed report and discussion of clinical implications will be presented later. We thank Dr. M. Wolman for criticism and the analysis of histological preparations. Support of the investigation by a grant from the Scientific Department, Defence Ministry of the Government of Israel, is gratefully acknowledged.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Contraction and Relaxation of Collagen Fibres

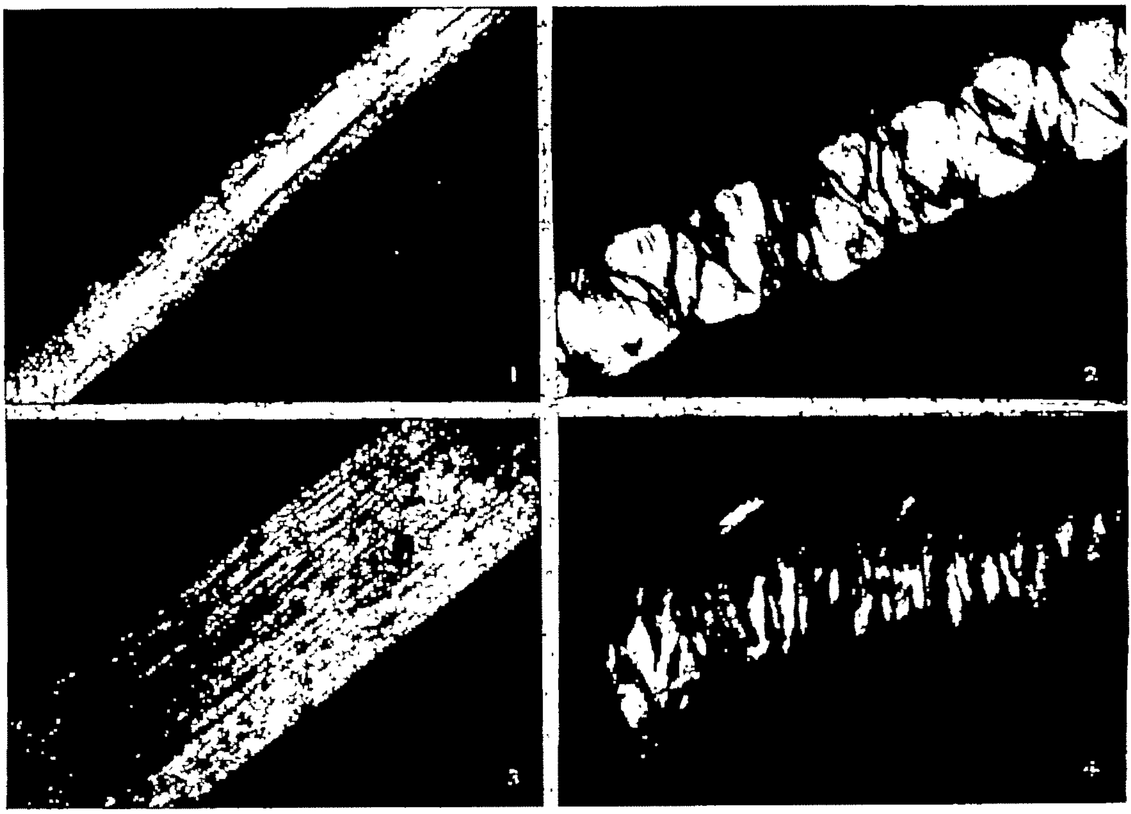
PARTRIDGE[1] reported that tendons from the tail of the rat loaded with small lead shot at above 60° C. in distilled water first shorten and thereafter lengthen, that is, contract and relax.

We have studied this phenomenon in detail by polarization microscopy, and by chemical and enzymical methods using isolated collagen fibres of rat tail tendon. We found that contraction and relaxation can be brought about also without heat at room temperature in concentrated salt solutions such as potassium iodate and potassium mercury-iodate in 40 per cent concentration. Single dry native fibres 1–2 mgm. in weight, 0·10–0·20 mm. in diameter and 5–6 cm. in length were loaded with small lead shot weighing 70–80 mgm. and placed at room temperature (20° C.) in the solutions mentioned above. Contraction starts after 20–30 sec. and ceases in 1–2 min. The fibres shorten to one-third of their length (67 per cent shortening). The relaxation only begins after 20–25 min., and it stops after approximately 60 min., when the fibres have lengthened to 80–85 per cent of their original length. We call this phenomenon observed in concentrated salt solutions at room temperature 'chemical contraction and relaxation'.

We have established that by the heat contraction of collagen fibres performed in water at 67° C. the fibres (as above) contract in 7–10 sec. and relax in 40–60 sec. The shortening is the same as in 40 per cent potassium iodate (67 per cent); the relaxation is 100 per cent. The analyses made by polarization microscopy and with chemical and enzymic methods show that the heat and chemical contraction – relaxation processes are similar to each other.

The native, contracted and relaxed fibres were examined separately in the wet and the dry state. The contracted fibres when wet are elastic, rubber-like, in contrast to the non-expansible native and easily torn relaxed fibres. By polarization microscopy we found that whereas the native fibre is optically homogeneous, in the contracted fibre two optically different phases can be observed: apparently an outer phase with small birefringence and an inner phase with helical structure and strong birefringence. The relaxed fibre is again homogeneous, showing fibrillary structure (Figs. 1, 2 and 3). Imbibition experiments show that in contracted fibre the two phases differ both qualitatively and quantitatively from each other.

The dissolution of protein was examined during the contraction – relaxation processes with larger amounts of collagen fibre. While the fibre is passing from the native to the contracted state, only a small quantity of mucoid[2] is dissolved; but the beginning of relaxation is connected with the dissolution of a larger amount of protein. Having kept the fibres for 20 min. in 40 per cent potassium iodate, relaxation starts; thus 36 per cent of the nitrogen of



Photomicrographs taken with the polarizing microscope. (1) Native fibre, optically homogeneous. (2) Contracted fibre. Outer phase of small birefringence and internal phase of strong birefringence with helical structure (3) Relaxed fibre, swollen, with pronounced fibrillary structure. (4) Contracted fibre after the effect of elastase; the outer phase is dissolved. × 100 the collagen is dissolved, and in 60 min. (complete relaxation) 75 per cent of the nitrogen of collagen goes into solution. By heat relaxation the same dissolution of protein takes place. At 67° C. in 2 min. 14 per cent, in 5 min. 47 per cent and in 10 min. 73 per cent of the nitrogen of the collagen is dissolved. The gross structure of the collagen fibre remains, as if the protein has dissolved only from the inside.

With elastase at pH 10, only 5–10 per cent of the native fibres were dissolved. From the contracted fibre the elastase dissolves the outer phase, which accounts for 15–20 per cent of the entire collagen nitrogen, while the internal phase remains intact. Fig. 4 shows a contracted fibre after treatment with elastase. The relaxed fibres are dissolved with elastase without residue.

The contraction process remains reversible if the fibres, just after contraction, were removed from the solution, washed, stretched and dried in the stretched state. But after relaxation, contraction could no longer be observed.

In a previous experiment, one of us (Banga[2]) showed that during the heat contraction of Achilles tendon a mucoid is dissolved which contains 6–8 per cent of carbohydrate. In those experiments the relaxation is already beginning and the analytical results may have related to the combination of two substances. It is to be noted that in Achilles tendon of cattle the heat contraction – relaxation processes follow much more slowly than in the collagen fibre of rat tail tendon.

Our experiments seem to prove that the collagen fibre is not built up from a single protein but at least of two different protein components. In our experiments the chondroitin sulphuric acid content of the ground-substance which stabilizes the collagen fibre does not play a part in the process of contraction – relaxation. This is shown by the following experiment. We treated the native collagen fibres with a concentrated aqueous solution of hyaluronidase, which dissolves chondroitin sulphuric acid. After treatment for 24 hr., contraction and relaxation took place in the usual way. This indicates that neither of the two proteins described corresponds to chondromucoid.

A paper containing the detailed results of the experiments will be published in the *Acta Morph. Acad. Sci. Hung.*

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A Lipid Component of Reticulin

In a previous communication in *Nature*[1], renal cortical reticulin was described as consisting of randomly orientated collagen fibrils embedded in a structureless matrix. X-ray diffraction photographs of these reticulin specimens showed a diffraction pattern quite typical of that of collagen, together with some additional rings; this suggested that the reticulin consisted of collagen together with an unidentified material.

Further studies on the chemical composition of this reticulin, isolated from kidneys as before, indicated that a fat component was present.

The X-ray diffraction pattern of this isolated fat has been compared with that of a series of saturated fatty acids, and the spacings and intensities show close agreement with the series. The precise member of the series present in reticulin was not identified from the diffraction pattern alone, but a melting point over the range 49°–52° C. suggested a mixture of fatty acids, with myristic acid predominating. Analysis by Imperial Chemical Industries, Ltd., using vapour phase chromatography, has given more than 90 per cent myristic acid.

In the X-ray diffraction pattern of reticulin, the broad collagen band at 4·5 A. somewhat masks the bands seen at 4·5 and 3·8 A., which are very intense when the isolated lipid component is examined alone. Outside the classical 2·9 A. collagen band seen in reticulin are other rings at 2·5, 2·35 and 2·2 A.; and these outer rings correspond very closely with those seen with saturated fatty acids.

From a reassessment of the electron microscope results, it is probable that the lipid was present in those regions which were too thick to give clear photographs. The reticulin as isolated was therefore a mixture of three components—collagen, fatty acid and polysaccharide-containing matrix. From the extraction methods used for isolating the reticulin samples, it was clear that the fatty acid was an essential component of the reticulin, and not a contaminant from extra-reticular sources.

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Staining Reactions of Elastic Fibres with Special Reference to 'Elastotic Degenerations' in the Human Skin

Part of our research programme is devoted to clarifying various aspects of skin carcinoma in man and in experimental animals. Careful study of the dermal accumulations of morphologically unusual fibrillar material, consistently found in our specimens, and generally referred to by other authors[1] as "an increase in elastic fibres", led us to suspect that these accumulations of unusual fibrils were not, in fact, unmodified elastic fibres. We conducted a systematic survey of the staining reactions of the fibrillar masses in the dermis and in diseased blood vessels, always carefully comparing our findings in the abnormal with those of the elastic and other fibres in apparently healthy human skin, aorta and other vessels.

The unusual clumps of dermal fibres, referred to above, as well as certain fibres which may appear in vessel walls during degenerative vascular diseases, stain with some of the dyes (for example, Weigert's, Verhoeff's, orcein and Gomori's aldehyde-fuchsin, in particular), but not with all the stains which sharply delineate apparently 'normal' elastic fibres. On the other hand, these same fibre clumps may stain with several dyes, or dye-mixtures, which do not stain 'normal' elastic fibres (see Table 1).

The conclusion, therefore, seems to be justified that the accumulations or clumps of morphologically

Table 1. TINCTORIAL REACTIONS OF ELASTIC FIBRES IN HEALTHY DERMIS AND ARTERIES COMPARED WITH 'ELASTOTICALLY DEGENERATED' FIBRES

Stain	'Normal' elastic fibres—dermis or arteries	'Elastotically degenerated' fibres—dermis or arteries
Orcein	Deep red-brown	Pale to deep reddish-brown
Verhoeff's	Dark blue-black	Pale to dark blue-black
Weigert's	Deep purple-blue	Deep purple-blue (+ eosinophilic 'granules')
Gomori's aldehyde-fuchsin	Deep red-purple	Deep red-purple to pale red
Periodic acid-Schiff	Red borders	Irregular red 'pools' and pink fibre borders
Iron hæmatoxylin	Grey, black or brown	Grey to jet-black fibres, rods and 'pools'
Safranin water-blue (Unna)	Pink to red	Pink to deep red
Van Gieson	Yellow with thin red fibre outlines	Yellow with irregular red 'granules'
Wilder's reticulum and basic fuchsin	Red fibre 'cores' with thin black outlines	Irregular coarse granular and fine black fibres
*Ponceau 2*R*—light green	Bright pink-red	Irregular blotchy 'grey' with red and yellow patches
*H. and E.	Pale pink	Pale blue-grey + pink 'granules' and threads
*Toluidine blue	Colourless to pale-blue	Deep blue-green coarse fibres and 'granules'
*Mallory's triple	Orange to pink	Completely chromophobic with scattered orange or blue 'granules'
*Mallory's phosphotungstic acid hæmatoxylin	Bright purple 'coat' with orange 'core'	Pale orange with occasional purple threads
*Rinehart–Abul Haj†	Pale yellow 'cores' with bluish-green outlines	Dirty pale green with scattered blue 'pools'

* Implies stains providing clearly distinguishable tinctorial differences between 'true' elastic fibres and 'elastotically degenerated' fibrillar aggregations.

† Modified Hale's method for acid mucopolysaccharides (ref. 4).

abnormal fibres, particularly in the dermis, while simulating that "increase in elastic fibres" described by modern authors, cannot be regarded as being constituted of unaltered elastic fibres, either on morphological or on tinctorial criteria. We suggest the name 'elastotically degenerated' fibres for these masses, since they are morphologically and tinctorially distinguishable from normal elastic and collagen fibres, although they stain with the generally used elastic stains.

These elastotically degenerated fibres seem to be derived primarily from alterations in the composition of preformed collagen, or, perhaps, from disturbances in metabolic processes during the formation of normal reticular, collagen or elastic fibres. The former possibility, concerning the origin of 'elastotically degenerated' fibres, is supported by our recently recorded finding[2] that, some time after the grafting of trypsin-treated auto- or homo-dermal tissue in man, numerous plaques or even extensive beds of 'elastotically degenerated' tissue can usually be found in the dermis of the host area. These fibre masses may have been derived from the original collagen of the graft. Alternatively, the grafted dermal collagen may have induced a change in the metabolism of the connective tissue in the host site, resulting in the deposition of new fibres, which were 'elastotically degenerated' *ab initio*—a possibility in conformity with the latter of the above two suggestions. Stages in the formation of these abnormal fibres, in dermis, can be defined on the basis of tinctorial reactions with the aid of the above-mentioned dyes. The final product of such elastotically degenerated fibres can be sharply distinguished from an increase in 'true' elastic fibres and from 'normal' collagen fibres.

Our findings also indicate that the generally accredited standard histological methods for demonstrating elastic fibres cannot be relied on to stain only 'normal' elastic fibres. This latter view is in conformity with that expressed by Astbury *et al.*[3] from their combined histological and electron-microscopic studies of normal and abnormal human dermis.

The expenses incurred during this study were defrayed primarily by a generous grant from the Schlesinger Organization, South Africa. Literature was made available, in part, through the Florence Powell Cancer Research Library Grant and through the kind assistance of Mrs. B. H. Robinow. We also acknowledge the technical assistance of Patricia R. Low.

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Secretion of Aldosterone and Corticosterone by the Rat Adrenal

A STUDY has been made of the nature and regulation of rat adrenal steroid secretion. The adrenal-vein blood of rats was collected, extracted and chromatographed by the method of Bush[1,2]. Corticosterone was detected and estimated by the soda-fluorescence reaction[1]. Mineralocorticoid activity was estimated by the biological method of Simpson and Tait[3].

A potent mineralocorticoid was detected in the zone of the paper chromatogram which would include aldosterone[4,5]. In concentrates of this zone there was a substance which had the same R_F and soda-fluorescence reaction as aldosterone and was present in an amount appropriate to the observed biological activity. The activity of this zone has been tentatively identified with aldosterone.

Intact rats, subjected to the surgical stress of collection of adrenal effluent, secreted aldosterone equivalent to about 45 μgm. of deoxycorticosterone acetate, and 150 μgm. corticosterone per adrenal/kgm./hr., with a ratio of 0·30 : 1. Treatment with deoxycorticosterone acetate for seven days (2 mgm. per day), or feeding a potassium-deficient diet for four weeks, reduced the secretion of aldosterone by more than 90 per cent without altering the corticosterone secretion. The ratio was lowered to 0·014 : 1 by the potassium-deficient diet, and to 0·044 : 1 by the deoxycorticosterone acetate treatment.

Untreated hypophysectomized rats, examined at two, seven or fourteen days after operation, secreted an average of 7·8 μgm. deoxycorticosterone acetate equivalent of aldosterone and 2 μgm. of corticosterone, per adrenal/kgm./hr., with a ratio of 3·65 : 1. In hypophysectomized rats two days after operation, acute treatment with corticotropin (homogeneous by ion-exchange chromatography[5]; 1 μgm. at the start, and 0·5 μgm. during collection) raised the rates of secretion of both steroids. There was a greater proportional increase in the corticosterone, and the quantities of both steroids secreted were not significantly different from those in intact rats. A similar result was obtained when hypophysectomized rats received a daily dose of 200 μgm. corticotropin for seven or fourteen days after operation, and the adrenal effluent was then collected with acute corticotropin stimulation.

Hypophysectomized rats kept for seven days without corticotropin maintenance gave a different response to acute treatment with corticotropin. The aldosterone secretion was increased to the equivalent of 50 μgm. of deoxycorticosterone acetate, comparable with the values in intact rats, but the corticosterone only to 9 μgm. per adrenal/kgm./hr. The ratio of the secretions, 5·4 : 1, remained typical of untreated, hypophysectomized rats.

In the only experiment on this point, daily treatment of hypophysectomized rats with both deoxycorticosterone acetate and corticotropin depressed aldosterone secretion to a level similar to that of the intact rats treated with the former, without influencing the secretion of corticosterone. This experiment suggests that changes in the secretion of aldosterone following treatment with deoxycorticosterone acetate, and possibly those following changes in electrolyte balance, can occur in the absence of the pituitary.

These studies show that a potent mineralocorticoid, probably aldosterone, is secreted by the rat adrenal; this observation is analogous to those of Simpson *et al.* with the dog[6] and the monkey[7]. The results provide direct support for the indirectly based view of Swann[8] and later workers[9], according to which mineralocorticoid secretion in the rat can vary independently of glucocorticoid secretion and can be influenced by extra-pituitary factors. However, our experiments show clearly that the simultaneous secretion of both aldosterone and corticosterone can be induced by corticotropin. It is also noteworthy that secretion of both steroids still occurs in the hypophysectomized rat without corticotropin.

We wish to point out that these results do not provide any evidence relating to the proposition that the zona glomerulosa of the rat is specifically associated with secretion of aldosterone.

A detailed account of these studies will be presented elsewhere. This work was largely financed by a grant from the Nuffield Foundation to Prof. F. G. Young and was under his general direction.

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Development of Pain-producing Substance in Human Plasma

WE have previously reported[1-3] that inflammatory exudates and fresh plasma produce: (i) pain when applied to the exposed base of a cantharidin blister in man, and (ii) contraction of the isolated rat uterus. Since we find these two actions to run in parallel, we assume that they are due to the same agent, which we term 'pain-producing substance'. When an inflammatory exudate is collected in a glass syringe, this substance is not at first detectable, but develops within 2–5 min. The same is true of whole blood, with or without anticoagulant.

The development of pain-producing substance in plasma can be prevented by avoiding contact with glass or metal during the process of collection and separation, as follows. Blood is withdrawn into a silicone-coated needle and syringe and rapidly transferred through polythene tubing immersed in ice to cooled polythene centrifuge tubes containing heparin (40 units/mL., final concentration). The blood is immediately centrifuged at 22,000 rev./min. for 4 min., after which the upper half of the separated plasma is removed and placed in fresh polythene tubes in ice. This plasma, in which there are no white cells and practically no platelets (< 50/c.mm.), contains little or no detectable quantity of the pain-producing substance when kept in polythene tubes for up to two hours, but activity develops within a few minutes after the plasma is transferred to a glass tube. This activity reaches a peak within 10 min. and decays to 1/10–1/20 of peak value within an hour. The decay of the substance in plasma is delayed at 0° C. and prevented by deep-freezing.

The same effects are observed when sodium citrate (3 mgm./mL., final concentration) is used as anticoagulant. In the absence of anticoagulant, plasma kept in polythene tubes still fails to develop the pain-producing substance; but when it is transferred to glass tubes activity appears and clotting occurs.

Biological actions of the pain-producing substance. (i) Active plasma applied to an exposed blister base produces delayed and prolonged pain[1]. It does not cause itching, flare or wheal. Our previous report[1] that plasma did not produce pain referred to tests performed from one to three hours after collection of blood, when the pain-producing substance would have decayed.

(ii) It causes contraction of the isolated rat uterus. At peak activity, 0·01 mL. of plasma (in a 30-mL. bath) may produce maximal uterine contraction. This action is not antagonized by atropine or dihydroergotamine. This preparation is particularly suitable for routine assays of the pain-producing substance.

(iii) It produces delayed slow contraction of the guinea pig ileum and also stimulates the rabbit jejunum. It lowers blood pressure in the cat and rat.

Chemical properties of the pain-producing substance. (i) Pressure ultrafiltration at 0° C. of active plasma through a 'Cellophane' membrane yields protein-free filtrates containing the pain-producing substance; their activity rarely exceeds one-fifth of average peak activity in plasma. Pain-producing substance produced in this way is stable for several hours at 20° C. There are, however, certain minor differences between the biological actions of ultrafiltrates and their parent plasmas, perhaps due to the presence of modifying substances in the latter.

(ii) Freeze-dried samples of active plasma or ultrafiltrate are active; such material can be used to study solubility characteristics of the substance.

(iii) The substance is soluble in water, glacial acetic acid, hot methyl alcohol, 90 per cent ethyl alcohol and 90 per cent acetone. It is insoluble in ether, absolute ethyl alcohol and anhydrous acetone.

(iv) It is precipitated with the proteins when alcohol or acetone (10 or 20 vol.) is added to active plasma in the cold.

(v) It is adsorbed by charcoal and cellulose powder, but not by barium sulphate. It is completely removed from ultrafiltrates by cation exchangers (hydrogen form), and partially removed by anion exchangers (hydroxyl form).

(vi) Pain-producing substance from ultrafiltrates is stable on boiling in $N/3$ hydrochloric acid for 10 min., but is largely destroyed on boiling in $N/3$ sodium hydroxide for 10 min.

(vii) It is rapidly inactivated by plasma.

(viii) The substance is inactivated by chymotrypsin (Armour). Trypsin (Armour) has a much weaker action, and crystalline pepsin has no effect.

It has not yet been possible to isolate the pain-producing substance in a pure form. Its biological and chemical properties resemble those of bradykinin, a polypeptide prepared by Rocha e Silva *et al.*[4,5] by the action of trypsin or *Bothrops jararaca* venom on plasma α-globulins.

A sample of bradykinin (activity 10 units/mgm.) in a concentration of 10 μgm./ml. produced pain like that due to our pain-producing substance; 100 μgm./ml. also produced itching, flare and wheal. Bradykinin also stimulates smooth muscle and lowers blood pressure[4]. It is rapidly inactivated by plasma and by chymotrypsin, but not by trypsin[5]. On Rocha e Silva's estimate[5] that such bradykinin preparations contain about 0·5 per cent of a pure polypeptide of molecular weight 5,000–10,000, our most active plasmas contain pain-producing substance in a concentration equivalent to 1 μgm./ml. of the pure bradykinin.

Certain other biologically active polypeptides, for example, angiotonin (hypertensin), substance P, leucotaxine, oxytocin and vasopressin, also produce both cutaneous pain and contraction of smooth muscle; but studies on relative potency, and some differences of action, have shown that our pain-producing substance is not identical with any of these. Nevertheless, the evidence suggests that it is a polypeptide. It can be readily distinguished from 5-hydroxytryptamine (serotonin)[2,6].

The processes concerned with the appearance of the pain-producing substance in cell-free plasma are obscure, but the failure to develop activity in contact with polythene and the time-course of development in contact with glass are strikingly reminiscent of the processes of blood clotting. However, heparin and sodium citrate do not prevent the activation of plasma by glass. The rapid decay of the substance in plasma, coupled with its much greater stability in protein-free solutions, suggest an enzyme-catalysed destruction.

The role of the pain-producing substance in the production of pathological pain is being studied. We suggest that development of the substance might occur when plasma escapes from capillaries and makes contact with damaged tissues as, for example, in burns.

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Estimation of the Survival-Rate of Anopheline Mosquitoes in Nature

THE daily survival-rates of *Anopheles gambiae* and *A. funestus* in two areas of tropical Africa have recently been estimated from the ratio of their sporozoite-rates immediately on capture and those recorded after keeping wild-caught specimens alive for the duration of the extrinsic cycle of the predominant malaria parasite[1,2]. This method naturally involves considerable time for the dissection and keeping alive of significant numbers of mosquitoes.

A more direct method of determining the age-composition of wild-caught populations, based on changes in the size of the ampulla of the oviduct with ovarian development and oviposition[3], has now been evolved. By this method the proportion of a given population which is parous (M) can be determined and the survival-rate per day (p) calculated from the expression[4], $p^n = M$, where n is the number of days between emergence of adult and first oviposition.

Table 1. AMPULLA DIAMETERS OF COLONY *A. gambiae* MEASURED IN DISTILLED WATER

Stomach and ovary conditions	No. of mosquitoes examined	Ampulla diameters in microns: Mean	Standard error	Median
Nulliparous females				
Never fed—ovary stage I	145	124	1·8	120
Fed once, but no ovarian development beyond stage II	187	168	2·2	160
Fed once or twice with ovarian development to stage III	72	204	3·1	200
Fed once or twice and gravid—ovary stage V	85	242	3·2	240
Parous females				
Laid once after one or two feeds—ovary stage II	62	265	3·8	264
Laid once, fed again and developing the second batch of eggs—ovary stage III	44	258	4·3	256
Laid twice—ovary stage II	25	279	4·7	280

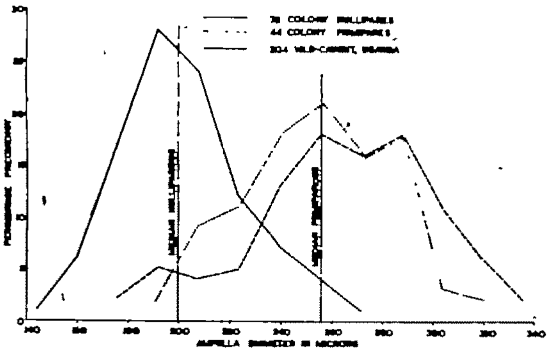

Fig. 1. Frequency distribution of ampulla diameters of colony and wild-caught *A. gambiae* with stage III ovaries

Evidence now exists[1-3] that in the case of *A. gambiae* the time from emergence to first oviposition is five days in the hotter parts of Africa, composed of: (*a*) the first feed, 24 hr. after emergence, but without ovarian development beyond ovary stage II; (*b*) the second feed, two days after the first; (*c*) two days elapsing from the second feed to the maturation of the eggs and oviposition.

Extensive studies of colony *A. gambiae* have shown increases in diameter of the ampulla of the oviduct with feeding, ovarian development and oviposition (Table 1); these were most marked when dissection was carried out in distilled water. At the same time, considerable variation in ampulla diameter was found to occur in females in the same stage of ovarian development in the same gonotrophic cycle and, as a result, a considerable overlap in measurements between mosquitoes in the same stage of ovarian development but in successive gonotrophic cycles (Fig. 1). However, the smallest diameter recorded for a particular ovary stage in primiparous females was very seldom less than the median diameter recorded in nulliparous females in the same stage. Thus it is considered justifiable, when dealing with wild-caught mosquitoes of any one ovary stage, to take those showing ampullæ of less diameter than the median recorded in nulliparous females of the same ovary stage as half the nulliparous females.

The proportions parous in each of the ovary stages II–V (females with stage I ovaries were obviously nulliparous) have been estimated in this way in three series of wild-caught *A. gambiae* from the two areas of Africa where the immediate and delayed sporozoite-rates were estimated (two of the series were dissected over the same periods as the latter), and the survival-rates were found to be almost identical by the two different methods (Table 2).

In practice it is considered simpler, instead of dissecting mosquitoes in all ovary stages, to restrict dissections to those of the commonest ovary stage found in Nature by the usual methods of mosquito capture. In the hotter parts of Africa the commonest ovarian stage in daytime house-resting *A. gambiae* is stage III. In this species the first stage III ovary is normally reached on the fourth day after emergence, and the gonotrophic cycle at temperatures of 23·3° C. and higher is two days[6]. Thus the proportion of mosquitoes at this ovarian stage which is nulliparous is:

$$\frac{p^4}{p^4 + p^6 + p^8 + p^{10} \ldots p^\infty}$$

$$= p^4 \bigg/ \frac{p^4}{1 - p^2}$$

$$= 1 - p^2;$$

from which p^2 = 1 − proportion nulliparous
= proportion parous.

Therefore, $p = \sqrt{\text{proportion parous.}}$

Thus the survival-rate equals the square root of the proportion parous if the gonotrophic cycle occupies two days (the cube root if it occupies three days).

In the three series of wild-caught *A. gambiae* already mentioned, the survival-rates calculated from stage III females only were:

Tanganyika, 1952	0·91
Tanganyika, 1953	0·91
Uganda	0·93

Thus the method in its simplest form requires:

(1) Analysis on colony-bred mosquitoes of the median ampulla measurement, and its range, for nulliparous and parous mosquitoes in the same stage of ovarian development (preferably stage III); this has been done for *A. gambiae*.

(2) A knowledge of the period occupied by the gonotrophic cycle.

(3) Capture of wild mosquitoes and derivation by the method given of the proportions nulliparous and parous; it is thought that this can be estimated with considerable accuracy providing it is established that none, or very few, of the ampulla diameters of parous mosquitoes fall below the median of nulliparous ones.

(4) Derivation from this of the daily survival-rate; this depends on an assumption that the population is relatively static in composition and needs correction by observation over several consecutive days.

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Table 2

Locality	Survival-rates: From immediate and delayed sporozoite-rates	Survival-rates: From ampulla measurements
Tanganyika, 1952	0·93	0·94
Tanganyika, 1953	—	0·90
Uganda	0·97	0·95

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Influence of Ribonuclease on the Division of Amphibian Eggs

Thomas, Rostand and Grégoire[1] observed that the puncture with a needle which had been dipped in a relatively pure solution of ribonuclease inhibits the development of undivided frog's eggs and prevents cellular division. They also showed that no such effect is obtained with deoxyribonuclease, nor with pepsin or trypsin used under the same conditions. We thought it of interest to repeat these observations with highly purified enzymatic preparations, taking advantage of the fact that only reduced ribonuclease has enzymatic activity[2].

Fertilized amphibian eggs (*Rana fusca*, *Axolotl*, *Pleurodeles*) were injected with reduced or oxidized ribonuclease; urease was used as a control. Reduced ribonuclease was prepared as previously described[2]; oxidized ribonuclease was prepared by the action of hydrogen peroxide on the reduced form[3].

Of all enzymes tried, only reduced ribonuclease was active; division of the injected blastomere was inhibited with concentrations of the order of 10^{-12} mol. per egg. Using higher concentrations, the neighbouring blastomeres are also affected. Neither oxidized ribonuclease nor urease (—SH form) showed visible effects, even when 10^{6} times more concentrated. Thus, only the enzymatically active reduced form of ribonuclease inhibits embryonic development, and the conditions of preparation of the enzymes exclude all possibility of contamination.

These results confirm those of Thomas, Rostand and Grégoire, and emphasize the need for the —SH groups in the enzyme. As the injection of concentrations higher than 10^{-10} mol. in one of the blastomeres of segmenting embryos inhibits the development of the neighbouring blastomeres, we thought this might be an indication that the enzyme is capable of crossing cellular membranes. We therefore placed the eggs of pleurodeles in solutions of reduced and oxidized ribonuclease of different concentrations. In these conditions, embryonic development is completely stopped by concentrations of reduced enzyme greater than or equal to 100 µgm./ml. Oxidized ribonuclease is also completely without effect on segmentation (Figs. 1, 2 and 3).

In order to verify if the enzyme really penetrates into the egg, we prepared radioactive oxidized and reduced ribonuclease with radioactive iodine[4] and we followed its diffusion by radioautography[5]. Sections show a zone where radioactivity appears in the embryo and which extends progressively from the animal pole. Simultaneously a zone of increased basophily appears in the radioactive region, but only when reduced ribonuclease was used. This zone appears to correspond to an increase in ribonucleic acid synthesis, as seems indicated by preliminary determinations on egg homogenates. This synthesis of ribonucleic acid induced *in vivo* by reduced ribonuclease is probably the first step in its antimitotic action. This action seems to be related to a modification of the process by which the cytoplasm assumed a gel form and which interferes with the normal formation of the segmentation furrows.

Summarizing, ribonuclease in its reduced form is a very potent antimitotic agent. Both oxidized and reduced enzymes diffuse easily through the cellular membranes of amphibian eggs. Reduced ribonuclease seems to induce a synthesis of ribonucleic acid during its diffusion, and this substance is probably related to the inhibition of segmentation.

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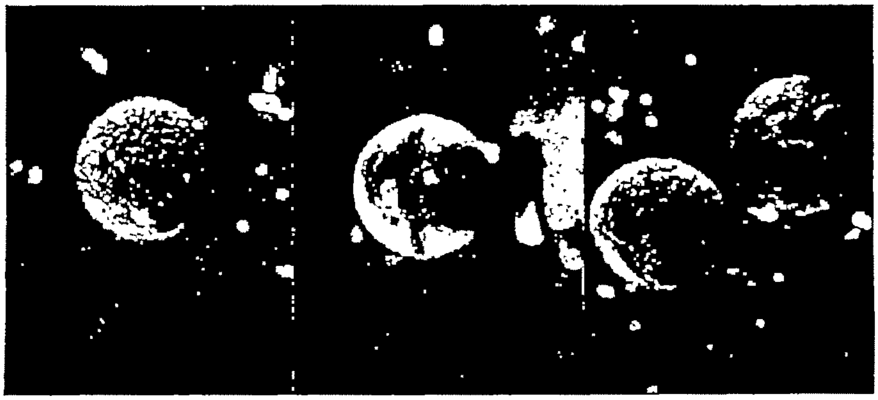

1) (2) (3)

Embryos at the 2-blastomere stage injected with: (1) oxidized ribonuclease (10^{-12} mol.); (2) reduced ribonuclease (10^{-12} mol.); (3) reduced ribonuclease (10^{-11} mol.)

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Breeding of the Tree Shrew

A colony of tree shrews, *Tupaia glis* (Diard), has been maintained at the University of Malaya for the past nineteen months, specimens having been obtained both from the Federation of Malaya and from Thailand. A total of fifty-five living animals has been received; the colony at the time of writing includes thirteen males and fourteen females. After heavy mortality in the early stages of the work, the death-rate dropped to a point where most of those animals surviving the first three months tend to live for at least a year.

Most of the animals are kept in compound cages consisting of six three-foot cubical units, but some are kept in a large outdoor cage of 1,280 cu. ft. capacity. The large cage is heavily planted with shrubs and vines.

The natural diet of *Tupaia* apparently includes a preponderance of insects, supplemented by soft fruits. The present diet includes fruits such as banana and papaya, and an 'insect substitute' mixture containing high-protein cereal, beef extract, honey, fresh eggs, powdered milk, dog biscuits for roughage, cod liver oil, vitamin E, calcium lactate and salt.

Extreme variations in weight obscure evidence of pregnancy by weight records until the last two weeks of pregnancy. Delicate abdominal palpation has often proved satisfactory in indicating pregnancy at an early stage. The animals are highly nervous, however and require delicate handling.

In no case has it been possible to keep two male tree shrews in the same cage. A male and one or more non-pregnant females live in reasonable harmony, a female being dominant despite he smaller size. Pregnancy has produced marked anti-social aggressiveness in the females observed

An aggressive attitude towards another individual, once begun, seems to remain fixed, and will lead to a fatal feud unless the animals are separated. Fighting occurs just as frequently in the large as in the small cages.

Copulation, first observed in January of this year, occurred with increasing frequency during February and March and declined through April and May. Nineteen out of twenty-four females were observed to copulate at least once; eight became palpably pregnant, some individuals more than once, with thirteen pregnancies in all. All but one of the pregnant females either aborted or killed and ate their young the night they were born. The exception (*Tf*39) has given birth twice; the first pair of young was neglected and was found dead and trampled in the nest box litter four days after birth; the second pair was eaten by the mother on the third day. *Tf*39 became pregnant a third time but aborted or resorbed the embryos at about half term.

There is no indication of male sterility, all males appearing sexually vigorous. The females appear to suffer from some factor or factors antipathetic to reproduction manifested by refusal to mate, sterility, spontaneous abortion, litter killing, and neglect of the young. In no case has there been any record of enlargement of mammary glands in pregnant females; the single case of neglect of the young may have been due to milk failure.

The gestation period for *Tupaia glis*, as indicated by the records to date, is between 46 and 50 days. Of six pregnancies for which the number of embryos is certain, there were twins in five cases and a single young in the sixth. (These records include autopsies on three pregnant newly captured females which were received dead.)

Female *Tf*39 showed what I interpret as post partum heat; she achieved a fertile mating between 48 and 72 hr. after parturition.

Observations to date indicate that male sexual aggressiveness is stimulated by female secretions and that the female goes through a socio-psychological pattern similar to that of heat in non-primates.

Cases of intra-uterine bleeding suggestive of menstruation are being investigated at present.

Acknowledgment is due to the Institute for Medical Research, Kuala Lumpur, Malaya, and to the U.S. Army Medical Research Unit in South-East Asia for supply of Malayan specimens and for financial aid in obtaining animals from Thailand respectively. Both bodies are interested in breeding of tree shrews as laboratory hosts of primate virus diseases. The study is proceeding, and I would welcome communication from interested workers.

Note added in proof, Sept. 29. A litter of two born on August 20 is now being weaned.

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Attempts at Nitrogen Fixation *In vitro*

THE low activation energies generally associated with free-radical reactions have prompted several workers to explain the high velocity of various biological processes[1,2], including nitrogen fixation[3,4], by mechanisms involving free radicals. Burris's fixation mechanism[3] postulated an enzyme–hydrogen peroxide complex and reduction or oxidation of molecular nitrogen by the free radical $A_2.H^{\cdot}$ or $A_2.(OH)^{\cdot}$, respectively, in the latter case producing $N_2(OH)_2$. Pethica *et al.*[4] suggested that nitrogenase, like catalase[5] and methæmoglobin[6], functions by way of a ferrous–ferric couple activated (as in Fenton's reagent) by hydrogen peroxide, which they regarded as an intermediate in respiration. The link between respiration and fixation could be hydroxyl radicals which reacted with nitrogen to form $N_2(OH)_2$.

Attempts were made, using the isotopic technique, to detect *in vitro* fixation by cell-free extracts from *Azotobacter vinelandii* in the presence of free hydrogen and hydroxyl radicals. Extracts from vigorous cultures were prepared by grinding centrifuged and washed cells with powdered 'Pyrex' glass and phosphate buffer solution (*p*H 7·0) at – 2° C.; the paste was spun out and the supernatant used immediately. An atmosphere of oxygen and heavy nitrogen was circulated by means of the apparatus previously described[7,8] through various solutions in the culture flasks for five hours. In case oxygen gas, some constituent of the medium[8], or free radicals were necessary before nitrogenase could function, these were supplied, singly and together. Hydrogen and hydroxyl radicals, which would according to Pethica be supplied *in vivo* by the respiratory system, were generated *in vitro* by reaction between *M* ferrous sulphate and *M*/2 hydrogen peroxide (inhibitor-free), one drop of each being added every five seconds throughout the experiment.

No shift in the abundance ratios of the atmosphere was observed in any experiment, nor were any gas samples obtained from the various solutions by the Kjeldahl digestion process[3]. In five hours, the equivalent of eighty litres of labelled atmosphere, containing 26·0 atom per cent excess nitrogen-15, passed through each solution, so that it is clear that no fixation of nitrogen is possible under the conditions described. It may be that nitrogenase does not survive the extraction, or must be augmented in some way not at present understood. It is of interest that nitrogen can be fixed in aqueous solution by an electric discharge. Campardou[9] gives the equations:

$$N_2 + 2H_2O \rightarrow NH_4NO_2$$
$$NH_4NO_2 + \tfrac{1}{2}O_2 \rightarrow NH_4NO_3$$

and observes that the net reaction uses nitrogen and oxygen in the exact proportion in which they dissolve in water at one atmosphere pressure. However, the results above, together with failure[8,10] to demonstrate the importance of compounds of formula $N_2(OH)_2$ (which is common to the different free radical postulates), constitute strong experimental evidence against such postulates.

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A Quantitative Biological Test Sensitive to Low Doses of Ionizing Radiations

THE important linear dose-effect relationship which is observed in the induction of mutations with ionizing radiations and which has been verified down to 25 r. has not been satisfactorily investigated below this value[1].

Owing to the existence of the 'induction' phenomenon, lysogenic bacteria may be used to demonstrate this relationship within a wide range of doses, including doses as low as 1 rep. The virus in such bacteria is in a masked state, the prophage, which is included in the genetic pattern. Its induction may be considered as a lethal mutation. That some radiations 'induce' the development of phage in lysogenic bacteria was discovered by Lwoff, Siminovitch and Kjelgaard[2] using ultra-violet radiations (2537 A.) and was later shown by Latarjet[3] to occur with X-rays. A bacterium 'induced' with X-rays bursts after a latent period, the length of which depends on physiological conditions, and liberates an average of 100–200 virus particles into the medium. By determining the number of free phages in an induced culture, it is possible to determine how many bacteria have been induced.

The strain utilized here is the lysogenic *E. coli* *K*.12(λ) cultured in 'Difco' tryptone broth. After induction with X-rays, the latent period is 55 min.; that is, after this delay, the first bacteria burst. However, the majority lyse between the 65th and 80th minutes. Both the latent period and the burst size (average number of phage particles liberated per bacterium) are independent of the dose.

In a non-irradiated growing culture of *K*.12(λ) one finds, owing to spontaneous bursts, about one phage per 200 bacteria. This figure corresponds to about 10^{-3} to 10^{-4} spontaneously 'induced' bacteria per generation time. After induction by X-rays, the number of free virus particles increases proportionally to the number of induced bacteria. By measuring the increase in frequency of free phage in the medium, the number of induced bacteria may be estimated.

In an irradiated sample the total number of free phages, N_r, is equal to the sum of the phages produced by induction, N_i, and those arising spontaneously, N_s. For the most accurate determination of N_r it is necessary to have N_s as small as possible. This condition is automatically fulfilled for high doses (more than 50 rep.), but for low doses N_s must be diminished. This may be done without appreciably affecting N_i owing to the fact that the large majority of N_i appear between the 65th and the 80th minute. N_s may be inhibited by adding anti-λ serum before the 65th minute and then suppressing the action of the serum by dilution.

The following experimental technique is used. Samples of a culture of *E. coli* *K*.12(λ) in tryptone broth containing 2 × 10^8 bacteria/c.c. are diluted tenfold in broth at 0° C. and irradiated. Aliquots of 1 c.c. are taken and kept at 37° for 55 min. At the end of this time, 0·05 c.c. of anti-λ serum is added. At this concentration the serum inactivates 90 per cent of a phage suspension in 5 min. at 37°. The serum is allowed to act for 10 min. and then diluted 100-fold in broth in order to stop its action.

The samples are then incubated for 10 min. at 37°. During this time N_s in the control increases to one-tenth of the initial value, while nearly all the phages arising from induction are liberated. At the 75th minute the bacteria are killed by the chloroform technique[4] and the free phages are titrated. Contrary to *T*2, λ is partly inactivated by this treatment, but since inactivation is the same for every sample the results are unaffected. The titration of the free phage is made using *K*.12S/Str. (streptomycin-resistant) as the indicator strain in the presence of 200 γ of streptomycin to prevent contamination. The plaques are counted after 18 hr. incubation at 37°.

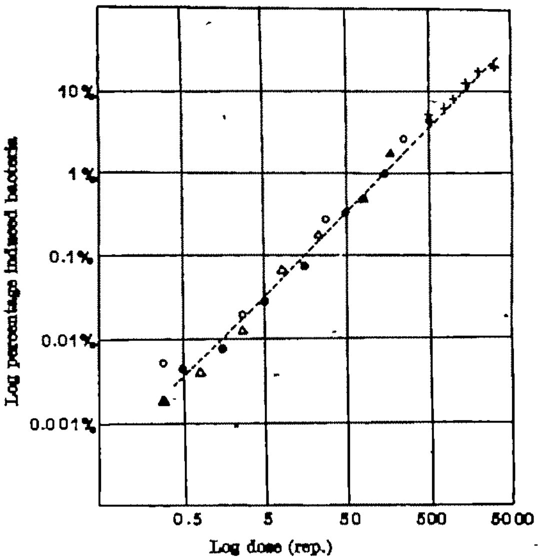

Fig. 1

The source of X-rays is a Holweck tube with a molybdenum target which operates at 37 kV. giving an average wave-length of 0·9 A.

With doses greater than 500 rep. the technique described above (free phage technique) is unnecessary. If the bacteria are plated immediately after irradiation (direct method) each induced bacterium gives one plaque and the percentage of induction may be calculated directly.

In the free phage technique the relationship between the ratio N_i/N_s and the radiation dosage is linear. The slope of this straight line is the same as that of the straight line obtained by the direct method which relates percentage of induced bacteria to dose (see Fig. 1). The two straight lines are brought into conjunction by determining for the same dose (500 rep.) the percentage induction by the direct method and the ratio N_i/N_s by the free phage method on the same sample. This procedure gives a constant which is added to log N_i/N_s so that results below 500 rep. may be expressed as percentages. Since in Fig. 1 the abscissæ and ordinates are on the same scale, it may be concluded that the number of induced bacteria is directly proportional to the dose and that, consequently, induction is a single-hit process.

In Table 1 are given the data used to calculate N_i/N_s for the experiment represented in Fig. 1 by circles. A dose of 1·5 rep. produces a significant increase in the number of the plaques.

Table 1

Doses		0·5	1·5	5	15	50	150	500
N_r		1,225	1,556	4,180	9,070	33,100	114,000	430,000
N_s	697							
N_i/N_s		0·75	1·23	4·85	11·96	46·28	161·8	613

On extrapolating the straight line it can be seen that 100 per cent induction corresponds to a dose of about 10,000 rep. On the basis of the target theory, the diameter of the target for induction is therefore of the order of 100 mμ.

The same doses expressed in rep. given as γ-rays of radium or as X-rays of wave-length 0·9 A. produce the same frequency of induction. By using both X- and γ-rays the inducing effect of radiations was found to be independent of intensity over a range of 10^4. The irradiated bacteria and the control may be kept at 0° C. for several hours without affecting the results of the experiment. This permits the study of ionizing radiations produced at some distances from the laboratory. After 24 hr., however, the sensitivity of the test is lower.

The sensitivity of the above test depends on the inactivating power of the antiserum. Since λ is unfortunately a poor antigen, other lysogenic systems are being investigated.

In addition it should be noted that the sensitivity of this method was found to be too low to detect any effect of cosmic rays at sea-level or any naturally occurring ionizing radiation.

I thank Dr. R. Latarjet for his criticisms and suggestions and Miss R. Vayne for technical assistance.

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Paramagnetic Resonance in Carbonaceous Solids

FOLLOWING the discovery[1,2] of a paramagnetic resonance absorption of high intensity, and narrow width, in charcoals and other low-temperature carbons, a systematic survey of different coal and carbonized coal samples has been undertaken, to determine what factors affect the magnitude of the absorption. The samples were prepared at Leatherhead and the measurements have been made at Southampton using frequencies of 24,000 Mc./s., 9,000 Mc./s. and 40 Mc./s.

The first effect studied was the variation in intensity of the paramagnetic absorption signal with carbonizing temperature, and the results are shown in Fig. 1. Two series of carbonized coals were used, and both gave very similar variations, having a marked maximum at a carbonizing temperature of c. 550° C., and then falling sharply to zero. This variation of signal strength with carbonizing temperature has also been found in other specimens, and it seems to be a general feature that the paramagnetic resonance absorption is destroyed once the carbon has been heated above c. 650° C. These results seem to confirm the previous suggestion[3] that this type of absorption is not due to conduction electrons such as those found in graphite[3], but rather to unpaired electrons associated with 'broken bonds' or 'free radicals'. We suggest that heating above 650° C. enables these bonds to join with those from neighbouring carbon atoms, the absorption signal being therefore considerably reduced.

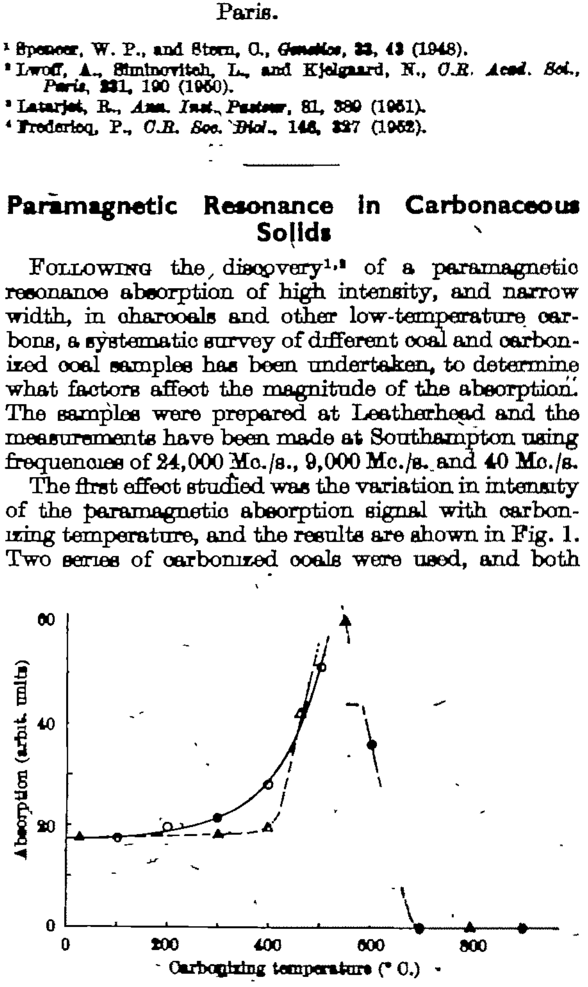

Fig. 1

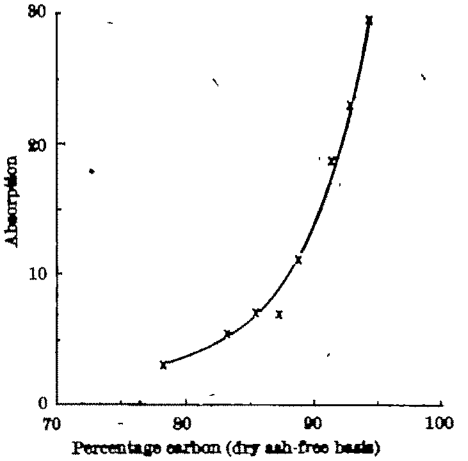

Fig. 2. Absorption of 30 units = 2·5 × 10^{19} free radicals/gm.

The line width and spectroscopic splitting factor remained constant over the whole range of carbonizing temperatures, having values of 8 ± 2 gauss and 2·0030 ± 0·0003 respectively. A width of 7 ± 1 gauss was still obtained at 40 Mc./s., which is in striking contrast to the value of 0·1 gauss obtained by Henning *et al.*[4] on graphites at these frequencies, again suggesting that this is an entirely different mechanism from that associated with the conduction electrons. It would appear that variations in width observed in other low-temperature carbons[3] are therefore due to special effects, such as gas adsorption.

An estimate of the number of free radicals present in the carbon was obtained by comparing the intensity of absorption with that from 50 μgm. of diphenyl trinitrophenyl hydrazyl; the results indicated that there are about 3 × 10^{19} free radicals/gm. in carbons showing the highest absorption (that is, one free radical per 1,600 carbon atoms).

The second effect studied was the variation of absorption intensity of raw coal with its percentage carbon content (rank). These results are shown in Fig. 2. A very sharp increase in the intensity of paramagnetic absorption is observed in coals of rank exceeding 80 per cent carbon content (dry ash-free basis), the intensity at 94 per cent being seven times that at 80 per cent. If the absorption intensity is plotted against the percentage of volatile matter in the coal, an alternative, though less reliable, measure of its rank or maturity, a straight line is obtained.

Since submitting this letter for publication, the work of J. Uebersfeld, A. Étienne and J. Combrisson on a similar subject has been reported (*Nature*, 174, 614; 1954).

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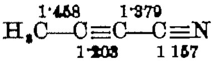
Microwave Spectrum of Methyl-Cyanoacetylene

THOUGH methyl-cyanoacetylene (methyl-propiolnitrile) is a substance of some interest structurally, its preparation has not apparently been described. With the object of studying the microwave spectrum of this substance, we have prepared it by the method used for obtaining higher alkyl-cyanoacetylenes by Grignard and Courtot[1] and Curran and Wenzke[2]. The Grignard reagent, $H_3CCCMgBr$, was treated with cyanogen chloride and a moderate yield of methyl-cyanoacetylene isolated as a colourless, low-melting solid of sweet, penetrating aromatic odour. The best sample obtained to date, by vacuum fractionation, has melting point 16° C., boiling point 101·5° C. (754 mm.) and $n_D^{20} = 1 \cdot 4342$, but we regard these values as preliminary ones, pending a closer study of possible traces of impurities.

The microwave pure-rotation spectrum of the substance suffices to identify the molecule with certainty. The spectrum is that of a strictly symmetric-top molecule of moment of inertia compatible only with the expected linear arrangement of the nitrogen and carbon atoms on the figure axis. Quadrupole coupling hyperfine structure is also observed, the splitting being that expected for a nitrogen-14 atom located on the figure axis in the group $—C \equiv N$; the *iso*cyanide grouping is thus excluded, since it is not expected to give rise to resolvable quadrupole coupling[3]. Measurements have been made on the $J = 5 \rightarrow 6$, $8 \rightarrow 9$ and $10 \rightarrow 11$ transitions, and spectroscopic constants are derived as follows: $B_0 = 2{,}065 \cdot 73$ Mc./s., $D_{JK} = 19 \cdot 8$ kc./s., $D_J = c.\ 0 \cdot 1$ kc./s. and eqQ of $^{14}N = -4 \cdot 4 \pm 0 \cdot 5$ Mc./s. Absorption lines due to molecules in excited bending vibrational states are also observed in the manner expected for this molecule.

The moment of inertia, I_B, derived from B_0 is $406 \cdot 20 \times 10^{-40}$ gm.cm.^{2}, and is in good agreement with the most probable structural parameters. Thus the structure



$$\overset{1\cdot458}{H_3C—C} \equiv \overset{1\cdot379}{C—C} \equiv N \quad (C \equiv C: 1\cdot203,\ C \equiv N: 1\cdot157)$$

(distances in A.), with $d_{CH} = 1 \cdot 10$ A. and the HCH angle 108° 30′, is in accord with I_B. These parameters are close to those found for analogous bonds in cyanoacetylene[4] and methylacetylene[5]. Methyl-cyanoacetylene has a structure very similar to that of penta-1 : 3-diyne[6], and the values of the distortion constants are very similar for the two molecules.

Further measurements on the fine structure of the spectrum are planned, and it is hoped to evaluate the coupling constant more precisely. Work is also in progress on D_3CCCCN, and we hope later to detect spectra of other isotopic combinations and to determine further details of the structure. We are also investigating the possibility of exchange reactions between the hydrogen atoms and deuterium oxide.

Details will be given in a full report to be published elsewhere.

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Thunderstorms and Sporadic *E* Ionization of the Ionosphere

IN the course of the ionospheric observations carried out at Calcutta (lat. 22° 33′ N., long. 88° 21′ E.) for more than two decades, it had always been found that sporadic *E* ionization (E_s) is greatly increased during the occurrence of thunderstorms. In view of the persistence of the phenomenon, it was thought worth while to make a close study of the increase of E_s ionization during the occurrence of severe thunderstorms of the squall type, known as 'nor'westers', which are a special feature of the weather of this part of India (Bengal) in the pre-monsoon months March–May. During these thunderstorms the wind generally blows from a north-westerly direction with velocity often exceeding 50 miles/hr. The thunderstorms are invariably accompanied by lightning discharges.

Sporadic *E* ionization during ten such squalls occurring in the months April–May of 1953 and 1954 has been studied. As the squall was seen to be approaching—indicated by the appearance of the towering cumulo-nimbus clouds—special observation on E_s (besides the usual routine ones) was started and continued until the squall passed over. The observation consisted in gradually increasing the frequency of the transmitter and noting the frequency (fE_s) at which the E_s echo disappeared. The E_s's were distinguished by the characteristic fluctuation of the echoes and the simultaneous appearance of the F_2 echoes. The observations were repeated every four minutes during the progress of the squall. Figs. 1 and 2 depict graphically the results of the study for two typical cases. (The meteorological data in the figures regarding the progress of the squall—start, highest gust and end—and the atmospheric pressure variations were obtained from the Meteorological Office, Alipore, six miles south of the ionosphere station.)

It will be seen that with the approach of the squall there is sudden appearance of intense sporadic *E* ionization over the observing station. fE_s attains values as high as 10 Mc./s., as compared with the

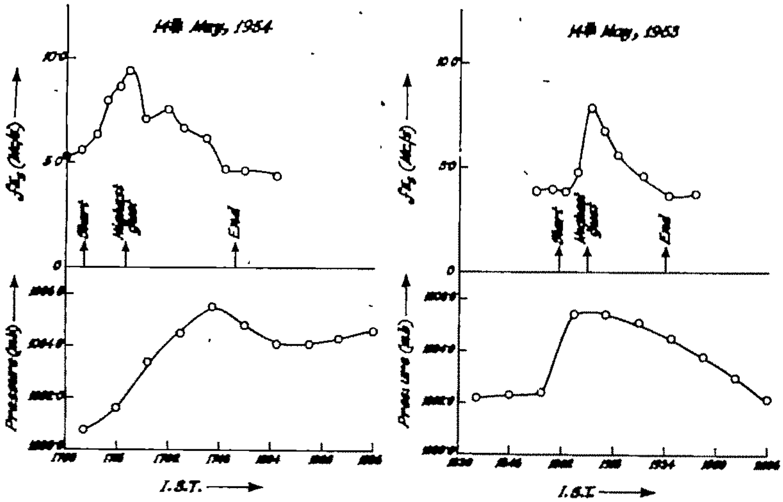

Fig. 1

Fig. 2

Figs. 1 and 2. Increase in the intensity of sporadic *E* ionization (measured by the penetration frequency fE_s) during the incidence of 'nor'wester' type of severe thunderstorms at Calcutta. The lower curves show the variation of atmospheric pressure during the progress of the storms

average no-storm value of 3·5–5 Mc./s. at this station. It is also to be noted that the development of the sporadic *E* ionization is such that it attains a maximum soon after the arrival of the squall overhead and decays gradually as the squall moves past the observing station.

The above results strongly suggest that one at least of the causes of sporadic *E* ionization, the origin of which is still insufficiently understood, is associated with thunderstorms.

The investigations described above form part of the programme of the Radio Research Committee of the Council of Scientific and Industrial Research, Government of India. One of us (M. R. K.) is a research assistant under the Council. We acknowledge the help of Mr. A. K. Saha, research assistant, in making the observations.

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Reactions of Molten Salts with Layer-Lattice Silicates

In a study of the reaction of molten salts with layer-lattice silicates, it has been found that treatment of muscovite less than 5 μ equivalent spherical diameter in size with molten lithium nitrate removes a large portion of the potassium from the mica, and lithium is fixed in a not readily exchangeable manner. When saturated with barium and glycerol-solvated, the material gives a 001 spacing of 17·8 A., the basal spacing for glycerol montmorillonoids. The intensity of the 17·8 A. line with respect to the 10 A. mica line varies with the muscovite/lithium nitrate ratio and the length of treatment. The muscovite was obtained by fractionation of delamica, a finely divided muscovite separated from Cornish china clay and containing a small amount of kaolinite.

As an example of the action of molten lithium nitrate on muscovite, the chemical composition of the treated and untreated material from one experiment is shown in Table 1. The 1–0·2 equivalent spherical diameter fraction of muscovite was heated with 60 parts by weight of lithium nitrate at 300° C. for 18 hr., washed free of excess salt and saturated with calcium by seven washings with 1 *N* calcium chloride, and total potassium and lithium determined with an Eel flame photometer.

Theoretically, muscovite should contain 250 milliequivalents of potassium per 100 gm. The negative charge equivalent to this presumably arises from substitution of Al^{3+} for Si^{4+} in tetrahedral co-ordination. If potassium is replaced by cation exchange or the negative charge on the layer decreased internally by penetration of lithium into the structure, the summation of milliequivalents of potassium, lithium and cation exchange capacity should be constant. The equivalences by Table 1 are a general feature of all treatments analysed. The experimentally determined cation exchange capacity is in good agreement with the difference 250 − $\Sigma K^+,Li^+$. These equivalences suggest the following mechanism: lithium replaces potassium, then enters the lattice and reduces the charge on the lattice, which renders it expandable.

The X-ray diffraction pattern of a glycerol-solvated specimen of the untreated muscovite showed no trace of any expanding material. When the lithium-treated muscovite was saturated with barium and glycerol-solvated, it showed a rational series of reflexions corresponding to a d_{001} of 17·8 A. on X-ray analysis.

Removal of potassium from muscovite by molten lithium nitrate proceeded quite rapidly in the case of the 1–0·2 μ fraction until the concentration of potassium in the melt reached a value of approximately 0·05 *N*. Treatment of muscovite with a melt of lithium nitrate having a potassium concentration of 0·05 *N* resulted in almost complete inhibition of the reaction.

Other dioctahedral micas, including an illite from Fithian, Illinois, a micaceous sub-soil clay on basement Carboniferous sandstone from North Wales, and paragonite reacted in a manner similar to the muscovite. Biotite, a trioctahedral mica, was not expanded by treatment with molten lithium nitrate.

Hofmann and Klemen[1], in explaining the irreversible loss of surface on heating of lithium-montmorillonite, suggested that lithium ions migrated into the vacant octahedral positions with a consequent neutralization of charge. The present work

Table 1. CHEMICAL COMPOSITION OF TREATED AND UNTREATED MUSCOVITE OF 1–0·2 μ EQUIVALENT SPHERICAL DIAMETER

	Potassium ions	Lithium ions	Cation exchange capacity	$\Sigma K^+,Li^+$, cation exchange capacity
	(milliequivalents per 100 gm.)			
Untreated	223	15	15	253
Treated	63	94	92	249

shows the lithium ions to be very firmly held by the dioctahedral layer silicates on treatment with molten lithium nitrate, and although it does not show that they enter octahedral co-ordination, it is unlikely that the lithium could be fixed between the layers or on accessible surfaces in such readily expanding material.

A more detailed account of this work will be published elsewhere.

Grateful acknowledgment is made to the British Museum (Natural History) for gifts of minerals. I wish to thank George Brown for his encouragement and general assistance and Dr. D. M. C. MacEwan for his interest and the invitation to work in the X-Ray Section of the Rothamsted Pedology Department. The investigation was undertaken while on sabbatical leave from the Purdue University Agronomy Department and during the tenure of a National Research Council (U.S.A.) Postdoctoral Fellowship.

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Conductivity induced in Polystyrene by X-Rays

A long time-constant of recovery for the conductivity induced by X-rays in a polystyrene-insulated condenser was observed by one of us (F. T. F.) in 1942[1]. We have recently made further measurements on polystyrene, using the d.c. amplifier technique with the insulating specimen in an evacuated chamber, as previously described[2,3]. The dependence upon temperature and dose-rate of the induced conductivity both during and after irradiation have been investigated.

These experiments have confirmed the long time-constant, which is comparable with those observed in polythene[3] and polytetrafluorethylene[4]. The magnitude of the induced current, however, is smaller than in the two latter materials, being in fact of the same order as that in 'Perspex' or some types of amber.

Dose-rate dependence. In the relationship between induced current i and dose-rate R,

$$i \propto R^{\Delta}, \qquad (1)$$

we find $\Delta = 0{\cdot}6 \pm 0{\cdot}1$ for polystyrene over the range $R = 2$–64 r./min., and between 20° C. and 110° C. Using Rose's model of photoconducting insulators[5], this value of Δ leads us to postulate an exponential distribution of trapping-levels below the conduction band. A consequence of this model is that when Δ is close to $\frac{1}{2}$, the variation of Δ with temperature should be large enough to be observed. This is in fact found to be so, Δ having the higher values at the lower temperatures, as in the case of polytetrafluorethylene[4].

Temperature dependence. Fig. 1 shows the graphs of log (conductivity) of polystyrene plotted against the reciprocal of absolute temperature. The resulting straight lines are of slope proportional to the activation energy, according to the general formula

$$\sigma = \sigma_0 \exp\,(-W/kT). \qquad (2)$$

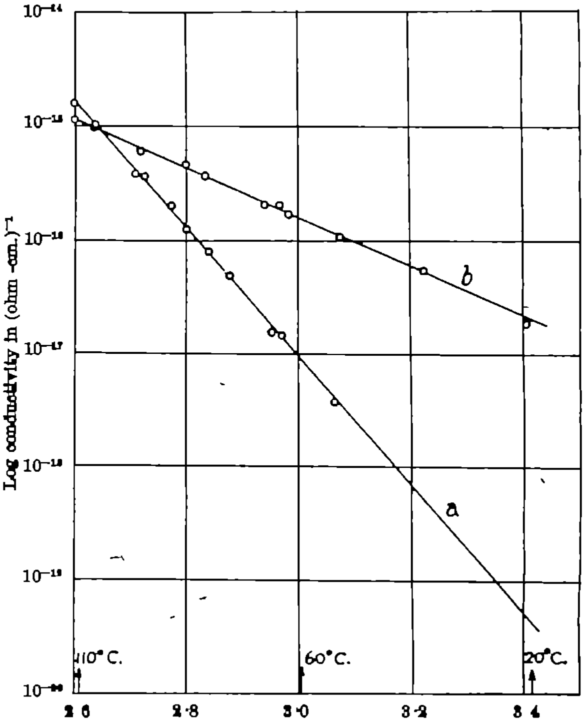

Fig. 1

In the case of static conductivity (that is, no incident radiation; Fig. 1*a*), $W = 1{\cdot}2$ eV. For the equilibrium induced conductivity under X-irradiation (Fig. 1*b*) at $R = 7$ r./min., the slope corresponds to $W = 0{\cdot}44$ eV.

From the latter graph it can be seen that the induced current increases by a factor of 60 between 300° K. and 400° K. The corresponding increase predicted using the model of an exponential distribution of traps is by a factor of 80, if we assume a value of $N_0 = 10^{19}$ for the number of available energy-levels in the lowest part of the conduction band a few kT wide. The agreement is fairly satisfactory, and shows that a slightly lower value of N_0 would give better agreement, as in the case of polythene and polytetrafluorethylene.

Decay of induced current. The time-constant of decay varies slowly with temperature, showing the same general features that we have described for polythene and polytetrafluorethylene: at temperatures below 70° C. the current falls at first more rapidly, but after a few minutes more slowly than at higher temperatures, so that complete decay takes longer at the lower temperatures. The current remaining after a few minutes is proportional to 1/time, as for polythene and polytetrafluorethylene. The time-constant decreases with increasing dose-rate, as expected, and the relationship appears to be reciprocal.

The magnitude of the time-constant is large, being even greater than for polytetrafluorethylene (for which $\Delta = 0{\cdot}63$), and considerably longer than for polythene ($\Delta = 0{\cdot}8$). The following table summarizes the results:

Temperature	Dose-rate	Time to fall to 10 per cent	Time to fall to 1 per cent
100° C.	7 r./min.	1 hr	6 hr.
20° C.	7 r./min.	¼ hr.	12 hr.

These recovery curves are in good agreement with the earlier results[1] of one of us (F. T. F.).

The magnitude of the induced current accords well with the results of Armistead, Pennock and Mead[6], and of Coleman and Bohm[7], if equation (1) is used to extrapolate the present measurements to the higher dose-rates used by them.

J. F. Fowler
F. T. Farmer

Royal Victoria Infirmary,
Newcastle upon Tyne 1.
June 25.

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[1] Farmer, F. T., *Nature*, 150, 521 (1942).

[2] Fowler, J. F., and Farmer, F. T., *Nature*, 171, 1020 (1953).

[3] Fowler, J. F., and Farmer, F. T., *Nature*, 173, 317 (1954).

[4] Fowler, J. F., and Farmer, F. T., *Nature*, [174, 136 (1954)].

[5] Rose, A., *R.C.A. Rev.*, 12, 362 (1951).

[6] Armistead, F. C., Pennock, J. C., and Mead, L. W., *Phys. Rev.*, 76, 860 (1949).

[7] Coleman, J. H., and Bohm, D., *J. App. Phys.* 24, 497 (1953).

Anomalies in Osmotic Pressure Measurements

In the course of a study of the molecular weights of coal-tar pitch fractions, we have observed unusual anomalies with two samples in benzene solution. A large number of fractions have been examined in benzene and in other solvents using modified Zimm–Meyerson osmometers fitted with specially prepared polyvinyl alcohol membranes[1] of the lowest possible permeability. We and other workers[2] have found samples of average molecular weight as low as 250 to be retained by the membranes, and nearly all our samples have followed van't Hoff's law almost exactly. As the full results of the investigation are being published elsewhere, attention is now directed only to the behaviour of two fractions produced by molecular distillation of that part of a coke-oven tar pitch which is insoluble in petroleum ether of boiling range 100–120° C. but soluble in benzene.

These two samples are believed to consist predominantly of condensed polycyclic aromatic hydrocarbons and to contain also limited quantities of compounds containing oxygen, nitrogen or sulphur in the ring structure or oxygen in phenolic form. Both have a number average molecular weight of about 400. The anomalous behaviour is a marked reduction of the reduced osmotic pressure, when measured at 25° C. in benzene solution, with increasing concentration. In both instances the actual osmotic pressure passed through a maximum and fell again as the concentration was raised. One of the samples was found to yield no detectable pressure at all at a concentration of 0·065 gm. per 100 gm. solvent. The other sample was examined at each of several temperatures in benzene and at 30° C. in nitrobenzene, the results being shown in Fig. 1. The phenomenon tends to disappear at elevated temperatures and does not occur at all in nitrobenzene solution.

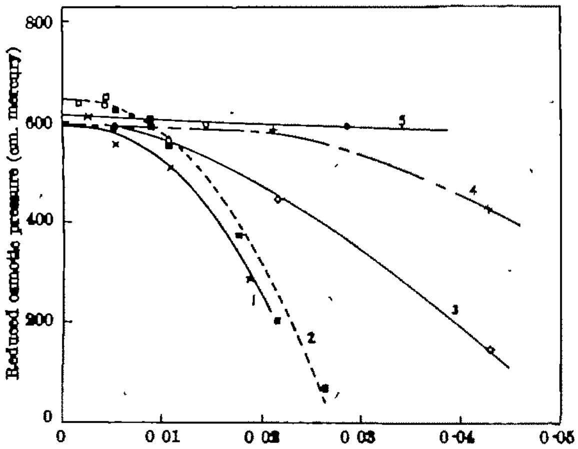

Fig. 1. Reduced osmotic pressure curves for pitch fractions. Curves 1–4, in benzene at 20°, 25°, 30°, 40° C. respectively. Curve 5, in nitrobenzene at 30° C.

At first sight this behaviour seems to be most readily explained by assuming association of the solute molecules in a weak solvent, and the effect of raising the temperature and of changing to the stronger polar solvent seems to support this view. That association should occur to the extent indicated by the results, however, and at so low a concentration, is difficult to imagine.

L. J. Wood
G. Phillips

Coal Tar Research Association,
Oxford Road, Gomersal, Nr. Leeds.
July 12.

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[1] Hookway, H. T., and Townsend, R., *J. Chem. Soc.*, 3190 (1952).

[2] Report of the Chemistry Research Board for 1953, 48 (H.M. Stationery Office, London, 1954).

Structural Changes in Boiling Solutions of Sugar with Reference to Chromatography of Carbohydrates

The sensitivity of the chromatographic method in detecting sugars has made possible a greater appreciation of the labile character of many monosaccharides, and has emphasized the significance, in quantitative work, of degradation in sugar solutions at the boil[1] and of accelerated epimerization attributable to trace alkalis in chromatographic paper[2]. It does not seem to be so fully appreciated, however, that structural changes in sugar solutions can occur during heating for periods comparable with those frequently used in polysaccharide hydrolyses, and that such changes might give rise to misinterpretation of the results of qualitative paper-chromatography studies.

The effect referred to may be illustrated by the chromatograms reproduced in Fig. 1, which were obtained by applying the appropriate syrups to the paper without heat-drying, developing with butanol/acetic acid/water solvent, and spraying with aniline hydrogen phthalate. The hydrolysate of the water-soluble fraction of chlorite-treated *Urena lobata* fibre, after neutralization and concentration to a syrup at 50° C., was applied, without heating, along a line on a sheet of filter-paper. A spot of the syrup was used to indicate the positions of the separated fractions in the main chromatogram (Fig. 1,*a*). Half the section of the paper which contained the rhamnose fraction of the hydrolysate was extracted with distilled water in a micro-Soxhlet apparatus, and the solution in the flask was maintained at the boil for 12 hr., a period in excess of that required for complete extraction, yet considerably less than many hydrolysis times quoted in the literature. On chromatographic development the concentrated solution yielded not only a spot corresponding to rhamnose but also another spot for a sugar with an R_G value approximating to that of xylose (Fig. 1,*b*). The other half of the section of the paper, with the remainder of

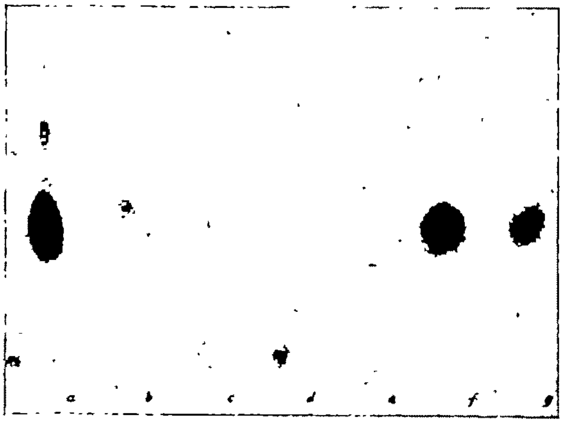

Fig. 1. Chromatograms illustrating the effect of heating sugar solutions. (a) Hydrolysate from *Urena lobata*; (b) rhamnose fraction of the hydrolysate after boiling; (c) rhamnose fraction from the hydrolysate eluted with cold water; (d) pure rhamnose solution after boiling; (e) pure rhamnose; (f) pure xylose solution after boiling; (g) pure xylose

the rhamnose separated out from the main hydrolysate, was eluted with cold distilled water, and the resultant chromatogram (Fig. 1,c), obtained as usual, showed only the single spot corresponding to rhamnose. Thus it would appear that the rhamnose isolated from the fibre hydrolysate was uncontaminated by other sugars, and that epimerization or other structural change had occurred by and during the heating of the aqueous solution. It seemed scarcely feasible that alkaline conditions could have arisen either from the glassware, which was of well-used 'Pyrex', or from the filter-paper, in view of the acidity of the solvent used. Confirmation that structural transformation occurs on heating rhamnose in non-alkaline solution was obtained by refluxing a solution of chromatographically pure rhamnose (Fig. 1,d) in distilled water for 12 hr., during which period the pH of the solution fell to a value of 3·9 (Fig. 1,e).

The conversions occurring are not confined to the methyl pentose, since xylose solution, which yielded a single spot on a chromatogram (Fig. 1,g), showed additional spots after boiling for 12 hr. (Fig. 1,f).

T. H. Soutar
Evelyn Hampton

British Jute Trade Research Association,
Kinnoull Road, Kingsway West,
Dundee. July 8.

[1] Laidlaw, R. A., and Reid, S. G., *Nature*, 166, 476 (1950).

[2] Duff, R. B., *Chem. and Indust.*, 898 (1953)

Effect of Chelating Agents on Heavy Metal Catalysis

In a recent communication, Pirie and Van Heyningen[1] have reported "a case where a chelating agent accelerated the oxidation of a substance (glutathione), which it was intended to preserve in the reduced state"[1]. The object of the chelating agent was "the removal of metals", traces of which would presumably catalyse the oxidation. Since chelating agents are being generally used for this purpose, it seems worth while emphasizing that the metal chelate complexes formed are not necessarily without catalytic activity. Thus 1 : 10 phenanthroline, $\alpha\alpha'$di-pyridyl and $\alpha\alpha'\alpha''$tripyridyl increase the iron-catalysed rate of decomposition of hydrogen peroxide by as much as one hundred-fold[2], and certain hæmoprotein complexes of iron are well known as catalysts in biological systems.

We are studying the effect of chelating agents on the metal-catalysed autoxidation of *cyclo*hexene. Only in the case of copper has the metal chelate complex been found to be catalytically inactive. In the case of iron, the formation of the chelate complex greatly increased the rate of the reaction. Approximate results are quoted in the table for the reaction at 60° C. in the presence and absence of 2 gm. mol. of NN′disalicylidene ethylene diamine per gm. mol. of the metal heptoate.

Metal, initial valency state and concentration	Extent of oxidation after 60 min. reaction (gm. oxygen/kgm. *cyclo*hexene)	
	No chelating agent	Disalicylidene ethylene diamine present
Cu^{II} 50 p.p.m.	13	0·12
Fe^{III} 500 p.p.m.	1·3	c. 50
Mn^{II} 49·5 p.p.m.	21*	25
Co^{II} 49·1 p.p.m.	27	36*
Metals absent	0·12	0·12

* Durations of these reactions are taken as 60 min. from the termination of the induction periods.

The formation of the chelate complex has little effect on the manganese-catalysed reaction. The kinetic characters of the two cobalt-catalysed reactions are completely different, however. In the absence of disalicylidene ethylene diamine the rate decreases, but in its presence the rate increases during the initial course of the reaction. The effect of a chelating agent sequestering copper but 'vivating' iron has also been established by us for the autoxidation of *cyclo*hexene in the presence of NN′di*cyclo*hexyldithiooxamide. Further, we have observed a similar phenomenon for the autoxidation of sodium sulphite in aqueous solution, thus indicating that it is by no means confined to non-aqueous media.

The foregoing results show that not only metal ions but also covalently bound metals can be effective catalysts for free-radical chain-reactions. The fact that copper catalysis is prevented by chelation may result from the special condition that cuprous–cupric transitions probably involve large free energies of activation when the metal is chelated. Both cuprous and cupric copper have a normal co-ordination number of four, but the former requires a tetrahedral and the latter a planar disposition. Iron, however, will co-ordinate octahedrally in both valency states. Moreover, a quadridentate chelating agent may sterically prevent reaction in the case of a metal with a normal co-ordination number of four if the electron transfer mechanism requires the reacting molecule to enter the co-ordination shell of the metal. The study of hexadentate chelating agents for metals with a maximum co-ordination number of six should throw further light on these possibilities. Work is continuing in this direction.

This communication is published with the permission of the Council of the Research Association of British Rubber Manufacturers.

A. J. Chalk
J. F. Smith

Research Association of
British Rubber Manufacturers,
Shawbury,
Shrewsbury, Shropshire.
June 17.

[1] Pirie, A., and Van Heyningen, R., *Nature*, 173, 873 (1954).

[2] Baxendale, J. H., "Advances in Catalysis", 4, 63 (1952).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 25

British Society for the History of Science (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. A. F. W. Hughes: "Some Aspects of the History of Microscopy".

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Whether Compatibility is Necessary for a Colour Television System in Great Britain".

Tuesday, October 26

Society for Applied Bacteriology (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 3 p.m.—Discussion on "Recent Advances in the Bacteriology of Milk and Milk Products".

Wednesday, October 27

University College, London (in the Gustave Tuck Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. D. Strömbäck (Uppsala): "The Academic Approach to Folk-Lore Studies". (From a series of lectures on "Folk-Lore".)*

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6 p.m.—Annual General Meeting. Rear Admiral (L) Sir Philip Clarke: Presidential Address.

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Units of Measurement of Length, Mass and Force Employed in the Teaching of Applied Mechanics and General Mechanical Engineering Subjects".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 7.45 p.m.—Dr. Cudjoe: "Ewe Folk-Tales, Children's Games, Drumming and Dancing". Leader: Mr. Desmond Tay.*

Thursday, October 28

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Hannah Steinberg: "Drugs and Psychological Tests".*

Thursday, October 28—Friday, October 29

Institute of Petroleum, Spectroscopic Panel of the Hydrocarbon Research Group (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Conference on "Molecular Spectroscopy".

Friday, October 29

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting. Mr. D. H. Sadler: "The Role of the Institute" (Presidential Address).

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. Dollin: "Factors Influencing the Continuing Development of the Steam Turbine" (Nineteenth Parsons Memorial Lecture).

Institute of Physics, Non-Destructive Testing Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. W. G. Cook: "Jet Engines and Non-Destructive Testing".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. L. Harrison Matthews, F.R.S.: "Animal Life in the Antarctic".

Saturday, October 30

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. H. J. Braunholtz: "The Potter's Craft in Africa".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Principal (with appropriate agricultural qualifications, together with experience in teaching, administration and practical farming) of the Yorkshire Institute of Agriculture, Askham Bryan, near York—The Chief Education Officer, County Hall, Wakefield (October 28).

Scientists (with a first- or good second-class honours degree in physics, engineering, mathematics or statistics, and experience in field, laboratory or operational research), in the Field Investigation Group, to carry out field work at collieries—National Coal Board, Establishments (Personnel), Hobart House, London, S.W.1, quoting TT/852 (October 30).

Lecturer (graduate in chemical engineering or graduate in chemistry with postgraduate training and/or experience in chemical engineering) in Chemical Engineering—The Principal, Manchester Municipal College of Technology, Manchester (November 1).

Research Fellows (2) (one with at least a second-class honours degree in physics, chemical or mechanical engineering, and the other with at least a second-class honours degree in mechanical engineering or physics) in the Department of Textile Industries—The Registrar, The University, Leeds (November 1).

Assistant Lecturer (with a university degree in engineering or equivalent, and preferably with some industrial experience) in General Engineering Subjects—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (November 2).

Assistant Lecturer in Pure Mathematics—The Registrar, The University, Sheffield (November 6).

Chemical Engineer or Chemist (with a good honours degree in chemistry or A.M.I.Chem.E., and with previous industrial experience), at the Divisional Laboratory, National Coal Board, Edgbaston, Birmingham, for investigations into the treatment and disposal of mine water effluents—The Divisional Establishment Officer, National Coal Board, Himley Hall, Dudley, Worcestershire (November 6).

Biometrician (with a good degree in mathematical statistics, and a wide experience in the design and analysis of field experiments in all branches of agricultural and animal husbandry research); a Fisheries Officer (graduate in natural science, and preferably with specialization in zoology, and with subsidiary knowledge of physiology and chemistry); a Dairy Officer (graduate in dairying or agriculture, and with experience in the administration of milk recording schemes); a Systematic Botanist (graduate in botany and preferably with experience in herbarium work); and an Animal Husbandry Officer (graduate in agriculture with specialization in animal husbandry), in the Department of Research and Specialist Services, Federal Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (November 10).

Technical Officer, Grade II (with good general training in chemistry, preferably up to degree standard, and experience in fuel technology and fuel analysis) in the Coal Survey Laboratory, Leeds—National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/856 (November 10).

Assistant Lecturer (Botany), and a Demonstrator (Zoology) in the Biology Department—The Registrar, University College of North Staffordshire, Keele, Staffs (November 13).

Cereal Technician (with a sound knowledge of wheats and milling technique, and City and Guilds of London certificate or equivalent qualifications) at the Agricultural Research Institute, New South Wales Department of Agriculture, Wagga, Australia, to be fully responsible for the preparation, appraisal and milling of wheat on Allis Chalmers test mill, and maintenance of plant—The Agent General for New South Wales, 56 Strand, London, W.C.2 (November 15).

Lecturer in Civil Engineering at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, November 15).

Lecturer (with a university degree in mechanical engineering) in Mechanical Engineering at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 22).

Lecturer in Applied and Industrial Chemistry at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 25) (Additional copy to The Registrar, University of Cape Town, Private Bag, Rondebosch, C.P., South Africa (November 30)).

Lecturer (with good experience in different types of educational posts, and preferably with ability to specialize in methods in teaching science) in Education at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30).

Professor (with a higher degree, teaching experience at university level and with research experience in at least one of the more important fields of psychology) of Psychology, at the University of Queensland, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 30).

Agricultural Economist (graduate in economics and/or agriculture, and with some postgraduate experience in agricultural economics), in the Department of Agricultural Economics, School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Assistant (graduate in metallurgy, chemistry or physics, and preferably with foreign language knowledge), for abstracting, translating, literature searching, indexing and editorial work—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

Chemists or Engineers (with an honours degree in science or engineering, or Corporate Membership of a recognized professional institution, and with varied scientific experience in industry or a research establishment) at Risley, to serve in a headquarters section whose function is the co-ordination and control of a group of laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 688.

Electrical Engineers and Physicists (with a first- or second-class honours degree or equivalent in physics or light electrical engineering) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work on radio and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.267/54A.

Engineer or Chemist, Grade I (with an honours degree in engineering or science or Corporate Membership of a recognized professional institution, and with wide and varied engineering or scientific experience, and preferably with experience in programme planning, cost control, staff management, etc.), to take charge of a headquarters section responsible for co-ordinating activities of a group of research and development laboratories—United Kingdom Atomic Energy

Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 686.

ENGINEERS and PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree or equivalent high professional attainments), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 246/52A.

GEOLOGIST (with a degree in science with geology as a major subject, or equivalent, and preferably with experience of economic geology) IN THE MINES DEPARTMENT of South Australia—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

JUNIOR INVESTIGATOR (Research Officer grade) (with a degree in metallurgy or equivalent qualifications), to undertake research work on the welding of aluminium alloys and special materials; and a LABORATORY ASSISTANT (Research Assistant grade), to undertake metallographic work and testing as a member of a research team—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

KEEPER (with practical experience in a herbarium and ability to organize and direct technical staff, and preferably with a science degree and a fundamental knowledge of taxonomic botany) OF THE HERBARIUM (Botanic Garden), Adelaide, South Australia—The Agent General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1.

MASTER or MISTRESS TO TEACH BIOLOGY throughout the school to university entrance standard—The Headmaster, Keswick School, School House, Keswick.

MICROBIOLOGIST (preferably with medical qualifications and some experience of clinical bacteriology and virus work), for research on aetiology of non-specific urethritis—Prof. A. A. Miles, Lister Institute, Chelsea Bridge Road, London, S.W.1.

ORGANIC CHEMISTS (Ph.D. or equivalent experience) to continue research on the degradation of carbohydrates—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

PHOTOGRAPHIC TECHNICIAN (with good training in photographic methods, and preferably with some experience in medical work)—The Secretary, Royal Free Hospital School of Medicine, Hunter Street, London, W.C.1.

PHYSICIST (with a good honours degree and preferably some research experience), to undertake research on the shrinkage and dimensional stability of fabrics—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

SCIENTIFIC ASSISTANT (with a university degree, a knowledge of at least two European languages and ability to write clear, concise English), for duties which include abstracting world scientific literature on animal breeding, genetics and production—The Director, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with higher school certificate (science) or equivalent), to assist in a chemical engineering branch, in the compilation of detailed flowsheets, design calculations, and plant specifications, required for the engineering design branch for new chemical plant and equipment—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 519/WGE/2.

TECHNICIAN IN THE DEPARTMENT OF CHEMICAL ENGINEERING to assist in preparation of Co-enzyme "A"—The Secretary, University College, Gower Street, London, W.C.1, quoting Chem.Eng./2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Excerpts from the speech of Academician Imre Nagy, Chairman of the Council of Ministers of the Hungarian People's Republic, at the General Assembly of the Hungarian Academy of Sciences on June 14, 1954. Pp. 14. (London: Hungarian News and Information Service (Hungarian Bulletin), 1954.) [98

Report by the Hydrographer of the Navy on the Surveys carried out by H.M. Naval Surveying Service, and of the work of the Hydrographic Department, for the year 1953. Pp. 10. (London: Admiralty, Hydrographic Department, 1954.) [98

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 18, No. 3: Report on Research from the *Ernest Holt* into the fishery near Bear Island, 1949 and 1950. By Michael Graham, G. C. Trout, R. J. H. Beverton, John Corlett, A. J. Lee and R. W. Blacker. Pp. 88+4 plates. (London: H.M. Stationery Office, 1954.) 12s. 6d. net. [98

Speeches at the dinner in honour of General Alfred M. Gruenther under the auspices of the English-Speaking Union of the Commonwealth, June 8, 1954. With an Introductory Note by Lionel Curtis. Pp. 21. (Oxford: Basil Blackwell, 1954.) 6d. [98

Report of the Departmental Committee on Foot-and-Mouth Disease, 1952–1954. Pp. 151. (Cmd. 9214.) (London: H.M. Stationery Office, 1954.) 5s. 6d. net. [128

Annual Report for 1953 (No. 66) of the Marine Biological Station at Port Erin, Isle of Man. Drawn up by J. S. Colman. Pp. 27. (Liverpool: University Press of Liverpool, 1954.) 2s. [128

Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing in the University of Leeds, for the Session 1952–53. Pp. 35. (Leeds: The University, 1953.) [128

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UTILIZATION OF RESEARCH IN THE BRITISH COMMONWEALTH

A RESOLUTION passed at the British Commonwealth Scientific Official Conference in 1946 recommended the preparation of a report on the methods for promoting the application of research carried out under government auspices which had proved successful in the countries of the Commonwealth. This arose out of the realization that what was of first importance for Great Britain in particular was not the general expansion of research but the more effective utilization of existing knowledge. Following Sir Henry Tizard's emphasis on the point in his presidential address to the British Association in 1948, the problem has been regarded as one of increasing urgency and has been considered both by the Parliamentary and Scientific Committee and the Advisory Council on Scientific Policy. It has also received some comment in the reports of the productivity teams which visited the United States under the auspices of the Anglo-American Productivity Council.

In spite of this, a draft report in implementation of the recommendation of the Scientific Official Conference was only presented to the British Commonwealth Scientific Conference held in Australia early in 1952, instead of in December 1947, as originally recommended. The draft report was endorsed by the Conference, and it has now been brought up to date to the end of 1953 and published[*]; it also includes a brief reference to the survey of the relations between industry and science in the Greater Manchester area carried out by the Manchester Joint Research Council, so far as it bears on the problem, issued only in April last. All but forty of the two hundred pages of a well-produced volume are occupied by a series of factual accounts of the means at present used in the United Kingdom, in Canada, in Australia, in New Zealand, in South Africa, in India, in Ceylon and in Southern Rhodesia for securing the rapid translation of research results into practice. A further appendix describes methods used in the United States by the Tennessee Valley Authority, the Bureau of Agricultural and Industrial Chemistry of the United States Department of Agriculture and the Research Corporation and University Research Foundations.

These factual accounts are clearly presented and, on the whole, are adequate; though, seeing that most of the information was reasonably accessible, the time-lag seems inexplicable. Where the book is inadequate is in the three chapters reviewing the methods by which the results of scientific research are normally communicated, supplementary methods, and obstacles to the use of information. These chapters fail so completely to provide the critical analysis required that the conclusions which follow likewise fail to get to the heart of the problem; indeed, the book makes practically no contribution to the question what are the forces and motives which retard or stimulate commercial development. It takes us no further than the discussion on the subject nearly three years ago at the International Symposium on the Organization of Scientific Research sponsored by the Department of Scientific and Industrial Research. Far more searching and relevant to present needs are the comments in the Comparative Study of Applied Research in Europe, the United States and Canada, published as Vol. 1 of the report of three Technical Assistance Missions of the Organization for European Economic Co-operation the substance of which, with two related volumes, was noticed in *Nature* of October 23, p. 778.

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[*] The Application of Results of Research. Compiled and Edited by Vera Connell, in collaboration with the British Commonwealth Scientific Offices (London). (British Commonwealth Scientific Conference.) Pp. vii+212. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1954.) 21s. net.

Nevertheless, it is worth looking a little more closely at the chapters on the communication of the results of scientific research in the volume arising out of the British Commonwealth Scientific Conference of 1946. The book is concerned primarily with the utilization of the results of research carried out under government auspices and, quite apart from the increasing extent to which both fundamental and applied research depend on government support, the shortcomings of the book may perhaps give a clue to some of the real causes of failure to secure effective development, or even to the real weaknesses in government-sponsored research. At least the complacency with which the adequacy of the existing arrangements is taken for granted should be challenged. When, for example, Sir Cyril Hinshelwood can write, as chairman of the Fuel Research Board, "On the basis of existing knowledge, and with no undue capital expenditure, the same amount of useful heat and power as are now obtained could be achieved with a saving over the country as a whole of several millions of tons of coal a year", it is time to examine not merely the receptivity of firms to scientific and technical information, but also the appropriateness of the way in which it is presented. We cannot assume that the multiplication of reports and scientific or technical papers, of liaison officers and the like will of itself achieve the object. The much more searching question of their appropriateness to their purpose must be asked.

On that point this report has little or nothing to say. As to whether reports or scientific and technical papers are actually read and understood by those to whom they are distributed, no evidence is offered. The validity of the existing methods of dissemination are taken for granted in the assumption that intensification or multiplication is all that is required. Yet the essential factor is the difference between securing the utilization or development of knowledge acquired as a result of some piece of investigation conducted or instituted by the firm itself, and the utilization of knowledge acquired from outside without its own effort. We cannot even assume that the latter process is parallel with the dissemination of scientific knowledge to scientists or technologists in general.

It is the psychological factor that is important and, however effective methods of overcoming it may prove, its existence is a reason for regarding with some reserve the tendency for the State to assume increasing financial responsibility for industrial research and especially technical development. Th selection of industrial research objectives can scarcel be as sound from outside as from within a firm, an from those two points of view alone the utilizatio of research results is more likely to be encourage by a government policy which encourages initiativ and enterprise by the individual firm than by actu government sponsoring of research and developmen Indeed, it might well be asked if a sound move t counter the prevailing sluggishness would not be fiscal policy which ceased to bolster up the inefficien firm and forced it out of existence.

Sir Henry Tizard has not concealed his ow uneasiness as to the rigidity of British industry an the dangers of relying on government initiative an support where development is concerned, if not al in regard to research. Moreover, where industry lacking in the spirit of adventure and in receptivit to new ideas, it is unlikely that such a defect will b corrected from the government side. In the Civ Service such defects are commonly accepted as pa of the price to be paid for its virtues and excellence It will be noted that, while the report records som of the activities, such as investigations into the rate technological innovation, which have been initiate by the Committee on Human Relations in Industr with funds from the Conditional Aid Programme, shows no appreciation of the urgency and importan of this work, if the obstacles to innovation ar development are to be overcome.

Such inquiries as are now being sponsored by th Committee on Human Relations in Industry ma well indicate ways and means for dealing mo effectively with human obstacles to the introducti of new production techniques and methods and new processes and products. Simultaneously, ho ever, the whole climate of industrial research an development in Great Britain requires examinati in relation to the application of existing knowledg There is room for more factual inquiry on questio which are commonly matters of opinion, as w recently pointed out in these columns (see *Natu* 174, 145; 1954); and the effectiveness of existin means of communicating knowledge should be n more immune from such inquiry than the relevan and appropriateness of the knowledge communicate or the ability and competence, as well as th receptivity, of those to whom it is supplied.

Admittedly, some such inquiries go outside t scope of the report contemplated by the Briti Commonwealth Scientific Official Conference in 194 but none the less, any critical appraisal of existin methods of promoting the utilization of resear results should have at least indicated the bearing such factors on the application of existing knowled and technological innovation. It should also ha examined the appropriateness of existing practic and considered whether or not some of the effo could not be better expended in other directions on new methods. It should not be assumed axiomatic, as this report appears to do, that all t existing effort given to the communication of resear results is necessarily effective and worth while. Ev if industry does need to employ more scientists a technologists at all levels, it no more follows that industry is being supplied with the information it most needs in the most appropriate way, or that all the existing information services should be maintained or expanded, than it follows that thereby the more fundamental psychological, economic or fiscal obstacles to innovation will be removed.

The report does not, it is true, overstress the part which methods of communication play in furthering the application of the results of research; but it does not seriously question the suitability of methods of distributing scientific and technical knowledge to the right places for utilization. "Information obtained through research represents in the aggregate very large expenditures of money and of the time, energy and intelligence of all-too-scarce trained men. Failure to make the fullest use of this effort is a flagrant waste which no country can afford. The responsibility for minimizing this waste must be shared by industry and research organizations. Management and labour must be receptive, and those responsible for research organizations must accept, as one of their primary duties, the task of ensuring that there is no waste of information through their default or neglect."

This, concludes the report, should be a cardinal point of policy, and it adds, "To give effect to it requires conviction of its necessity, continuous and close attention to its operation, imaginative but realistic choice of the methods to be used and persistence in their application". Nevertheless, no hint is given that this is exactly what is required of those actually engaged in the task of communication, and that the technique of communication and the trained man-power devoted to it are as appropriate a subject for scrutiny as the disposition of trained man-power in industry and in government service generally. The very fact that industry is already in fierce competition with the universities, with government departments and with the schools for the present supply of scientists makes it essential that such scientists should be wisely and effectively used, and not employed on duties which could be equally well performed by less highly trained persons.

Any such scrutiny of the use made of scientists in industry must include their use in information and like services, as well as in research. We should be as careful to satisfy ourselves that scientists are only employed in information work when their scientific qualifications are really essential, as will often obtain, as to ensure that industrial research is directed to objectives that are worth while; and neither duplicates what is being done elsewhere or is being pursued in fields unlikely to yield returns commensurate with the effort. What has to be realized is that every scientist engaged in such activities is one less available for the myriad other tasks involved in technological development, that each information officer or liaison officer employed on a non-essential task means one less available elsewhere, either for some essential part in winning the confidence of industry, in interpretation, or in training the fresh scientists and technologists that industry still needs.

All this is emphasized by even the limited comparative study of the organization of applied research in Europe and the United States and Canada made for the Organization for European Economic Co-operation. Most countries, it is clear, would benefit from an expansion of their research effort and from a close scrutiny of their policy with regard to research staff and their arrangements for co-operation, co-ordination and the exchange of information. Everywhere the critical factors are the shortage of qualified workers and their most effective use, and the inadequacy of allocations for research, and, especially in Europe, for the commercial application of the results.

Greater efforts in all countries, and also internationally, are recommended to ensure the more effective communication of research results and technique, and far more stress is laid in these reports than in that presented to the Commonwealth Scientific Conference on the importance of the personality of the liaison officer in the increasingly active industrial liaison service which is recommended. While once again it is emphasized that there is no lack of quality in European research, conditions in the United States are generally more favourable for applied research and industrial innovation. What is needed in Europe is a more frankly commercial initiative on the part of the applied scientist, and more direct support and recognition of the production and profit potentialities by industry and government.

Though there is much in these reports which repeats what has frequently been said in discussions on scientific and industrial research in Great Britain during the past ten years—the principles commended in the chapter on the research climate in the United States and Europe, for example, have been pressed in these columns for even longer—they make a number of suggestions, adoption of which might well help Britain to foster the enthusiasm for research which gives the United States so marked an advantage. We have still, for example, to formulate an adequate national research policy with the appropriate balance between fundamental and applied research, and scientists are reminded that when their work receives little attention and appropriations are not forthcoming, the fault may be partly their own failure to make full use of their opportunities for stating their opinions or selecting research projects of sufficient scientific or economic importance. Again, the need is emphasized for a constant review of the work and growth of government research organizations, and research councils are recommended to make a determined effort to collect and analyse data on investment in industrial research and development. A study is also recommended of the possibilities of minimizing the deterrent effects of taxation and encouraging both the commercial exploitation of research and the appropriation of funds for research.

What emerges particularly from this study is that for each country the organization and encouragement of applied research present a challenge to imaginative enterprise and to constructive thought. There is no general solution to the problems, however much the experience of other countries may assist any particular country in working out a pattern and solution appropriate to its own needs and conditions. Forms of co-operation even may differ, and while in the United States, for example, sponsored research institutes are already well established and the co-operative research association finds no favour, the situation varies considerably in Europe, where the field for sponsored research institutes depends on the extent and efficiency with which industry and government meet the requirements for research. No wholly satisfactory solution to the research needs of the small firm has yet been found; but on the other hand, the factors responsible for a satisfactory research climate are well understood and valid generally. The reports of these Technical Assistance Missions are well calculated to dispel any complacency engendered by that submitted to the Commonwealth Scientific Conference. Even in regard to documentation and the communication of results, they call for a critical review of existing methods and for active attempts to improve the means of communicating research results to industry; and the research worker himself is summoned to take part in this work. In particular, he is urged to examine the form in which information is supplied to him and, where appropriate, to indicate and press for better means. No scientist who reads the reports of these Missions is left in any doubt as to the importance of the contribution which he has to make, both personally and through his professional associations, to the constructive thinking and critical scrutiny of our whole organization for scientific and industrial research and for the means of disseminating the results of its activities. That thinking and scrutiny must precede alike the formulation of an adequate national research policy, and the devising of appropriate measures both to foster a real research climate and to overcome the obstacles, whether fiscal, psychological or technical, which hinder technological innovation in industry.

ANALYSES OF MARINE ORGANISMS

The Elementary Chemical Composition of Marine Organisms

By A. P. Vinogradov. (Memoir No. 2.) (Translated from the Russian by Julia Efron and Jane K. Setlow, with Bibliography by Virginia W. Odum.) Pp. xiv + 647. (New Haven, Conn.: Sears Foundation for Marine Research, Yale University, 1953.) 17 dollars.

THOUGH less than one-half per cent of the organisms that live in the sea have been submitted to any kind of elementary chemical analysis, much has been done. Analyses have become buried in a mountain range of journals, many highly inaccessible. There has been no means by which a research worker in a reasonable time could find what has been done in his own field. Full assessment of the part played by marine organisms in geochemistry has been impossible.

As part of the programme of Prof. V. I. Vernadsky's Biogeochemical Laboratory of the Academy of Sciences, Moscow, Prof. A. P. Vinogradov undertook the exceedingly onerous task of collecting and assessing this literature. He has published the results in the *Travaux* of that Laboratory in three parts in 1935, 1937 and 1944. These included much fresh and accurate analytical work from Russian laboratories by Vernadsky, Vinogradov and their school. Of these Russian publications, very few copies are available to the Western world. The reviewer knows of no accessible copy of the 1944 part in the British Isles.

The translation of this unique work into the English language has resulted from a happy Russo-American collaboration under the ægis of the American Museum of Natural History and the Sears Foundation of Marine Research. It is not a word-by-word translation by hacks but really a new work. The additions of the 1944 part were incorporated as appropriate in the earlier parts. The whole English translation was then seen by Vinogradov, who added new and unpublished material and made corrections. Still more recent material was added during editing and preparation for the press. There are also many helpful footnote commentaries by the translators. The bibliography of about 2,500 entries is essentially new and adds greatly to the value of the work for the advancement of geochemistry, marine biochemistry and systematics, oceanography, as well as of industrial biology and the science of petroleum.

One chapter is devoted to each phylum and may occupy 100 pages or less than one. For phyla much investigated such as algae, molluscs and fishes, the chapters are broken down into sections dealing either with single chemical elements or with single families. Owing to the difficulty of removing extraneous salt from the marine organism there has been much confusion in the meaning of such basic terms as 'wet weight'. Vinogradov has made order out of chaos, and future analysts of marine organisms would be wise to model their procedure to fit his classification.

The language of such a compilation is always likely to be repetitive, stilted and dull. In fact, this work is none of these, but has literary merit and holds attention by well-marshalled presentation and attractive writing. The technical production is superb and, in a book which will long retain scientific value, may be justified. However, in spite of heavy subsidy from the American Museum of Natural History and the Sears Foundation of Marine Research and the financial advantages of printing in Denmark, its price is so high as to place it beyond the means of most individuals outside the United States. Many would forgo the pleasure of consulting a collector's piece in a wealthy library for the advantage of themselves possessing a shoddier edition of an essential working tool. The cost of essential books which should be in a research worker's personal library is ever rising. Is there a case for again pressing on the Board of Inland Revenue, perhaps in the debates on the Finance Bill, the view that such costs are properly chargeable as personal expenses against taxation?

This book is as complete as any work of man is ever likely to be, but it cannot remain so. In a few years supplements will be needed, perhaps to the 327 tables with their numbers unchanged. It is to be hoped that the Biogeochemical Laboratory of the Russian Academy of Sciences, the American Museum of Natural History and the Sears Foundation may be able to achieve the preparation and publication in Russian and English of such supplements.

L. H. N. COOPER

THE RAW MATERIAL IN FOOD PRODUCTION

Soil

By G. V. Jacks. (Nelson's Agricultural Series.) Pp. ix+222+10 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1954.) 12*s*. 6*d*. net.

THE problem of food supply will always be with us; it will not be solved by pretending it does not exist; it can be properly approached only through some knowledge of the soil, which is the basis of all agricultural pursuits. The brown or grey surface layer of the fields—the 'earth' to the uninitiated—is but the visible sign of an ageless development of soil, in the genesis of which parent material, climate, vegetation, topography and time are the factors inextricably related and on which man can finally exert an influence that may completely upset for good or ill the slow change of centuries.

What is soil in its origin, physical and chemical properties, fertility, utilization? These are the questions that are dealt with in this book, the fifteenth in the Nelson Series for farmers and students of agriculture, and one that could also be profitably read by any others seriously interested in the question of food production. As becomes a writer with an enviable reputation and a wide knowledge of his subject, the text carries the stamp of authority; it is a straightforward statement in plain English of what we know and what we do not know, with the emphasis on general principles and the interplay of factors. Mr. Jacks has, in fact, most ably achieved his aim of presenting an interpretation of the scientific facts in language comprehensible to the non-specialist reader.

He has taken soil structure as the all-important measure of fertility, for it is upon structure that aeration, water absorption and movement and, consequently, the growth and health of the plant depend; a good soil is a complex and balanced biological medium adequate for those micro-organisms that assist in all the physical and chemical changes concerned in nutrition. To understand what is meant by structure requires some comprehension of the forces that have produced the complete picture or profile upon which the fundamental systems of classification have been based. The relationship between genetic classification and productivity ratings is not always precise, but soil science is young and practical applications have so far outstripped fundamental studies. Hence, although the successful renovation of worn-out grasslands and rehabilitation of sea-flooded areas, for example, are based upon well-established principles in soil chemistry and physics, the reasons for the build-up or break-down of the mineral–organic aggregates or stable crumbs of a fertile soil are still somewhat speculative, and it is here that wrong management, quite as much as mismanagement, has assisted the erosion forces of Nature and where conservation services—but not nearly enough of them—are striving to redress the balance.

The author constantly stresses the relative stability of the 'plant-made' soil in contrast to that of the 'man-made' soil. That the latter may become many times more productive in certain situations is the result of the system of agriculture established through trial and error and the sensible adoption of modern aids in the form of better machines, better varieties and the fertilizers to improve and maintain fertility.

The well-chosen plates illustrate clearly the points in the text dealing with soil formation, structure, microbiology and conservation, and there is a short bibliography. One might criticize an occasional looseness in the nomenclature relating to nutrients, and there is an obvious slip at the top of p. 60; but the book is all but free of printing errors and is very well produced.

A. M. SMITH

TISSUE CULTURE

The Cultivation of Animal and Plant Cells

By Philip R. White. Pp. xii+239. (New York: The Ronald Press Company, 1954.) 6 dollars.

THE foreword states that this book was written with three objects: to describe the major techniques of plant and animal tissue culture in sufficient detail to enable them to be used in research, to present a group of simple methods suitable for teaching purposes and to emphasize "the essential importance of the cell itself, as the basic physiological entity".

While it is probable that few people can master an intricate technique like tissue culture merely by studying a book on the subject, it is very valuable to have the methods of leading experts recorded for the benefit of other workers in the field.

The book begins on a philosophical note with a discussion of the relationship of the cell to the organism. This is followed by an account of the history of cell culture, and in this connexion an interesting chart is provided tracing the various lines along which tissue culture has developed. It is unfortunate that the name of T. S. P. Strangeways is omitted from this summary, since he was one of the pioneers of the method in Europe and wrote two of the earliest books on the subject. The author deals next with the many different types of plant and animal cells that can now be grown *in vitro* and then proceeds to describe the tissue culture laboratory, its equipment, and routine procedures such as washing glassware and sterilization; succeeding chapters are devoted to nutrients and the preparation of various types of cultures. As he tells us in his foreword, Dr. White has been animated by the laudable ambition "to strip from the study of this subject [cell culture] its former atmosphere of mystery and complication", and the procedures he advocates are not unduly elaborate.

The difficult and controversial questions of how to measure growth and how to interpret the quantitative results obtained are considered at some length, and it is wisely emphasized that the observer must "take into account not merely the numerical data but also many qualitative features of the results which cannot be set down in numerical form". The last chapter, which deals with the various ways in which tissue culture can be applied in different medical and biological fields, is perhaps the most stimulating. In the reviewer's experience, so much attention is sometimes paid to developing and polishing the method that this tends to become an end in itself; it is therefore important to stress the fact that tissue culture is merely a technique, and useful only in so far as it is applied to the solution of biological problems.

Finally, there is an appendix in which are described some fairly simple experiments for beginners; an attempt has been made "to choose examples which are as simple as possible, so that they will not be beyond the means of small schools". This section should be useful for those wishing to organize courses in experimental biology for senior students.

A minor defect of the book is the considerable number of verbal slips which are encountered; for example, 'serum' when 'plasma' is meant (p. 200). The work can be recommended, however, as a clear and interesting account of some valuable methods; the more solid matter is enlivened here and there by some delightful quotations from ancient authors, which serve as texts for some of the chapters.

HONOR B. FELL

BELOW 1° K.

Magnetic Cooling

By C. G. B. Garrett. (Harvard Monographs on Applied Science, No. 4.) Pp. xi+110. (Cambridge, Mass.: Harvard University Press; New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1954.) 36*s*. net.

JUST over twenty years have elapsed since the temperature region below 1° K. was opened by the adiabatic magnetization of paramagnetic salts. Except for the war years there has been a steady increase in the work in this field, and the stage has now been reached where magnetic cooling is becoming a standard technique in many cryogenic laboratories. Comparing the progress of the magnetic cooling method with the state of gas liquefaction two decades after Cailletet and Pictet, there exists a strong resemblance which is reflected in Dr. Garrett's book. Now, just as then, the physical properties of the cooling agent completely hold the stage. Dr. Garrett is as preoccupied with the susceptibility of paramagnetic salts as the low-temperature physicists of the nineties were with the equation of state. The result is that his book seems a little out of balance, which is particularly noticeable in a short monograph of only 105 pages length. Detailed discussion of the paramagnetic phenomena is, at the present stage of development of magnetic cooling, certainly justified, but this means that "other experiments" had to be dealt with in eighteen pages. Rather more serious is the summary way in which the whole of demagnetization technique is treated in only eight pages. The sealed capsule method, for example, is not mentioned here at all. Description of experiments admittedly lacks the glamour of the theoretical discourse, but a monograph in applied science could have afforded slightly more space for technicalities at a time when the magnetic cooling method is being taken up by more and more laboratories.

While one may criticize the choice of balance in the book, it should be emphasized that the material has been treated competently and with clarity. The chapter on technique is followed by one on thermodynamic relations and one on the magnetic temperature scale. The following three chapters deal with the theory of paramagnetism at low temperatures, with the results of specific heats and susceptibilities for a number of salts and finally with co-operative effects. This section with its extensive set of references to original work will be found most useful by those who work in the field of adiabatic demagnetization or who are entering on it. A closing chapter gives a short survey of the use to which paramagnetic cooling has been put, such as investigations on liquid helium and on superconductors. Multi-stage demagnetization and nuclear alignment also receive here a short mention.

Subject to its limitations, the book will be of interest to most low-temperature physicists and to students specializing in either cryogenics or magnetism. It is unfortunate that the price will put it out of the reach of many of the latter.

K. MENDELSSOHN

SCINTILLATION COUNTERS AND PHOSPHORS

Scintillation Counters

By Prof. J. B. Birks. (Pergamon Science Series: Electronics and Waves.) Pp. viii+148+4 plates. (London: Pergamon Press, Ltd., 1953.) 21*s*.

THE development of scintillation counters in the past seven years is one of the most rapid contemporary advances in the techniques of nuclear physics, and Prof. J. B. Birks's book gives a timely summary of this recent work and a picture of the present state of the art.

The subject of these instruments is dealt with, not only from the point of view of those who wish to use them as tools, but also of those who are interested in the properties of the phosphors themselves. The author follows a logical sequence beginning with a brief but adequate summary of the principles of scintillation counting; this is followed by a discussion of photomultiplier tubes and data on the commercially available types. Measurements of instrumental resolution are then considered, and the next three chapters are devoted to descriptions of the various types of phosphors. The final section is a survey of some applications of scintillation counters.

Prof. Birks's main interest has been the study of organic crystalline phosphors, and the section on these materials forms the longest single chapter in the book. This is a comprehensive account including results of recent work by the author, and his interpretation of these results in terms of the 'photon exchange' process which he has proposed as an alternative theory to the 'exciton migration' process as a mechanism of energy transfer in mixed crystals. One wonders whether a monograph, particularly with the present title, is the best place for the detailed presentation of such a theory, at least until there is general agreement on its tenets. As one concerned with the use of counters, the reviewer would have preferred to see a greater proportion of the space devoted to discussion of problems likely to arise in the applications of the instruments. For example, to anyone wishing to use the fast response of these counters to their best advantage, a fuller indication of the circuit problems met with in the millimicrosecond region would be a welcome addition. A description of experimental methods of crystal production would also be useful.

Prof. Birks has, however, written a very readable book and he has included a good bibliography which will be useful to the reader interested in further experimental details.

The publishers are to be congratulated upon the speed with which the book was produced, an essential requirement for a monograph in a rapidly developing subject: very few misprints occur, and the diagrams and type are pleasing.

A. R. CRATHORN

DISTRIBUTION OF MINOR ELEMENTS IN ROCKS

RESEARCH on the geochemistry of the rarer elements was given a real impetus in the 1930's by the investigations of the late V. M. Goldschmidt and his co-workers. Progress at that time was due, in the main, to the introduction and application of sensitive methods of instrumental analysis. Except for the period of the war years, interest and investigation on the geochemistry of the rare elements has continued to grow, and the recent discussion at Oxford arranged by Section C (Geology) of the British Association reflected in several respects the progress which has been made during the past few years. The programme of speakers and discussion was arranged so as to cover the distribution of minor elements in a broad way, starting with aspects of cosmochemistry and followed by consideration of minor element behaviour of igneous rock series, sedimentary rocks and finally metamorphic rocks. In his introductory remarks, the chairman, Prof. L. R. Wager (University of Oxford), pointed out that once geochemical patterns of minor element-behaviour were firmly established for known conditions—as, for example, in fractionated rock sequences—they could no doubt be used in solving more complex geological problems of rock genesis where processes are less clear.

Dr. L. H. Ahrens (University of Oxford) directed attention to the general qualitative similarity of composition of various materials composing the observable universe. He pointed out, however, that it is only the earth and the meteorites which can be sampled directly and are capable, therefore, of precise quantitative investigation: this opens up the possibility of testing exact quantitative equivalence of composition. Evidence of such equivalence would be of geochemical, geophysical, petrological and nuclear-physical significance. Tests could be carried out by examining pairs or larger groups of elements, provided they show a high degree of geochemical coherence: zirconium–hafnium; niobium–tantalum; some rare earths and potassium–rubidium were cited as possibilities. Adequate data are available only for the pair of alkali metals, and their association in the commonest rocks and meteorites were discussed in detail. Earlier investigations of Ahrens, Pinson and Kearns[1] indicated that the ratio potassium/rubidium remains uniform throughout the principal types of rock and is very similar or possibly equal to that in chondrites, the commonest meteorites. Their observations were restricted mainly to North American rocks, and evidence from other sources was therefore desirable. Some seventy new determinations, mainly on igneous rocks from South Africa, have since been made and all observations are represented in Fig. 1. The close association of potassium and rubidium in rocks and meteorites is evident, and calculation shows that the ratios of potassium to rubidium for rocks and chondrites are equal to within about 5 per cent. Dr. Ahrens pointed out that as neither element is a participant of either metal or sulphide phases, it can be concluded similarly that the ratio of potassium to rubidium for the earth is equal to that for meteorites ± 5 per cent. This is the first, and so far only, example of its kind and has been taken as evidence in support of a common origin for the earth and meteorites. This information does not, however, appear to be of use with regard to the problem of two possible origins of the meteorites—either from a shattered planet or from a collision of asteroids. It is desirable that similar research be carried out on other possible pairs or groups of elements. Sir Edward Bailey commented on the analogy between the ratio of potassium to rubidium and the ratios of various isotopes of different elements in the earth and meteorites which observation has shown to remain uniform. Prof. Wager and Dr. M. H. Hey commented on the fact that Dr. Ahrens's data apparently show that different parts of the earth may be characterized by slight but significant differences in their potassium–rubidium ratio and that this is perhaps the first and only reliable indication of any fundamental regional differences.

Dr. S. R. Nockolds (University of Cambridge) described some of the results of recent research at Cambridge. The principal objects of these investigations were to examine the behaviour of trace elements with respect to the major constituent elements in some well-described igneous rock series of calc-alkali, alkali and tholeiitic character: to determine how their behaviour varied from series to

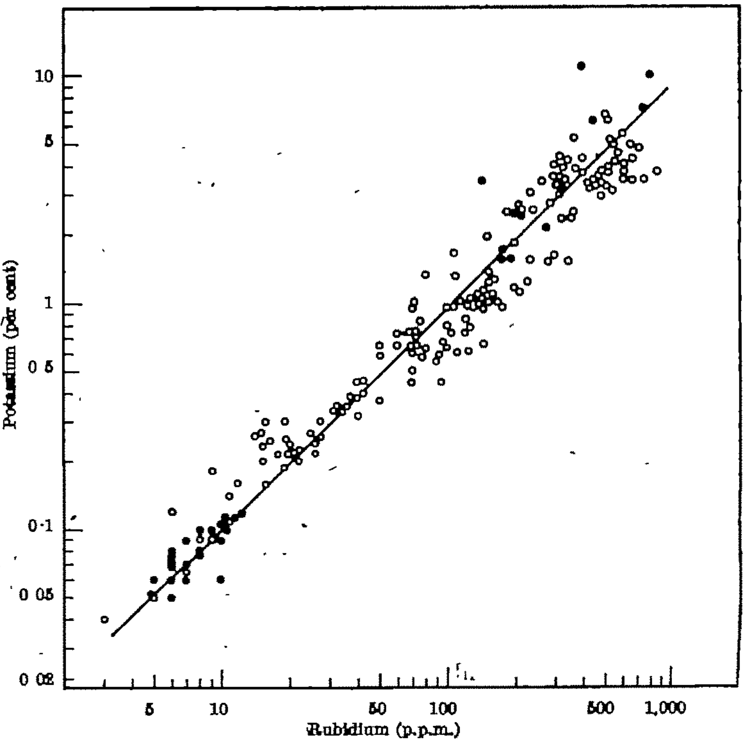

Fig. 1

series and from group to group and to see what light, if any, they might throw on the origin of the three main branches of igneous rock evolution. Particular attention was given to the calc–alkali and alkali groups, which were represented as follows: (calc–alkali) southern California batholith, the Scottish Caledonian and lavas of Lassen Peak, Crater Lake, Lesser Antilles, the Medicine Lake Highlands and Sierra Nevada; (alkali) Scottish Tertiary, Hawaiian alkali rocks, Polynesian alkali series, and the latite series of Sierra Nevada.

Discussion was confined to lithium, chromium, nickel, cobalt, iron and vanadium, some data on which have already been published[1,2]. For the purpose of demonstrating behaviour, the concentration of each element is related (as ordinate) to the function $[(\frac{1}{3}Si + K) - (Ca + Mg)]$, as suggested by Larsen. The characteristic behaviour of chromium and nickel—a regular and sometimes sharp decrease of concentration with increase in acidity, followed by some levelling—is clearly evident in nearly all examples of a series from each of the three groups. Iron and vanadium behave in much the same way in series of calc–alkali rocks; the concentrations of both decrease regularly with acidity. A similar behaviour is sometimes shown by iron in the alkali rocks, although the amount often remains fairly uniform over a considerable range of low $[(\frac{1}{3}Si + K) - (Ca + Mg)]$ values. Vanadium, on the other hand, invariably increases with increase in the magnitude of the function, passes through a maximum and then decreases regularly with increase in the magnitude of the function. As anticipated, lithium invariably increases with decrease of $[(\frac{1}{3}Si + K) - (Ca + Mg)]$ in all series from each group. Cobalt often follows magnesium, particularly in the calc–alkali rocks, and sometimes iron. Behaviour patterns in the calc–alkali series are often similar to rock series classed as belonging to the tholeiitic group. Dr. Nockolds finally directed attention to recent investigations on hybrid rocks, and it was shown that, unlike the igneous rocks of a series, variation of concentration is linear in respect to the function $[(\frac{1}{3}Si + K) - (Ca + Mg)]$. During discussion of a point raised by Dr. W. Campbell-Smith, Dr. Nockolds stated that the data on the rock series are evidence in support of crystal fractionation.

In a discussion on the distribution of elements in sedimentary rocks, Dr. J. R. Butler (Rothamsted Experimental Station) referred first to the transportation of elements to the oceans, either as ions (simple or complex), as constituents of or associated with colloids, or as constituents of detrital material. The ionic potential (the ratio of ionic charge to ionic radius) of Cartledge as used by Goldschmidt can be used as a starting-point for classifying elements according to their tendency to occur in aqueous solutions as cations or anions, or to be precipitated as hydrolysates. Lead, however, can be transported as a complex ion, and in a discussion which followed it was pointed out that several of the poorly shielded cations (as defined by Ahrens[4])—Au^+, Hg^{2+}, Cu^{2+} and Pt^{2+}, for example—are likely to be transported as stable complexes depending, of course, on *p*H, composition of the waters and other factors. In a reducing environment, such agencies as hydrogen sulphide may bring about precipitation of a sparingly soluble sulphide (Ag_2S or Cu_2S, for example) provided the solubility product can be exceeded and provided a complex can be broken; the complex AuS^- is particularly stable in this respect.

The significance of cation hydration was emphasized by considering the alkali metals. Degree of hydration is determined mainly by size. It was pointed out that available evidence for the pair Cs^+ and K^+ (radii 1·67 and 1·33 respectively) indicates that the ratio of cæsium to potassium is greater in shale than in igneous rocks; further fully quantitative investigations are, however, required to verify this. Dr. Butler suggested that a critical examination of the cæsium to potassium ratio might prove to be helpful in the problem of the origin of glauconite. The importance of illite as a constituent of argillaceous sediments was stressed. Unlike other clay minerals, illite can provide inter-sheet structure sites of potassium for camouflage of rubidium and cæsium.

Gallium, chromium, cobalt, copper, zinc, tin, lead, zirconium and the alkali earths were discussed in addition to the alkali metals. When contrasting the abundance of gallium in igneous rocks (15 p.p.m.) with the value of 50 p.p.m. for shale, Dr. Butler pointed out that although interesting conclusions can be derived on the basis of these figures, the latter come from different sources, and as different analytical procedures have been used they are not strictly comparable. The danger of comparing data from different sources was strongly endorsed by those participating in the discussion. Available data should be used with extreme caution and there is a great need for improving the quality of future determinations.

Prof. F. J. Turner (University of California) emphasized the fact that whereas considerable data are now available on igneous rocks in particular, and sedimentary rocks to a lesser extent, quantitative data on the metamorphic rocks are conspicuously lacking. This has led to much speculation on patterns of behaviour and their possible geological significance in the metamorphic terranes. Thus, for example, Sahama[5] has observed in a reconnaissance investigation that the boron concentration in serpentine is much higher than that in parent peridotite; this suggests the action of sea water as a cause for boron enrichment, as it contains appreciable boron. Prof. Turner concluded that provided large samples are examined, departure from ideal iso-chemical metamorphism is rarely profound in the case of the common elements. It was felt, however, that concentrations of the trace elements are more likely to show large variations. He referred to the earlier reconnaissance work of Sahama[5] and Shaw[6], which indicated iso-chemical metamorphism with respect to several of the minor elements. He then considered from a theoretical point of view the possible patterns of behaviour which may be found when data become available, and dealt briefly with the only two exhaustive investigations known to him, neither of which has yet been published. The first of these is an investigation by A. E. Engel and Celeste Engel (California Institute of Technology) on progressively metamorphosed rocks of the Grenville Series in the Adirondacks, which indicates trends different from the earlier work; for not only do elements such as strontium, lead, manganese and chromium appear to be added to some beds and removed from others, even when there is no indication of general metasomatism or magmatic influence, but also isotope composition varies. The second detailed work is that of Pitcher and Sinha (Imperial College of Science and Technology, London), who have analysed several series of bulk samples taken across a pelitic hornfels formation in a contact aureole in Donegal. In profiles of 1,500 ft. in length taken normal to the contact, the mean composition of all samples was found to remain the same. The formation had remained a closed system and there appeared to be no metasomatism; metamorphic differentiation had, however, occurred along each profile and compositional gradients had been set up.

A general impression left by the discussion on the distribution of minor elements was that most investigations nowadays involve far more analyses than heretofore; this is a healthy development. There is no doubt that a vast amount of fresh and exciting information remains to be unearthed, but real progress will only be achieved by combining quality with quantity.

[1] Ahrens, L. H., Pinson, W. H., and Kearns, M. M., *Geochim. Cosmochim. Acta*, **2**, 229 (1952).

[2] Nockolds, S. R., and Allen, R., *Geochim. Cosmochim. Acta*, **4**, 105 (1953).

[3] Nockolds, S. R., and Allen, R., *Geochim. Cosmochim. Acta*, **5**, 245 (1954).

[4] Ahrens L. H., *Nature* [**174**, 644 (1954)].

[5] Sahama, Th. G., *Bull. Comm. géol. Finlande*, **136**, 15 (1945).

[6] Shaw, D. M., *Geochim. Cosmochim. Acta*, **2**, 185 (1952).

ANIMAL POPULATIONS AND FORESTRY

AT the recent meeting in Oxford, Sections D (Zoology) and K* (Forestry) of the British Association held a combined symposium under the chairmanship of Prof. L. W. Grensted to discuss animal populations with reference to British forestry. Mr. G. H. Thompson, of the Department of Forestry, University of Oxford, opening the symposium with a general introduction, reviewed briefly some of the more important forms of injury caused by animals at different stages in the life of a forest. Insects, rabbits, squirrels, mice and voles often severely damage seed and young trees. In older forests the chief pests are insects, particularly those feeding on foliage. Conifers have a smaller capacity for regenerating lost foliage than broad-leaved trees, yet in Great Britain defoliating insects have so far killed comparatively few conifers. The British fauna includes species, such as the nun moth and pine noctuid, that are important pests of conifers on the Continent of Europe, but which in Britain have so far remained uncommon: the reason for their scarcity is unknown. The pine looper (*Bupalus piniarius* L.), although usually a common moth, first reached epidemic numbers in 1953 at Cannock Chase, completely defoliating 120 acres of Scots pine and severely attacking a much larger area. A similar attack in 1954 would almost certainly produce heavy tree mortality. Non-lethal degrees of defoliation presumably reduce growth increment, but no data exist.

Trees weakened by drought or defoliation, or unthrifty owing to unsuitable site conditions or old age, are susceptible to attack by insects such as wood-wasps and certain bark-beetles which cannot successfully oviposit in healthy vigorous trees. At Cannock Chase the defoliated pine are entered by a bark-beetle (*Myelophilus piniperda* L.), the tunnels of which in the cambium girdle and kill trees that might recover if protected from further loss of foliage. It is often hard to decide whether an insect species feeds exclusively on weakened trees, because of the difficulty of defining health.

Apart from safeguarding future vigour by choosing tree species suited to the sites to be planted, the forester may attempt to prevent or reduce animal injury by sylvicultural, biological or by chemical means. His choice of methods should be based on ecological knowledge, and in particular of those factors limiting population numbers. In fact, little is known of the population dynamics of even the more important forest pests. The science is new, and population studies are very time-consuming; the collection of data for even a dozen species of insect and three species of mammal is a formidable task. Climate, predators and parasites, and food supply are probably the chief factors influencing animal numbers. Past freedom from epidemics of coniferous defoliators may have been due to the absence of large blocks of forest of an appropriate age-class.

The application of insecticides may be justifiable to save a tree crop otherwise doomed; but, apart from the expense and impermanence of treatment, the biological implications are not fully understood, and the pest may ultimately benefit by destruction of its associated parasites and predators, or resistance to the insecticide may be developed. Forest practice should aim at keeping the injurious animal fauna below the level at which economic damage occurs by biological and sylvicultural methods; and to achieve this objective detailed knowledge is required of the factors affecting animal numbers.

Mr. F. A. Courtier, of the British Forestry Commission, described studies recently initiated to determine a satisfactory method of estimating grey squirrel populations in order that the efficacy of control measures may be assessed. A native of North America, the grey squirrel was first observed in Great Britain in 1828 and has since spread to almost every county. It is most injurious in forests, particularly to broad-leaved trees, girdling and killing stems at ground-level and also destroying leading shoots. Barking usually occurs in late spring or early summer when sap-flow is most active. There are two main breeding periods—December–January and May–June. The restricted breeding periods and relatively long time—ten weeks—spent by the young in the drey offer excellent opportunities for control.

Visual counts of adults have not given comparable results under varied woodland conditions. The relationship between the number of the breeding and the sheltering type of drey and the size of the squirrel population is being studied in mature oak woodland.

Courtier referred to estimates of population by the capture–recapture method being undertaken by Monica Shorten in an isolated wood that offers seasonal variation in food; this produces a more settled squirrel population. After intensive trapping, marking and release, the area is cleared of dreys and as many squirrels as possible are killed. Records of marked squirrels shot also provide information concerning their movements.

The squirrel population on a small area in Alice Holt forest is being studied for a period of years. Permanent trapping sites have been established. After pre-baiting for five days, trapping is conducted for four consecutive days; this procedure is repeated at intervals of six weeks. Trapped squirrels are marked and released after recording sex, weight, breeding condition, injuries and moult-stage. The squirrels show little fear of the traps and appear not to travel far, almost all recaptures being in the original traps. Twelve nesting-boxes have recently been erected to provide information on young squirrels and their ultimate dispersal.

Mr. H. N. Southern, of the Bureau of Animal Population, University of Oxford, dealt with fundamental population studies of two of the commonest deciduous woodland rodents, the wood mouse (*Apodemus sylvaticus* L.) and the bank vole (*Clethrionomys glareolus* Schreb.). These two species probably play an important part in preventing forest regeneration, but little is known about the control of their numbers. The first step in studying this problem is to know what numbers are present and how many are born and die every year. The best available method is live-trapping. A proportion of the population is caught, marked with numbered leg-rings and released. Later, another trap sample is taken to determine the proportion of marked to unmarked animals, and so the number present at the original marking can be calculated. An extension of this method from a series of trappings also gives information on the numbers coming into and leaving the population during each interval. The statistical problems involved in this kind of calculation have been recently discussed by Chitty and Leslie, and under optimum conditions estimates should be accurate to within 10 per cent. However, serious errors may be introduced by the marked animals entering the traps more readily than the unmarked ones. This complication is still being studied.

Preliminary results from continuous trappings on 250 acres of woodland between 1948 and 1952 suggest that the trappable population of both rodents varies between 5 and 25 per acre according to season. But there are other more interesting variations. During the first year both species reached a peak in autumn; in the second year wood mice failed to reach an autumn peak; in the third year both species failed to reach an autumn peak; in the final year both species were recovering from this decline in numbers. It is interesting to note that the tawny owls (*Strix aluco* L.) which were preying on these rodents, and whose population was also being studied, showed repercussions. In the first year they preyed mostly upon wood mice; in the second year they changed to bank voles when the wood mice declined; in the third year—when both prey species were at their lowest ebb—the owls practically failed to rear any young because of food shortage.

These preliminary results illustrate the labour which will be needed to obtain a true idea of the balance of interrelationships between members of an animal community. Only when these fundamental problems are thoroughly understood will it be possible to predict, and perhaps prevent, economic catastrophes instead of resorting to *ad hoc* measures to palliate damage already done.

Dr. Myles Crooke, of the Forestry Commission, described a survey conducted in Britain during the winter of 1953–54 into the status of the pine looper (*Bupalus piniarius*) in all the State pine forests considered to be susceptible to attack. The survey was a sequel to the pine looper epidemic at Cannock Chase in 1953. The moth has an annual life-cycle: adults are in flight from May until July and the larvæ feed until October or later before descending into the litter layer to pupate. The survey was extensive in design and was based on counts of number of pupæ found in quadrats one yard square. At low populations the insects are uniformly distributed and a sampling intensity of 0·005 per cent is considered satisfactory. This is achieved by assessing five quadrats in about one out of every ten compartments in a forest. The intensity of sampling is increased when populations are high. For example, at Cannock Chase every compartment of suitable age was sampled, using as many as fifty quadrats per compartment. Four population zones were discernible: (1) defoliation complete: more than 150 pupæ per sq. yd.; (2) defoliation severe: 80–150 pupæ per sq. yd; (3) defoliation not serious: 40–80 pupæ per sq. yd.; (4) no apparent defoliation: less than 40 pupæ per sq. yd.

On the Continent of Europe, where intensive sampling over a small area is employed, the endemic population-level is considered not to exceed 0·1 pupæ per square metre: a mean of six or more pupæ per square metre carries the threat of obvious defoliation the following summer. The British survey shows that many forests exhibit considerably higher pupal counts than this. It would seem that either a much higher endemic level can be maintained under British conditions, or that pine looper populations are on the increase and epidemics similar to that at Cannock may be expected elsewhere. No underlying cause, such as recent climatic change, is apparent to support the latter hypothesis.

The normal range of population fluctuations, capacity for increase and limiting factors of the pine looper require investigation. Meanwhile, the survey has proved of immediate value in indicating areas where control measures are necessary.

Prof. G. C. Varley, of the Hope Department of Entomology, University of Oxford, discussed long-term studies, started in 1949, of the winter moth and other species the larvæ of which defoliate oak trees. This research is currently supported by a grant from the Nature Conservancy. In order to assess the effects of climatic factors and of predators and parasites it is necessary to estimate the population densities of the species concerned as frequently as possible and to understand the life-cycles of the commoner parasites and predators. Some forest insects, like the winter moth, are particularly easy to study: they spend the early summer in the larval stage feeding upon the young leaves of oak, where they can be sampled. From these samples some idea of the effects of parasites and predators can be gained. They then spin to the ground on a silken thread and can be intercepted by traps covering a known area. A detailed investigation of this sample provides an estimate of the factors killing full-grown larvæ.

A census is made of the winter moth adults by trapping a sample as they ascend the trees in November or December. The results can be expressed in the form of a table showing the successive causes of mortality and their percentage. The largest percentage destruction takes place between the time of adult emergence and the appearance of the well-grown caterpillars. The percentage of survival of the eggs presumed to be laid on the trees has been found to vary considerably from tree to tree. On trees which open their buds early some 10 per cent of the expected number of caterpillars can be discovered; but on trees which flush late only 2 per cent of the expectation is found. This is partially due to the dispersal of caterpillars when they first enter oak buds. In windy weather they are blown considerable distances on threads of gossamer and can be trapped at a high level between the tree tops on sticky traps. The inability of the winter moth to establish itself in trees which open late suggests that it may be possible to choose strains of oak which may be genetically resistant to this form of damage.

Curiously enough, under those trees which open their buds early the heavy caterpillar population suffers proportionately greater destruction when it enters the pupal stage. This may be due to differential attack by predatory animals such as shrews or small rodents in the soil.

At first sight, parasites seem to be relatively unimportant: they kill some 30 per cent at most of the caterpillars of the winter moth. Similar investigations of other caterpillar species have shown approximately the same degree of parasitism. This might be interpreted as an indication that parasites have little effect on caterpillar numbers. However, since many parasites are specific, this explanation would appear to be incorrect. If a specific parasite of an uncommon host is to maintain its numbers it must be extremely efficient at searching for the favoured host. This suggests that the relatively high efficiency of specific parasites may be the basic factor which keeps their hosts to the status of uncommon species, whereas the winter moth and green tortrix, attacked as they are by far less efficient parasites, remain regular pests of great economic importance.

In discussion, Mr. M. V. Laurie, of the Forestry Commission, pointed out that the pine looper has avoided Corsican pine at Cannock Chase. Dr. E. W. Jones, of Oxford, remarked that wood pigeons and squirrels are sometimes the major destroyers of acorns. He also described preferential feeding by mice on acorns from three trees. Analysis showed that the acorns from the preferred tree had the highest sugar and lowest tannin content. Dr. K. R. S. Morris, of the Nature Conservancy, suggested that destruction of carnivores may be largely to blame for upsetting Nature's balance and emphasized that many animals serve a dual purpose: for example, mice distribute seed as well as destroy it.

The chairman, in summing up, said that the papers read had shown that it is the healthy balance in the body corporate which is the fundamental problem.

G. H. Thompson

FACTORS CONTROLLING BIOLOGICAL MULTIPLICATION

On September 24 and 25, the Institute of Biology, with the idea that different fields of investigation often gain from a joint discussion of their results and problems, arranged a symposium on "The Numbers of Man and Animals". The symposium was opened by Sir Alexander Carr-Saunders and he stressed the need for caution in applying the results in one field to the problems of another. There was much vigorous discussion between people of dissimilar training; it demonstrated that the warning had been unnecessary or that it had been heeded. Discussion was greatly helped by the circulation of the papers before the meeting. Most authors assumed, and the assumption seemed to be justified, that their papers had been read; they therefore introduced them with only a brief résumé of the main conclusions and then waited for the argument.

Economics and mathematics dominated the first session. Mr. A. T. Peacock discussed "Economic Theory and the Concept of an Optimum Population". He doubted whether we could predict accurately enough the consequences of changing the size of a population for it to be wise to take any active steps to promote such a change; he therefore thought the proposals to diminish Britain's population from 50 to 25 million were misguided. He also doubted the value of the concept of an optimum population, but not sufficiently emphatically to satisfy Mr. F. Le Gros Clark, who felt that people who are considering the effects of different sizes of market on production often overlook the fact that much of what is produced could be dispensed with without detriment, and perhaps even with advantage, to the community. Several speakers in the discussion pointed out that even if the concept had reality, the ideal size must depend on whether we are trying to arrange for comfort in peace or safety in war, and that many economic arguments are trimmed to suit the supposed requirements of strategy. The uncertainty of forecasts about human populations was the theme of Prof. E. Grebenik's paper; he said that forecasts are at least consistent in one thing—they all prove wrong. The main reason for this, he said, is the incursion of new factors such as sanitation and contraception, which affect numbers in opposite but not always equal ways. Contraception was the main theme of the discussion, and the readiness with which the governments and women of Japan and India accepted it was contrasted with the official obstruction of the Catholic hierarchy and the Communist Party. The attitude of the latter was epitomized by a quotation from the recent United Nations population congress in Rome: "The government of the U.S.S.R. does not believe in fitting population to resources but in fitting resources to population". The widely different attitude of people in different parts of the world was also shown by Prof. I. Schapera in a paper on the position in the Bechuanaland Protectorate which was presented but not discussed because of the absence of the author. The Kgatla hold that it is unjust and ridiculous that a woman should not have a child as often as is compatible with the welfare of any existing children, and the Protestant ethic, which is officially held by many of them, has undergone some consequent modification. Sir Charles Darwin looked on contraception as a palliative, and did not think that either it or the awareness of the danger would keep world population from pressing alarmingly on world resources.

Mr. J. G. Skellam's paper on "The Mathematical Approach to Population Dynamics" provoked a discussion on the relative merits of mathematics and observation, although the author had said that they work best when working hand-in-hand and that modern computing machinery can cope with problems approaching the complexity of actual experimental, even if not natural, conditions. He argued that many ecological experiments are foredoomed to failure by the predictable chance of random extinction because the colonies are so small. Mr. M. E. Solomon pointed out that the rigid mathematical formulation of a hypothesis has the merit that it forces attention on to the component parts of the hypothesis and so might reveal methods of testing not apparent from a verbal statement.

In the next session, Dr. D. Lack gave examples of the types of factor that control the density reached by different species of animal, and he showed that generalization from one species to another is hazardous. In wild populations, reproductive rate is mainly controlled by food shortage, predation, and disease. These factors interact and the position is still further complicated by the effect, on predation of one species, of variations in the numbers of an entirely different alternative food species. Dr. D. H. Chitty brought out a different aspect of the problem by describing striking physiological differences, which are apparently transmitted to the young, between voles maintained under different conditions of crowding and intraspecific strife. It has for long been apparent that neither food shortage nor disease gives an adequate explanation of the periodic 'crashes' in the numbers of wild voles. The new factor is that voles in stable and in rapidly expanding communities differ in rate of growth and in the weights of such organs as spleen, adrenal and testis; there is therefore no need for us to be surprised if their reproduction- and survival-rates are widely different too. Prof. T. Park described his extremely comprehensive experiments on interspecific competition using two similar species of flour beetle, *Tribolium confusum* and *T. castaneum*. From them it appeared that the successful species need not be the one that in isolation would have reached the greatest density, that the change which ultimately would lead to the extinction of one species probably took place early in the association, and that the permanent co-existence of two species which compete is improbable. One environment, flour, was used and six climates in which the temperature varied from 24° to 34° and the humidity from 30 to 70 per cent; these affected the species differently, so that sometimes one and sometimes the other prevailed.

Although Park had said, "Most probably, if causation were better understood for control cultures, the usual, and unusual, events seen in experimentals could be more accurately forecast", much of the discussion turned on the extent to which the concept of a random event, for example, the random extinction of a species, has any value. If events are random in a fully controlled environment, then, as one speaker put it, "the beetles were just being used to work out sums"; if not, the important feature is to ascertain the precise nature of the competition and the mechanism by which one species eliminates the other. Several speakers mentioned other species in which crowding affects physiology; for example, *Eurygaster* was quoted by Prof. J. B. Cragg as living on wheat for as long as its numbers are increasing but on other plants during the phase of decline.

In the third session, the symposium started with man before moving on to his domestic animals. Prof. A. L. Banks surveyed the history of disease control in Britain and other countries and, taking *festina lente* as his motto, urged the need for caution before upsetting the established customs of other countries by the immediate introduction of our public health measures. His plea that "No matter what new discoveries are made in the future, whether they include a 'cure-all' for disease, or a simple method of preventing conception, action on a large scale should be withheld until all the implications have been fully thought out", demands perhaps too much *lente* when we consider that the consequences of a single change in a laboratory colony of *Tribolium* have not yet been fully thought out. There was, however, general agreement with his strictures on the Olympian use of the word 'we'. The motives that lead people to decide that 'we' will do something for or to a less developed community have in the past been fear, altruism and economic needs. These motives are still with us; they vary in acceptability; but, whatever the motive, there is little chance of a successful and stable result unless local opinion understands the activity and co-operates in it.

From the chair, Prof. J. Z. Young urged speakers not to be apocalyptic, but to remember that at each stage of history thoughtful people had maintained that the world was in a very unpromising condition. Dr. F. Fraser Darling thought they had probably been right, and commended a Brahman who released trapped rats during a plague epidemic; but most contributors to the discussion had a more optimistic outlook. Mr. Le Gros Clark stressed that a community that has been freed from the most debilitating diseases, even if it does in consequence have occasional famines, will, for physical reasons, recover from them better than one that is still debilitated; and also, as Dr. C. Gordon put it, "because they are people who are aware of having been well". For each reason, in the fit of anger that is likely to succeed the famine, they are more likely to do something about the causes that led to it.

Dr. A. S. Parkes dealt vividly with the research that is being done on contraception, on the factors that affect the sex ratio in man and animals, and on the preservation of sperm by freezing. Present-day contraceptive methods are inefficient anachronisms, and he surveyed the various possible modes of approach, stressing the advantages of finding something that would, when eaten, inhibit spermagenesis or ovulation. He was, however, unconvinced that any of the plant extracts used by primitive peoples have a significant contraceptive effect. Work on the third problem may be of great short-term importance in solving the first, because the successful preservation of human sperm goes far to offset the irreversibility that has hitherto been the primary objection to vasectomy as a mode of contraception.

Dr. P. S. Henshaw, Sir Charles Darwin and Mr. E. M. Nicholson stressed the point that, whether a community wishes larger or smaller numbers, the wish cannot become effective until we know more about the processes of fertilization and implantation. They contrasted the importance of this work with the niggard support coming from public funds. In suitable circumstances, venery and fecundity are each commendable, but they are separate human activities and the breaking of their historically necessary association is long overdue.

Human communities with a high standard of living tend to have low birth-rates, whereas the opposite is true of domestic animals. The reasons for this apparent contradiction were considered by Dr. J. Hammond and others. No definite conclusion was reached in the discussion, but it appeared that the effect in animals is physiological whereas in man it is the consequence of associated social and cultural changes; where improved nutrition does not lead to these changes, it increases human fertility also.

In the final session, Fraser Darling presented a spirited analysis of the ravages man has wrought in most of the areas he has dominated, though he accepted pastoralism as less harmful than other activities so long as it is fully nomadic. In discussion he extended the area best suited to pastoralism to include 'wet deserts' such as Scotland, but did not carry the audience fully with him; several speakers thought that if a little intelligence were used it should be possible to restore fertility to land without letting it revert to scrub for intermittent twenty-year periods. Prof. L. S. Penrose made the basic assumption that an inhomogeneous population probably finds its variety useful, and described various ways in which what at first sign seem to be harmful traits can be of use in a community. He was unconvinced that civilized communities are deteriorating in the manner that eugenists commonly assume, and he argued that, even if there were this deterioration, there is no reason for thinking that it has a genetic rather than an environmental origin. Colourful phrases such as 'humanity is silently rotting at the core' and is being 'recruited from submen' seemed to him without foundation and no one in the audience saw fit to support them. The topical question was raised of the long-term genetical effects of the increase in radiation to which, as a result of industry and nuclear weapon testing, we are being exposed. Penrose thought that the increased mutation-rate that this would probably lead to, simply added one more imponderable to an already ample supply, and would make no positive predictions about its effect.

Lord Boyd Orr, summing up the symposium, said that he welcomed all the developments there might be in sanitation and preventive medicine, on one hand, and contraception on the other. To a large extent they cancel one another out, but he expected the world to hold perhaps 4G ($G = 10^9$) people by 1980 and 5 or 6G by the end of the century. This prospect, and the prospect that the existing ratios between the numbers of the different nationalities would be altered, left him unworried. With modern knowledge, food production could be increased by a larger factor than population is likely to increase by, and there could be enough for all. The difficulties that he foresaw were political rather than scientific. Physics appears to governments to be much more useful than biology both in war and for making money; it therefore gets the lion's share of research endowment. People had got on very well in the past without jet planes and hydrogen bombs, but they could not get on without food, and he looked forward to an era of agrarian abundance in which we no longer galloped through irreplaceable resources with our present abandon but farmed wisely and depended for our energy supplies primarily on the inexhaustible flow from the sun. He looked forward to a magnificent new world even though it is likely to be very different from the one we have known as children. But we would only get it if we got rid of fear and used our wits.

The humanism of Lord Boyd Orr's tone of exuberant confidence suited the mood of the symposium and it finished in an atmosphere of restrained optimism. It did not, however, go so far as to produce overt Swinburnian exaltation: "Glory to Man in the highest! for Man is the master of things".

N. W. Pirie

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

For the eighth year in succession the Chemical Research Laboratory, Teddington, was open to visitors from universities, industry and government departments during September 28–October 1. Exhibits by the High Polymers Group illustrated how systematic changes in the structure of the resin matrix and the number or nature of the functional groups can lead to resins of particular value in specific separations. Resins containing amphoteric groups were shown which act as insoluble sequestering agents with great selectivity for certain ions such as copper. Of special interest were the ion-selective membranes. These are of considerable importance in physical and biological science and are being used in osmometry and dialysis. Polyvinyl alcohol and methoxymethyl nylon films of graded permeability have considerably extended the scope and accuracy of osmotic pressure measurements; other membranes show promise for use in the dialysis of aqueous solutions.

The Radiochemical Group showed a wide range of chromatographic methods of analysis as applied to the inorganic field. A striking example was the simplified and rapid method for field use in geochemical prospecting. Applications of ion-exchange resins were demonstrated: in one, the quantitative separation of metals such as copper, cobalt and nickel adsorbed on an acidic ion-exchanger was effected by an organic solvent; in another, gold and other metals (such as zinc, nickel, copper, iron, silver and cobalt) adsorbed on a strong base exchanger could be eluted separately by use of suitable organic solvents. Other separations involved the use of ion-exchange membranes.

A novel apparatus for continuous extraction of a metal salt solution by organic liquids consisted of a rotating cylinder mounted concentrically inside a stationary outer vessel; the liquids passed counter-current in the annular space between the cylinders. The measurement of carbon-14 based on the use of acetylene in a scintillation counter was demonstrated, the acetylene being prepared from carbon dioxide by reaction with lithium and conversion to carbide. The method is particularly useful for very low activities.

In the Inorganic Group, an exhibit demonstrating the occurrence of selenium in wastes from the flash-roasting of pyrites typified the interest taken by the Laboratory in waste materials as sources of valuable products. Wastes from pyrites plants arise in the final purification of the sulphur dioxide by acid wash or water sprays; samples were shown containing from 20 to 60 per cent of selenium. Methods of recovering the element are being studied and various products were on view, as well as excellent specimens of the various allotropic modifications of selenium. Work has been commenced on the separation of rare earths by ion-exchangers, and promising separations of the cerium group of elements have been made using ethylenediamine tetra-acetic acid as the eluting agent. Techniques for the preparation of pure rare-earth metals are being studied, and samples of cerium and lanthanum by reduction of the fluorides with lithium were shown. The fine collection of metals of high-degree purity held by the Laboratory on behalf of the Pure Metals Committee of the Department of Scientific and Industrial Research was again on view.

The current programme of the Organic Group was illustrated by collections of new intermediates and pure chemicals of potential usefulness. A recently introduced technique, that of zone melting, was shown in its application to the purification of organic compounds. The convenience of this method lies in the ease with which the cycle of operations can be repeated automatically. The purification effected was strikingly demonstrated by the removal of a coloured material, induline, from naphthalene.

Other interesting apparatus included that used for pressing clear disks from mixtures of pure potassium chloride and various solid organic materials for examination by infra-red absorption spectroscopy; a cryoscope for measurements of the vapour pressure of acetylene; and a micro-analytical train in which isotopically labelled carbon dioxide was collected for isotope abundance measurement. Progress in preparative and synthetic work was shown under the following headings: an exploration of possible uses of 4-hydroxy-*iso*phthalic acid and its derivatives; reactions of epoxides with phosgene; isomerization of ethyl*cyclo*pentane; new methods of labelling aromatic compounds; and new ion-exchange resins.

The National Collection of Industrial Bacteria presented a colourful exhibit in which various pigment-producing bacteria were used to produce paintings and the printing of words on agar plates. The more prosaic work of the Collection was illustrated by demonstrations of the techniques employed in identifying, classifying and preserving bacteria.

An apparatus of interest to fermentation technologists was that used for the continuous anaerobic culture of sulphate-reducing bacteria, in which hydrogen is the reducing agent and carbon dioxide the main carbon source. The apparatus, which was developed at the Microbiological Research Department, Porton, for aerobic organisms, can be adapted for the culture of most micro-organisms; the continuous technique is claimed to be more efficient than batch fermentation. A process for the production of sulphide from sulphated sewage sludge was demonstrated. At present the sulphide is produced at the expense of the valuable methane formed during the normal digestion of sludge; attempts are being made to enable the two processes to proceed simultaneously. Chromatographic techniques have been applied to follow the carbon metabolism in sulphate-reducing bacteria, and a new type of cytochrome has been detected in these organisms. This is the first time that a cytochrome has been observed in an anaerobic organism.

The field covered by the Corrosion Group was strikingly demonstrated by a wide variety of exhibits. Of particular interest was a collection of characteristic examples of damage by corrosion in industry and in the home. The common danger of using unsuitable combination of metals in constructions was illustrated by galvanic cells in which various pairs of metals were immersed in salt solution. Specimen tubes and histograms of corrosion data showing the influence of various treatments of tubes and boiler water illustrated the study of the corrosion of mild steel tubes in Scotch marine boilers undertaken on behalf of the British Shipbuilding Research Association. New studies of the oxidation of special steels in flue-gas atmospheres have been commenced in collaboration with the British Electrical and Allied Industries Research Association and the British Iron and Steel Research Association; a new apparatus designed for this work was on view.

Ancient buried iron objects in a good state of preservation illustrated the inhibitive effect of tannins in the soil on the activities of sulphate-reducing bacteria. Field trials of tannins as a means of combating underground corrosion are in progress. Recent work on the prevention of tarnishing of copper and silver has led to the use of paper wraps impregnated with certain compounds, for example, copper chromate. The method is based on the removal of traces of hydrogen sulphide from the air. Other exhibits included the rapid attack of steel by aqueous suspensions of sulphur; the use of *cyclo*hexylamine carbonate as a vapour-phase inhibitor; applications of sodium benzoate and sodium nitrite in cooling systems; and examples of filiform corrosion. A new and comprehensive classification scheme for corrosion topics was on view.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine: Profs. J. F. Enders, F. C. Robbins and T. H. Weller

The Nobel Prize for Physiology and Medicine for 1954 has been awarded jointly to Prof. John F. Enders, of Boston, Prof. Frederick C. Robbins, of Cleveland, and Prof. Thomas H. Weller, of Boston, for their work on poliomyelitis. This team of workers had been studying the growth of certain human viral infections in tissue culture. Early in 1949, they announced that the Lansing strain of poliomyelitis virus caused cytopathogenic changes in cultures of various human embryonic tissues and that this action could be neutralized by specific antibody. Afterwards, their isolation of the three known serological types of poliomyelitis virus in tissue cultures by direct inoculation with fæcal material from human subjects, along with the demonstration of direct typing of the virus strain with specific antisera, has opened up a new field in the laboratory diagnosis of the disease and is providing also a valuable technique for epidemiological studies. The utilization of tissue-culture methods for the possible production of safe poliomyelitis vaccines is another immediate result of immense practical importance and is now being actively pursued.

An additional contribution of all this work is that it has brought poliomyelitis research within the reach of investigators previously debarred by lack of elaborate experimental facilities. Of special importance, however, to virus research is the unequivocal demonstration that an apparently strictly neurotropic virus can multiply *in vitro* in cells which are not ordinarily susceptible to it *in vivo*, and the conditions and mode of growth in such a system have applications for other problems. Within the past year, Prof. Weller has described the cultivation of chicken pox and herpes zoster viruses, and Prof. Enders that of measles virus in tissue culture. The stimulus of all these discoveries is activating research not only in virology but also in microbiology generally.

Presidency of the Royal Aeronautical Society: Mr. N. E. Rowe, C.B.E.

Mr. N. E. Rowe, technical director of Blackburn and General Aircraft, Ltd., Brough, East Yorks, has been selected as president-elect of the Royal Aeronautical Society and will take office at the annual general meeting of the Society to be held on May 5, 1955. After his apprenticeship in marine engineering at Devonport Dockyard and service in the First World War, Mr. Rowe went to the Imperial College of Science and Technology, London, holding a Royal scholarship and Whitworth exhibition, and gained a diploma of the College in 1924 for postgraduate work in hydro-electric engineering. During 1924–46 he was employed by the Air Ministry and the Ministry of Aircraft Production, becoming director of technical development in 1941 and director-general of technical development four years later. From 1946 until the end of 1951, when he took up his present post, Mr. Rowe was controller of research and special developments for British European Airways. He was elected a Fellow of the Royal Aeronautical Society in 1942, and has been a member of council since that year; he is also a member of council of the Helicopter Association. In 1944 he was made C.B.E. for his work in the Ministry of Aircraft Production.

Chemical Engineering in Great Britain

In his presidential address on April 30 to the Institution of Chemical Engineers at the thirty-second annual meeting, Mr. Stanley Robson spoke mainly on the progress of the Institution and the steps it is taking to assist industry by the provision of highly qualified chemical engineers. The full address, which has only recently been made available, includes many interesting figures, among which may be specially mentioned the increase in production of the chemical industry by 29 per cent from 1948 to 1952. In the same period the number of operatives scarcely changed, indicating the greatly improved efficiency per man employed. This is no doubt largely due to the increase of 20 per cent in the number of qualified scientific workers in the industry. Membership of the Institution simultaneously increased by the satisfactory figure of 30 per cent, while training facilities, in which it is keenly interested, are now available in more than twenty colleges as opposed to four in 1934. Comparative tables showing the relative numbers of chemical engineers employed by different industries in Great Britain and in the United States, and also the numbers engaged in various occupations such as plant operation, show, generally speaking, remarkable agreement, the main differences being that 20 per cent held administrative posts in Britain, as opposed to 10 per cent in the United States, and 22 per cent undertook research and development, as against 31 per cent. It follows that statements which have been made that chemical engineers in the two countries have different functions, and that consequently their training should be on different lines, have little to support them. A more important problem is the securing of adequate supplies of men to train, and the Institution, by issuing the publication "Careers in Chemical Engineering", for which there has been a widespread demand, has made a very valuable contribution to this side of the question. As Mr. Robson pointed out, in spite of this and the many other activities of the Institution for encouraging the development of chemical engineering and keeping its members in touch with recent progress, there is no room for complacency. The present trend in the chemical industry is to build much larger and more complicated units of plant; this can only be done after extensive and costly research and by making use of chemical engineers of the first grade, with scientific training of the highest order.

Bulletin of Endemic Diseases

Important developments in preventive medicine in Iraq have prompted the publication, by the Institute of Endemic Diseases, Baghdad, of a new journal, the *Bulletin of Endemic Diseases*, the first issue of which is dated July 1954 (6*s*. per issue; 20*s*. for four issues). The *Bulletin* will be issued approximately every six months and its articles will be in English. Issued with the authority of the Ministry of Health and the Government of Iraq, this new journal is tastefully produced and well printed in Baghdad. Its objects are to publish original papers on the epidemiology of parasitic and insect-borne diseases, especially those relating to Iraq. This first issue contains a detailed summary, by Dr. Gordon Pringle, of the Institute of Endemic Diseases, Baghdad, of existing knowledge of malaria in Iraq before 1946 and of its control; an article, by the same author, on the identification of adult anopheline mosquitoes of Iraq and neighbouring territories; a preliminary study, by Hannah Zakaria, of the Biology Department, Royal College of Medicine, Baghdad, of the bionomics of snails belonging to the genus *Bulinus* in a locality near Baghdad, the inhabitants of which are heavily infected with schistosomiasis; a preliminary report, by Younis Bashir, of the Pathological Laboratory, Royal Hospital, Mosul, on the occurrence of infantile kala-azar in northern Iraq, with an editorial comment on other cases observed in the region of Baghdad and central Iraq and on the survey of sand-flies (Phlebotominae) of infected localities that has been begun; and an account, by Haikal Riyadh and Mohammed Azzawi, of the Institute of Endemic Diseases, Baghdad, of a comparison of the efficiency of two types of sprayer used for malaria control with DDT. Everyone interested in the progress of knowledge of tropical medicine will welcome this addition to the literature of this subject and will wish every success to its editorial board and to the workers whose results will appear in this new *Bulletin*. The Institute of Endemic Diseases is establishing a library, and its secretary appeals for exchanges of journals on tropical medicine and hygiene, medical zoology and parasitology, microbiology, hydrobiology and related sciences.

Histochemische Methoden

A useful new publication entitled *Histochemische Methoden* has appeared under the editorship of Dr. Walter Lipp, of Graz, Austria. It consists of concise working directions for carrying out the selective staining of tissues for the detection and location of specific inorganic and organic substances, chemical groupings and enzymes. General histochemical procedures such as preparation of tissues will also be covered. A short bibliography is provided with each method. The three issues which so far have appeared have included among other topics the detection of potassium, arginine, carbohydrates (polysaccharides), sulphydryl and disulphide groups, and esterases. The publisher is R. Oldenbourg, of Munich, and the price is 30 DM. a year (six parts) or 6 DM. for separate parts.

Forest Products Research: Report for 1953

The report for 1953 of the Forest Products Research Board, together with the report of the Director of Forest Products Research (pp. vi+62+8 plates. London: H.M. Stationery Office, 1954. 3*s*. net), opens with the statement that the major work of the year has continued to be the evaluation of new tropical species of likely importance, while there has been an increasing amount of testing and assessment of sample consignments of home-grown species from the plantations of the Forestry Commission. The former work is undertaken with the object of finding new timbers from the tropical forest likely to be of importance to manufacturers and timber users. This latter research is of first-class importance to the tropical sylviculturist, for such knowledge will assist him in the future management of tropical crops in which formerly only one or two species had any marketable timber value. Kiln-drying experiments are still being undertaken, especially in connexion with the hardwoods, where favourable results are being obtained. Satisfactory factors are coming to light in connexion with wood bonding and the weathering of plywood investigations. In this latter, weathering tests have been carried out both in Britain and in Nigeria over the past three years. The principal object of the tests was to assess the durability of the glues used in the manufacture of plywood. In the entomology branch, studies of the common furniture beetle and the house longicorn beetle, the latter a serious pest on the Continent of Europe but in Great Britain chiefly confined to Surrey, have been given priority because of their importance.

Similarity of Algal Proteins

The gross chemical composition of many algae has now been recorded. In a recent paper, W. Fowden (*Ann. Bot.*, N.S., 18, 71, 258; 1954) describes how he has isolated representative protein fractions from species from four different systematic classes, namely, *Chlorella*, *Anabaena*, *Navicula* and *Tribonema*, and made quantitative determinations of their amino-acid compositions. This important investigation has shown that there is a close similarity in the proteins of the four species selected for study, and hence the tentative conclusion is reached that the protein complements of all algae are similar. It will be recalled that the contemporary accepted classification of the algae is based on the composition of their pigments and storage materials. The author points out that his analytical methods only provide an average amino-acid composition of the bulk protein of each species and can give no information regarding the nature and reaction of the individual proteins which may be present. He has also indicated that there is a general similarity between the bulk proteins of algae and those of the leaves and tubers of some flowering plants and of *Nitrosomonas*; but, as with the algae, these materials probably contain different individual proteins, these determining the characteristic metabolism of the species.

Root Culture and Biochemical Genetics

The technique of excised root culture affords a means of investigating the hormonal control of plant growth and seems likely also to prove of value in biochemical–genetical studies of the tissues of higher plants. W. G. Boll (*New Phytol.*, 53, 2, 177; 1954) has discussed the problems involved in the application of the technique of root culture to comparisons between strains and hybrids of the tomato. The growth of six clones of excised roots, each derived from a different seed of one inbred plant of an inbred line of tomato, was studied through a series of passages. Both quantitative and qualitative differences were found between the clones. The implications of the results are discussed. Using a seven-day passage and a modified White's medium it was found that root apices, of the strains and hybrids of tomato used, only occasionally survived on subculture into a second passage. Experiments designed to overcome this difficulty are described. Reduction of the passage length, or control of pH drift, increased the expectation of life of the apices on subculture; but conditions permitting continuous subculture of the radical apex were not realized. The implications of these results, and of the effects of the different media on the growth of excised tomato roots, are discussed.

University of Birmingham

Dr. C. A. Rogers, formerly reader in the Department of Pure Mathematics, University College, London, has been appointed to the Mason chair of pure mathematics in the University of Birmingham. The following appointments have been announced by the University: Dr. J. D. Lawson, lecturer in geology; Dr. J. N. Pratt, lecturer in physical metallurgy; M. G. Cockcroft, lecturer in industrial metallurgy; F. Benson, lecturer in engineering production; Dr. A. Kelly, Imperial Chemical Industries, Ltd., Fellow in industrial metallurgy. Dr. S. R. Carter, lecturer in chemistry in the University, has recently retired. The following have resigned their posts: Dr. C. S. Ball, lecturer in industrial metallurgy; Dr. J. H. Cort, lecturer in physiology; Mrs. B. Eckstein, lecturer in geography; H. Grisbrook, lecturer in engineering production; Dr. H. Nuttall, lecturer in mechanical engineering; E. C. Park, research Fellow in physics; Dr. C. A. Ramm, lecturer in physics; G. K. Williamson, Imperial Chemical Industries, Ltd., research Fellow in physics; J. Y. Freeman, Department of Scientific and Industrial Research research assistant in physics; R. F. Coe, Department of Scientific and Industrial Research research Fellow in physics.

Bishop Museum, Honolulu, Hawaii

The annual report of the Bishop Museum for 1953 recalls that the Bernice P. Bishop Museum was founded in 1889 with a sphere of interest described as "Polynesian and kindred antiquities, ethnography and natural history". The Museum made its reputation through its sponsorship of field research in the natural history and anthropology of the Pacific area and through publication of the results of such research. But those concerned with the Museum realized that their educational role lay in the diffusion of knowledge. Although the Bishop Museum had maintained exhibition halls, it had no policy in this direction, and one of the present major objectives is to transform the Museum into an effective instrument of education through informative and dramatic display techniques in the galleries.

University of Sheffield

The following appointments have been made in the University of Sheffield: Dr. A. Roberts, senior lecturer in the Postgraduate School of Mining; P. B. N. Neal and D. M. Woo, lecturers in mechanical engineering; and P. H. Mann, lecturer in social studies. The following have resigned their posts in the University: Dr. H. E. Harding, reader in pathology, on appointment as director of pathology to the Salisbury Area Pathological Service; Dr. R. Shepherd, senior lecturer in the Postgraduate School of Mining, on appointment as a senior scientist with the National Coal Board; Dr. C. E. Davies, senior lecturer in medicine, on appointment as consultant physician to the United Sheffield Hospitals; B. R. Dudley, lecturer in applied mathematics; Miss C. M. Hamill, lecturer in pure mathematics; and F. G. West-Oram, lecturer in glass technology. Mr. P. Irwin Packington has given a cabin cruiser to the Department of Zoology for use in both coastal and inland waters.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. Bowden (entomologist, Gold Coast), senior specialist, Department of Agriculture, Gold Coast; T. W. Brandon (government chemist, Public Works Department, Gold Coast), specialist, water examination, Public Works Department, Gold Coast; N. O. Walsh (senior scientific officer, Jamaica), deputy government chemist, Jamaica; H. M. Maugham-Brown (assistant conservator of forests, Tanganyika), conservator of forests, Tanganyika; T. P. Lecky (senior livestock officer, Jamaica), chief livestock officer, Jamaica; C. S. Ramage (scientific officer, Royal Observatory, Hong Kong), assistant director, Royal Observatory, Hong Kong; R. H. Bennison and B. F. Hanger, agricultural officers, Kenya; B. Buckler, agricultural officer, Zanzibar; D. L. Curtis, plant breeder, Nigeria; J. W. Deering, agricultural officer, Fiji; G. Dowson, agricultural officer, Sarawak; M. J. Furber and A. B. Hearn, agricultural officers, Nyasaland; R. C. Knill, agricultural officer, Sierra Leone; W. P. Mowat, plant pathologist, Tanganyika; A. J. Pritchard, botanist, Uganda; J. J. Rae, agricultural officer, Nigeria; E. M. Laing, field geologist, Sierra Leone; G. P. Jones, geologist, Nigeria; A. R. Newton, geologist, Northern Rhodesia; W. J. Phillips, geologist, Uganda; R. D. Brown, veterinary research officer (virologist), East Africa High Commission; T. E. Fletcher, scientific officer (chemist), East African Malaria Unit; M. C. Williams, medical research officer, grade 3, East Africa High Commission; J. Williamson, research parasitologist, West African Institute for Trypanosomiasis Research, Nigeria; J. R. Lang-Brown, assistant conservator of forests, Uganda; M. J. Davies, assistant conservator of forests, Nigeria; S. R. M. Harvey, geologist, Fiji; Miss E. M. Holden, biochemist, West African Cacao Research Institute, Gold Coast; J. E. McKerlie, assistant conservator of forests, Tanganyika; E. B. May, agronomist, West African Institute for Oil Palm Research, Nigeria; J. C. Parkinson, assistant conservator of forests, Fiji.

The Night Sky in November

FULL moon occurs on Nov. 10d. 14h. 29m., U.T., and new moon on Nov. 25d. 12h. 30m. The following conjunctions with the moon take place: Nov. 3d. 19h., Mars 5° S.; Nov. 15d. 14h., Jupiter 2° N.; Nov. 24d. 03h., Saturn 6° N.; Nov. 24d. 03h., Mercury 6° N.; Nov. 24d. 07h., Venus 2° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on Nov. 24d. 01h., Mercury 0·4° S., and also in conjunction with Venus on Nov. 25d. 05h., Mercury 3° N.; and Venus is in conjunction with Saturn on Nov. 29d. 00h., Venus 2·5° S. Mercury is a morning star and rises nearly two hours before the sun on November 15, when it is visible, but throughout most of the month it is too close to the sun for observation. Venus is unfavourably placed for observation during most of the month and is in inferior conjunction on November 15. At the end of the month it rises about two hours before the sun and can be seen in the eastern sky, stellar magnitude −4. Mars, an evening star, sets at about 22h. 10m. during the month. Its stellar magnitude varies between 0·1 and 0·5, the decrease in brightness being due to its increasing distance from the earth—from 91 to 111 million miles. It moves from Capricornus into Aquarius, and on November 10 it lies almost south of and close to θ Capricorni. Jupiter rises at 21h. 35m., 20h. 45m. and 19h. 40m. on November 1, 15 and 30, respectively; owing to its decrease in distance from the earth by about 38 million miles, its stellar magnitude changes from −1·8 to −2 during the month. Saturn, in conjunction with the sun on November 5, is unobservable in the early part of the month; on November 15 it rises less than an hour before the sun but by the end of the month it rises at 5h. 30m., more than two hours before sunrise, and can be seen a little north-east of α Librae. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Nov. 5d. 23h. 55·7m., χ Aquar. (*D*); Nov. 6d. 22h. 27·7m., χ Pisc. (*D*); Nov. 12d. 23h. 38·6m., 121 Taur. (*R*); Nov. 14d. 05h. 52·3m., *d* Gemi. (*R*); Nov. 20d. 03h. 45·9m., 13*B* Virg. (*R*). (*D*) and (*R*) refer to disappearance and reappearance, respectively. The Andromedid meteors, associated with Biela's Comet, attain their maximum about November 28.

Announcements

DR. D. A. ALLAN, director of the Royal Scottish Museum, Edinburgh, has been elected president of the Royal Scottish Geographical Society.

THE title of reader in computational methods in the University of London has been conferred on Dr. A. D. Booth, in respect of his post at Birkbeck College.

As part of the United States conditional aid programme, the Ministry of Agriculture of Northern Ireland has awarded three postgraduate scholarships, each £600 a year, for a period up to two years, as follows: two scholarships in agricultural economics (farm management) to G. L. Morrison (University of Reading) and W. Thompson (University of Leeds); one scholarship in agricultural statistics to A. A. Rutherford (University of Aberdeen).

THE Fulmer Research Institute, Stoke Poges, Bucks, is arranging an open day, which will be held on November 2.

THE work of the London Group Laboratories of the British Iron and Steel Research Association will be open for inspection at 140 Battersea Park Road, London, S.W.11, on November 18 and 19.

IN conjunction with the annual congress of the British Institute of Radiology, an exhibition of X-ray apparatus will be held at the Royal Horticultural Hall, Vincent Square, Westminster, London, S.W.1, during November 23–26 (Nov. 23, 2 p.m.–6 p.m.; Nov. 24 and 26, 9 a.m.–6 p.m.; Nov. 25, 9 a.m.–8 p.m.). Admission tickets, which are free, can be obtained from the British Institute of Radiology, 32 Welbeck Street, London, W.1.

THE Northern Branch of Aslib will hold a one-day conference on November 19 in the North of England Mining and Mechanical Institute, Neville Hall, Newcastle upon Tyne, with Mr. R. W. Mann, managing director of Victor Products, Ltd., Wallsend upon Tyne, in the chair. Four papers will be read dealing respectively with the activities of Aslib; public technical library service for industry; microfilming; and new ideas and the small firm. The conference will be open to non-members on completion of a registration form (to be returned by November 12) which is obtainable from the honorary organizing secretary, Mr. E. Westerby, 11 Duchess Street, Whitley Bay, Northumberland.

THE MURDOCH BICENTENARY

THIS year marks the bicentenary of the birth of William Murdoch (1754–1839), the originator of gas lighting. For that great achievement alone he would stand out as a great figure in the history of progress, yet it was only one of his many inventions. The story of his life should serve as an incentive and example to every scientific worker. Possibly forgotten is the incident of the wooden hat which brought about his association with Matthew Boulton and James Watt, and his opportunity for achievement. After having walked all the way from his home in Ayrshire to the now famous Soho Works in Birmingham, he might have been turned away by Boulton had not Murdoch dropped his wooden hat at the prospective employer's rebuff. Boulton noticed, however, the unusual character of his head-gear, questioned him about it, and learnt that he was the inventor of the oval lathe with which he had made it. That was the beginning of the famous triple partnership.

As a boy, Murdoch had made himself 'a wooden horse' for his journeys to school, a distance of 2½ miles; it was the forerunner of the tricycle and the bicycle, which only became a practical reality many years later. This experience ultimately led him to construct a model non-condensing locomotive steam-engine, now in the Birmingham Art Gallery; but his attempts to patent it were, strangely enough, opposed by Watt. An entrancing story of these early beginnings and his many other remarkable inventions has been recently published in *West's Gas*, the house journal of West's Social Society, from the pen of his great-grand-niece, Margaret L. Murdoch. Attractive, too, is the 1954 Murdoch Memorial Lecture of the Institution of Gas Engineers, under the distinguished authorship of no less a person than the chairman of Imperial Chemical Industries, Ltd., Dr. Alexander Fleck. Therein has been paid a fitting tribute to Murdoch's memory in a very informative account of the origins and development of gas for industrial purposes, viewed from the angle of an organization which has, above all others, so successfully applied the service of gas to the chemical industry. It is, in Dr. Fleck's words, a record "of the development of a great concert of industrial processes—today as powerful and as full of promise as ever before to make available the things we value in our way of living".

In effect, gas becomes increasingly a great source of chemicals. The vast output of ammonia and nitric acid for chemical manufacture and explosives are the products of a synthesis which begins with the gasification of coke, and the production of hydrogen and carbon monoxide, as water gas. The same process is the starting point of that remarkable synthesis of hydrocarbons and the complex series of by-products associated with the Fischer–Tropsch process, so actively applied to the German economy in the Second World War. From the same origins, with benzene, is produced nylon. From the hydrogenolysis of natural oils and fats arise higher alcohols, solvents and plasticizers, to mention but a limited range of many wonders.

To turn to the wider needs of the fuel industries, there must ultimately come an urgent and crying demand for the greater application of total gasification in the gas and heavy industries, for the supplies of good coking coals are showing signs of exhaustion, and processes must be devised to utilize weakly and non-caking coals. The 'smog' problem also points out the same objective. With the provision of cheap gas for industry, the efficiency and adaptability of many types of heating and processing plant become greatly advanced. A process for the cheap production of oxygen would expedite all the prospective developments in this field. That the gasification of oil may also serve as a useful adjunct to the processes based on coal may be envisaged with a measure of certainty. In the pursuit of these objectives, reference to the example of Murdoch's career may be timely—to the example of his energy and persistence in an age when technical skills were weak and groping, under rebuffs and disappointments such as the opposition of no less a person than Watt. But for this opposition, Murdoch's locomotive would have been an accomplished fact nearly half a century before Stephenson's, and a quarter of a century before Trevethick's. Indeed, as a boy, Trevethick had been a frequent visitor to Murdoch's home at Redruth, and must have seen him at work on his engine. It is said that Trevethick purchased the model from the disappointed inventor. Murdoch has been called "the incomparable mechanic"; further, we must recognize what an amazing achievement has emerged from disappointment and effort.

R. J. SARJANT

THE HEALTH OF CHILDREN

A NEW exhibition at the Wellcome Historical Medical Museum, at 28 Portman Square, London, W.1, deals with "The Child Through the Ages" and illustrates by means of skilfully selected objects, books and prints the methods which have been used to feed, clothe and transport the young child from early times. It also shows the development of the idea that disease in the child is often so different from that in the adult as to warrant the creation of the specialty later termed 'pædiatrics'. This exhibition covers the whole field from the earliest times to the beginning of the present century. It contains many objects of great beauty, and is worthy of the traditions of the Wellcome Museum.

It is well known that the Museum possesses a very fine collection of effigies of ancient Egyptian gods, and a few of these are shown in this exhibition. In the classical period of Greece and Rome the emphasis is rather on the portrayal of the mother with her child. Third-dimensional art had become fully representational, and the artists found in this theme a congenial subject. Some of these third-century B.C. terra cottas show a gracefulness of line which often escapes more ambitious compositions. The marble bas-relief from Ostia of a mother suckling her child exhibits a different treatment from that used in the Greek figures, and is also noteworthy.

During the medieval period, the attitude of the Christian Church resulted in the cult of certain saints who were especially concerned with the care of children. This attitude is exemplified by several very interesting Breton effigies in wood, dating from the thirteenth century and later. The Renaissance saw the foundation of the Ospedale degli Innocenti at Florence, with its well-known Della Robbia medallions, and there are exhibited a number of interesting illustrations of this and similar institutions.

So far as the management and treatment of children were concerned, there was little change in practice from the time of Soranus (first century A.D.) until the seventeenth century. During the sixteenth century the popular emphasis was on swaddling clothes, the bath and the baby's toilet. Prints by the Dutch, French and Italian masters depict such scenes, and sometimes show practices which are not referred to in the books of the period. The humanitarian movement in Great Britain, so well epitomized by Thomas Coram with his establishment of the Foundling Hospital, led finally to George Armstrong's dispensary (1769) and to the foundation of hospitals for sick children. The Industrial Revolution and the consequent employment of children in industry led to results which are illustrated by contemporary documents. The work of the great Victorian sanitary reformers had an important bearing on the welfare of children. But it was towards the close of the nineteenth century that French work on infant feeding was taken up in Britain and led directly to the great infant welfare movement.

The development of pædiatrics as a specialty is well illustrated in this exhibition by the first editions of many of the classics of that subject, such as the books by Hieronymus Mercurialis, Thomas Phaer, Robert Pemell and Walter Harris, to name only a few of those which are shown.

Some comments may be made regarding methods of feeding infants at different periods. Some of the third-century B.C. Greek feeding bottles which are shown have artistic merit. The Roman feeding vessels are of a glass of great beauty. One of the most interesting types of feeding vessels exhibited is the so-called breast-shaped feeding bottle, used by the Greek settlers in southern Italy during the three centuries before our era, of which several examples are shown. Of a complicated design, these charming bottles must have been difficult to fill and next to impossible to keep clean. In the sixteenth and seventeenth centuries feeding bottles resembled rather large spice pots, and were made in pewter. Several fine examples are shown. The early nineteenth century saw the florescence of the boat-shaped feeding bottle, with a spout at one end and an opening for filling on the upper side. Made at first in porcelain and earthenware, some had interesting designs. Wedgwood and Spode both made such types. From these to similar glass vessels was a short step. Some fine cradles of different periods are also shown, together with the 'walking-stool' which appears in paintings by the great masters as early as the sixteenth century.

As a pendant to the historical exposition, some cases are devoted to the management of the child among primitive races. The baby-carriers used by certain African tribes and by the American Indians are beautifully made. Those of the Indians consist of highly decorated pouches of hide. The feeding of infants among primitive peoples is illustrated by several carvings. One of the most interesting of these is a fine ivory from Central Africa, showing a mother suckling her child. The exhibition also contains a very interesting series of amulets, used both by primitive peoples and by Europeans up to the present day.

EAST AFRICA HIGH COMMISSION

REPORT FOR 1953

THE East Africa High Commission was constituted on December 19, 1947, to replace the East African Governors' Conference, and came into operation on January 1, 1948. It grew out of the experience of common administrative organization of the Second World War, and the scope of the Commission is due for review before the end of 1955. Its purview included on January 1, 1948, the four research organizations comprised in the East African Research Services, to which have since been added the Desert Locust Survey and Control, the East African Bureau of Research in Medicine and Hygiene, the Filariasis Research Unit, the East African Medical Survey, the Virus Research Unit, the East African Malaria Unit, the East African Inter-Territorial Leprosy Specialist and the East African Marine Fisheries Research Organization. Although the annual report of the Commission for 1953* includes as Part 3 an account of the evolution and of the constitution and scope of the Commission, out of its total of ninety-eight pages a full forty are concerned with the research and scientific services, and the record of activities thus presented is one which is of unusual interest to the scientist, whose clearly evinced support may be required if next year is to see no interruption to such services and the provision of inter-territorial financial support on an adequate scale.

During the year the East African Advisory Council on Agriculture, Animal Industry and Forestry was replaced by a Governing Body for the Natural Resources Group of the High Commission Research Services. The Body now constituted will be responsible for seeing that the activities of the four East African Research Organizations are directed to effective ends and supervising their general financial policy. To some extent the chapter of the report dealing with research and scientific services overlaps with that in "Colonial Research", but fuller accounts are given of certain activities than is possible in that report. On the other hand, the activities of the East African Industrial Research Board are covered more fully in the eleventh annual report of that Board (see *Nature*, September 4, p. 430). In the East African Agriculture and Forestry Research Organization, completion of farm buildings for the Animal Industry Division filled a main gap in research facilities, and the Plant Quarantine Station at Muguga was also completed during the year. Considerable work was carried out on breeding crop plants for resistance to disease, particular success being had with a strain of maize resistant to rust (*Puccinia polysora*). Entomological research was directed mainly towards the survey of insects attacking forest trees and timber and investigations of the more dangerous pests and the use of insecticides on field crops. Soils research was concentrated on the characteristics of a soil, determinable by analysis, that will indicate the ability of plants grown on it to respond to dressings of phosphate and nitrogen. The Veterinary Research Organization continued to work on the development of a quantitative serological test for the virus and antibodies of rinderpest, as well as field surveys of east coast fever, studies on problems of identification of the genera

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* Colonial Office. Annual Report on the East Africa High Commission, 1953 (Colonial 306). Pp. ii+100+4 plates. (London: H.M.S.O., 1954.) 3s. 6d. net.

Rhipicephalus and *Hyalomma* and on paramphistomes of domestic ruminants and on the larvæ of *Haemonchus contortus*.

Good progress was made with the construction of the Central Trypanosomiasis Research Laboratory at Sukulu, Uganda, and fields-trials to determine the role of biting-flies in the spread of animal trypanosomiasis in tsetse-free country were continued, while treatment with 'Antrycide' pro-salt at two-monthly intervals for a limited period protected cattle exposed daily to attacks of the tsetse *Glossina austeni* even after cessation of treatment. Research on the race of *G. morsitans*, which occupies about a hundred thousand square miles of the western fly-belt of Tanganyika, was extended to include the race of *G. morsitans* inhabiting a different type of vegetation in some ninety thousand square miles of eastern and southern Tanganyika. Important advances in the determination of blood meals taken up by tsetse flies have been made and were due to be published.

A comprehensive collection of hydrological data from Lake Victoria by the Fisheries Research Organization indicated a significant lack of sulphates in the waters of Lake Victoria, and the complicated water movements in this lake have to some extent been related to the variable growth of plankton in different areas. Data on the growth-rate of *Tilapia* indicate that the quality of the food may be more important than the amount. Some successful fish-marking experiments were carried out in the Kavirondo Gulf, while in marine waters the Marine Fisheries Research Organization made extensive studies on pelagic fish as well as correlated investigations on the plankton or biological content and the hydrography of the area. Good progress was made on the construction of a new headquarters building for the Meteorological Department, which was occupied mainly with providing a forecast service covering East Africa and an area of the Indian Ocean and with the collection and collation of climatological records.

At the end of 1953 the total strength of the Desert Locust Control and Survey was 174 officers and 522 vehicles and, besides the major operations in the Somali Peninsula and in Kenya against the increasing extent and intensity of the plague of the desert locust, fifty swarms of which invaded British East Africa early in 1954, control measures were carried out in Aden, Yemen, Kuwait and Oman. About £1 million was expended on control and research during the year. The Filariasis Research Unit began to operate on July 1, 1949, and the report gives a brief general review of the results achieved by the Unit in its study of bancroftiasis and onchocerciasis methods of control. The reduction of staff in the early stages has necessitated an extension of the scheme before the work in East Africa can be completed. The first phase of the East African Medical Survey also terminated in December 1953. In the five years work reviewed in this report, the surveys conducted in Kenya and Tanganyika have yielded statistical data which illustrate the relation of such influences as agriculture, animal husbandry and domestic practices to the health of the community.

Early in 1953 the Virus Research Institute undertook an investigation which has elucidated the nature of dengue-like fever around Newala in south Tanganyika. Work on yellow fever was less extensive, but a survey was made at Newala; and the Institute is also studying the inter-relation between a virus and its insect host, using rift valley fever and *Aedes aegypti*, and the relation between virus and the host's tissue, using influenza virus and the embryonated hen's egg. Although the activities of the Malaria Unit were restricted by absence of staff, an investigation of the epidemiology of malaria in Buganda was initiated, and one on residual house spraying with 'Gammexane' in the Northern Province of Tanganyika, which was concluded, indicated the uncertainty of house-spraying over a limited area as an anti-malarial measure. Use of mass house-spraying technique indicated that the total anopheline population in an area was about 40 per acre.

The Inter-Territorial Leprologist estimates that £200,000 a year over ten years would be required to attack leprosy on a broad front in all the Territories simultaneously, with good prospect of reducing it to negligible proportions in that period; there are at present some 216,000 leprosy cases, with eighteen leprosaria and various out-patient and rural schemes. Good results are being obtained with sulphone and other specific drugs, and under the regional leprosy surveys of the Territorial Leprologist, rural leprosy work developed particularly well in Uganda.

INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY

LONDON, 1954

DURING September 1950 an international conference on electron microscopy was held in Paris, and at an informal meeting of members of the various national groups it was decided that some international organization should be set up to arrange international conferences at regular intervals. The British Group, namely, the Electron Microscopy Group of the Institute of Physics, was asked to investigate the best method of attaining this object. Mr. F. W. Cuckow, who was secretary of the British Group at the time, approached the International Council of Scientific Unions, and it was eventually decided to set up a Joint Commission on Electron Microscopy on which the scientific unions interested in the subject would have representatives. It was the privilege of the Committee of the British Electron Microscopy Group, together with those members of the Joint Commission who could attend committee meetings in London, to organize the first International Conference under the auspices of the Joint Commission, at the London School of Hygiene and Tropical Medicine, during July 15–21. The detailed organization was carried out jointly by Mr. F. W. Cuckow (acting as secretary of the Joint Commission) and Dr. C. E. Challice (as secretary of the British Group). Office facilities were made available by the Institute of Physics. A programme committee, consisting largely of the secretaries of the national groups, was set up, with Dr. V. E. Cosslett (chairman, British Group) as its secretary. At the beginning of the conference the Joint Commission held its first meeting and before the conclusion of the conference a committee had been set up, under the Commission to co-ordinate future international meetings.

After the Conference had been formally opened, three invited survey papers were read. First, Prof. B. von Borries (Technische Hochschule, Aachen), a pioneer in the electron microscope field, reviewed recent developments in the use of beams of fast-moving corpuscles for microscopy. Dr. F. S. Sjöstrand (Karolinska Institut, Stockholm) outlined recent advances in biological knowledge achieved with the electron microscope, and devoted most of his review to the outstanding results obtained in the past two years by the application of the ultra-thin sectioning technique, of which he himself was a pioneer. Dr. J. Nutting (Metallurgy Laboratory, Cambridge) then surveyed the developments in metallurgical, chemical and industrial applications of the instrument.

Following these three papers came the sessions of original contributions. It would be impossible to present, in the space available, even an indicative review of the 160 papers read, as the result would be merely a list of titles. In any event, in order to get through this number of papers in the five working days assigned to the meeting, parallel sessions had to be held on four of the afternoons and one morning, thus making it impossible for anyone to hear all the papers read. As the authors' abstracts are available[1] and the full proceedings are to be published[2], the scientific sessions will be reviewed here in a superficial manner only.

Electron Optics

Seven sessions were devoted to subjects which can be classified under this general heading. Two theoretical sessions, one on electron optical theory (twelve papers) and one on electron interference and phase effects (three papers), showed that more consideration is now being given to aberration theory than to general lens theory. Some interesting practical results from a 'phase-contrast' electron optical system were produced by M. Marcel Locquin (Paris). A more experimental session on ion microscopes and X-ray microscopes (six papers) included papers on a lithium ion microscope (Dr. M. Gauzit, Paris) and a proton microscope (Prof. G. Magnan and Dr. P. Chanson, Paris) together with three papers on the theory and application of the X-ray shadow microscope. Dr. R. Castaing (Toulouse) gave a summary of his work on electron probe techniques. A session on emission and reflexion microscopy (six papers) included a report from Prof. G. Dupouy and Prof. Ch. Fert (Toulouse) on reflexion electron microscopes and a description of metallurgical emission-microscopical techniques by members of the Philips Co.'s research team. Spectacular results obtained by Prof. G. Mollenstedt and Dr. M. Keller (Mosbach-Baden) were shown. Their apparatus consisted of an emission microscope in which the cathode (specimen) emission was excited by ion bombardment. Other aspects of emission microscopy were presented in three further contributions.

Three sessions devoted to the conventional type of electron microscope were all intended to be of general interest to users of the instrument. "New Electron Microscopes" (four papers) contained descriptions of two experimental instruments and two commercial models (R.C.A. and Siemens), and "Apparatus; Operation of Microscopes" (nine papers) contained descriptions of a number of pieces of experimental apparatus directly connected with the electron microscope or its use. "The Attainment of High Resolution" (three papers) provided a promise of 5 A. or so resolving powers in the foreseeable future.

Specimen Techniques

Four sessions were devoted to specimen preparation techniques. In that on general specimen techniques (eleven papers) Dr. Marcel Locquin (Paris) described how living specimens contained in a small water-containing cell can be examined in the electron microscope. A number of replica processes for different particular types of specimen were described by other workers, particularly striking results being obtained by Mr. D. E. Bradley (Aldermaston) by the use of carbon replicas. In the session on metallurgical specimens techniques (six papers) a number of methods of preparing metals and metal surfaces for examination by electron microscopy were discussed. The microtomy session contained descriptions of two new microtomes, together with a method of preparing steel knives for cutting ultra-thin sections. A symposium on the preservation of biological material contained five papers. This included two major American contributions, one by Dr. G. E. Palade (New York), whose introduction of the practice of buffering osmic acid for the fixation of tissue has been copied by practically all workers in the field, and the other by Prof. T. F. Anderson (Pennsylvania) on the preservation of structure in dried specimens. The results of Prof. Anderson's technique of taking the medium in which the specimen is suspended around its critical point were presented in a number of most impressive stereo slides.

Non-Biological Applications

The three sessions falling under this general heading showed that considerable progress has been made in this field of application since the 1950 conference. On metallurgical applications there were thirteen contributions in which it was described how the techniques of emission and reflexion microscopy have enabled a number of problems to be studied directly, without the use of replicas, while the carbon replica process has enabled the full resolving power of the conventional transmission electron microscope to be exploited. Studies on steels subjected to various treatments, together with studies on a number of non-ferrous metals, were described. Industrial, chemical and other applications (thirteen papers) referred to all non-biological work not covered by metallurgy, and included some studies on crystals, colloids, rubber, paper and gels.

A symposium on the action of the electron beam on the specimen (five papers) was concerned with the changes both morphological and chemical which take place in the specimen when the electron beam is applied.

Biological Applications

Fifty-seven papers were presented in the sessions on biological applications, and the diversity of the biological fields covered was so great that it is quite impossible to do justice in this review to the work described. Generally speaking, the contributions were dominated by the application of the thin-sectioning techniques which, at the Paris Conference in 1950, were still in their infancy. Bacteria, viruses, spermatozoa and cilia have all been sectioned and examined, together with a large number of tissue cells. Among the virus studies described (fourteen papers) were animal, plant, insect and bacterial viruses, and the bacterial studies (ten papers) covered work performed on a number of different strains of organisms. Internal structure of cells (thirteen papers) included studies on muscle, pancreas, retina, nerve cells and yeasts. Five papers were devoted to the structure of cell and body walls, while eight papers on fibrillar structures included some interesting work on the application of the reflexion technique to the examination of fibres. Work on muscle and collagen was also described. A symposium on the microanatomy of cilia, flagella, etc., included some interesting speculations by Miss W. van Iterson (Amsterdam) on possible relationships between flagella, cilia and sperm tails.

It was interesting to note, throughout the conference, the increasing use which is being made of the stereo technique. This technique is proving of real value, as it is impossible in many specimens to obtain adequate information on spatial relationships by any other method.

In connexion with the Conference, an exhibition of commercial apparatus and books, and also of research micrographs, was held at the London School of Hygiene and Tropical Medicine; indeed, the Conference owed much of its success to the dean and staff of the School for their generous help and for making available excellent facilities.

C. E. Challice

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[1] Handbook of the International Conference on Electron Microscopy, London, 1954 (obtainable from the Institute of Physics, 47 Belgrave Square, London, S.W.1).

[2] Proceedings of the International Conference on Electron Microscopy, London, 1954 (Royal Microscopical Society, London) (in the press).

THYROID FUNCTION

As part of a joint meeting with the Association of Clinical Pathologists held at the Grand Hotel, Brighton, on October 2, the afternoon session was devoted to a programme of papers on thyroid function organized by the Association of Clinical Biochemists.

The subject was introduced by Prof. E. J. Wayne (University of Glasgow), who discussed the use of radioiodide in the diagnosis of thyroid disorders. The opinion was expressed that it is preferable to use two or three tests, especially the determination of the thyroid uptake of radioiodine, four hours after a dose, and the plasma protein-bound activity forty-eight hours after a dose. The latter corresponds best with the final clinical diagnosis in cases of hyperthyroidism, while tests based on urinary excretion are specially valuable in the diagnosis of hypothyroid states.

The results of some five hundred cases in which the iodine-131 thigh-neck clearance test was employed were reviewed by Dr. B. W. Meade and Prof. N. F. Maclagan (Westminster Medical School, London). In only forty cases was there a discrepancy between the results of the test and the clinical condition. In seventeen cases which showed a high clearance-rate, sixteen were due to goitrogen administration and one to a large non-toxic goitre. The remaining anomalous results were low—eleven were due to iodide and six to thyroxine; two were post-thyroidectomy, and four were not explained.

Drs. F. Brown and H. Jackson (Christie Hospital, Manchester) then reported the results of the treatment of thyroid carcinomata with therapeutic doses of iodine-131. The plasma was found to contain thyroid protein in addition to thyroxine, and in some cases small amounts of diiodotyrosine. The results of certain animal experiments which were also reported showed that the metabolism of thyroid protein shows a definite species specificity: dog thyroid protein is not metabolized by rats, nor is that from rats metabolized by dogs.

Dr. A. Tickner (Guy's Hospital Medical School, London) discussed the serum cholinesterase level in thyroid disease. It was found to be high in thyrotoxic states and low in myxœdema, but there was some overlap. Since the liver is regarded as the source of cholinesterase, it seems that in thyrotoxicosis the cholinesterase activity is a measure of liver function.

The measurement of thyroid-stimulating hormone in thyroid disorders was reported by Dr. I. C. Gilliland (Postgraduate Medical School, London), who found that the level is high in myxœdema and low in Simmond's disease, whereas in thyrotoxicosis it is low unless eye signs are present, when it is raised. In cases of exophthalmos without thyroid involvement, there is no increase in the thyroid-stimulating hormone-level. Dr. Gilliland therefore concludes that more than one factor is involved.

Drs. A. L. Tárnoky and P. White (Royal Berkshire Hospital and University of Reading) have investigated the relationship between a number of conventional tests in thyroid disease. Highly significant correlations were found between the basal metabolic rate, the serum cholesterol and the urinary pigment: creatinine ratio.

The last paper was by Mr. C. H. Bowden, Prof. N. F. Maclagan and Dr. J. H. Wilkinson (Westminster Medical School, London), who described the application of the ceric sulphate – arsenious acid reaction to the detection of thyroxine and triiodothyronine in plasma. An outline of the techniques employed for the extraction of the protein-bound iodine components from normal plasma and their detection on paper chromatograms was given. Preliminary results indicate that thyroxine and triiodothyronine are components of both normal and thyrotoxic plasma.

J. H. Wilkinson

PERTURBING ACTION OF THE EARTH ON METEOR STREAMS

A paper discussing a criterion concerning the perturbing action of the earth on meteor streams by L. Kresák, of the Astronomical Observatory of the Slovak Academy of Sciences, Skalnaté Pleso (*Bull. Astro. Inst. Czechoslovakia*, 5, No. 3; 1954), deals with the possibility of the dispersion of meteor streams by the earth. He makes use of Tisserand's well-known criterion for the identity of comets which are perturbed by a comparatively close approach to a planet; this states that

$$1/a + 2\sqrt{a(1-e^2)}\cos i = C,$$

where a, e and i have the usual significance in dynamical astronomy. He then develops another criterion, the earth being the disturbing body and a meteor stream taking the place of a comet. The treatment has some advantages: for example, geocentric velocities of meteors can be determined more directly than orbital elements involved in Tisserand's criterion, and also they can be obtained directly by means of radio-echo technique. After a few substitutions and transformations of the above equation, it can be expressed in the form:

$$1/a + 2\sqrt{a(1-e^2)}\cos i = 3 - w^2,$$

where w is the geocentric velocity of the meteor; as the left-hand side of this equation is the Tisserand invariant C, the expression on the right is also constant. This shows that the geocentric velocity of a meteor is unaffected by the earth's perturbations and remains unaltered for each next encounter with the earth; the velocity vector may undergo only a reorientation. While the perturbations of the major axis may be considerable for those meteors which just escape the atmosphere, yet they appear only in a displacement of the radiant, the change of heliocentric velocity being compensated by the change of elongation of the radiant from the apex of the earth's way. In the case of meteors reaching the point of nearest approach ahead of the earth, the true and apparent radiants are shifted nearer the apex; but if the nearest approach is behind the earth, they are shifted farther from the apex.

The matter is very fully discussed in the paper and attention is concentrated on eleven of the most important meteor showers; if any observable results of the earth's action are to be found, they should be detectable in four favourable cases—in the constitution of the Taurids, Geminids, Quadrantids and Delta Aquarids—but the investigations show that the distribution of geocentric velocities does not satisfy the condition expressed above by Tisserand's equation. The conclusion is that meteor orbits are dispersed in an entirely different way from what would be expected by the earth's action. Nor can the Poynting–Robertson effect have been responsible for the arrangements of meteor orbits within the streams, and the only single factor that can be held responsible is the occasional local perturbations by the major planets acting from the time when the particles became dispersed along a portion of the original orbit.

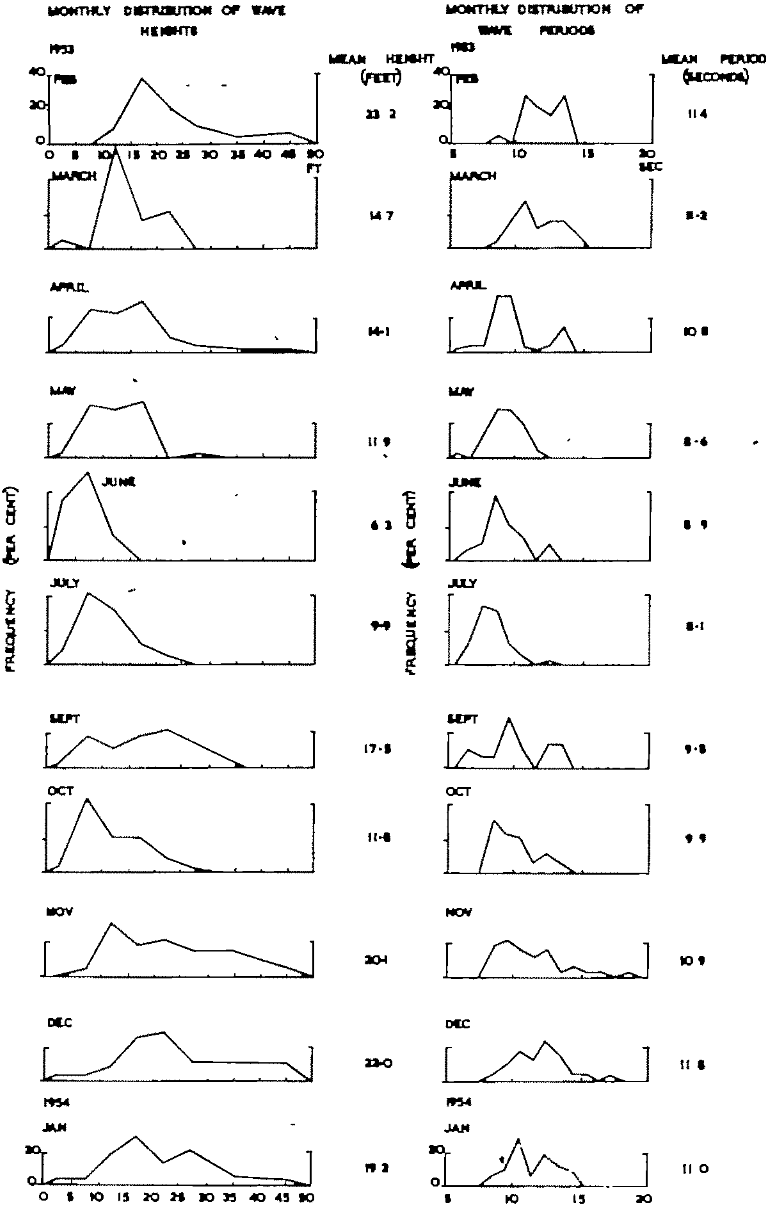

Fig. 1

WAVE CONDITIONS IN THE NORTH ATLANTIC, 1953–54

By J. DARBYSHIRE

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WAVES have been recorded regularly in the North Atlantic Ocean by the Ocean Weather Ship *Weather Explorer* since February 1953. Wave recordings of about 8–10 min. duration are taken eight times daily using the ship-borne wave recorder already described by Tucker[1]. Sufficient results are now available to form a statistical summary of the wave characteristics.

The *Weather Explorer* occupies in turn the positions 'India' (61° 00′ N., 15° 20′ W.) and 'Juliet' (52° 30′ N., 20° 00′ W.), and observations at both positions have been combined as being representative of wave conditions generally in this part of the Atlantic Ocean. No records were obtained in August. The records were examined and the maximum height and the significant wave-period found. The significant wave-period is the mean period of the highest one-third of the waves recorded. The wave characteristics are summarized in Tables 1 and 2 and Fig. 1. Table 1 shows the percentage of time the maximum wave height is greater than 40 ft., between 30 and 40 ft., 25 and 30 ft., 20 and 25 ft., 15 and 20 ft., 10 and 15 ft., 5 and 10 ft., and less than 5 ft., for each month from February 1953 to January 1954, also the mean significant period of the waves which fall

Table 1. Distribution of Wave-Heights

Wave-height (ft.)		Feb.	Mar.	April	May	June	1953 July	Aug.	Sept.	Oct.	Nov.	Dec.	1954 Jan.
40–50	% Frequency	11·1	0	1·9	0	0	0		0	0	6·1	10·6	3·6
	Mean period (sec.)	13·0	—	13·0	—	—	—		—	—	15·0	13·8	13·0
30–40	% Frequency	5·5	0	1·9	0	0	0		7·7	0	10·2	10·6	7·2
	Mean period (sec.)	13·5	—	13·5	—	—	—		12·0	—	12·4	12·8	13·5
25–30	% Frequency	11·1	0	3·8	2·9	0	0		15·4	2·9	10·2	10·6	21·4
	Mean period (sec.)	12·0	—	13·3	10·5	—	—		12·8	13·0	12·7	13·8	12·0
20–25	% Frequency	22·2	21·9	9·6	0	0	5·0		23·1	8·8	20·4	29·0	14·3
	Mean period (sec.)	11·0	12·0	10·8	—	—	10·3		11·1	11·2	10·7	10·7	10·0
15–20	% Frequency	38·9	15·6	30·8	34·4	0	12·5		19·2	20·6	18·4	26·3	28·6
	Mean period (sec.)	11·5	12·0	9·8	9·3	—	8·3		9·2	10·9	11·2	11·2	10·7
10–15	% Frequency	11·1	50·5	23·1	28·6	13·8	32·5		11·5	20·6	30·6	7·9	17·8
	Mean period (sec.)	10·0	10·7	9·7	9·1	8·6	7·9		9·2	9·6	9·2	11·2	12·3
5–10	% Frequency	0	0	25·0	31·4	52·0	42·5		19·2	44·0	4·1	2·6	8·6
	Mean period (sec.)	—	—	9·0	8·3	8·7	7·3		7·2	9·2	9·0	10·0	9·0
0–5	% Frequency	0	3·5	3·8	2·9	34·4	7·5		3·8	2·9	0	2·6	3·6
	Mean period (sec.)	—	14·0	5·5	5·0	9·8	9·0		6·0	10·5	—	10·5	6·0
Mean maximum height (ft.)		23·2	14·7	14·1	11·9	6·3	10·0		17·5	11·8	20·1	22·0	19·2

Table 2. Distribution of Wave-Periods

Wave-period (sec.)		Feb.	Mar.	April	May	June	1953 July	Aug.	Sept.	Oct.	Nov.	Dec.	1954 Jan.
> 14	% Frequency	0	9·4	0	0	0	0		0	0	12·2	13·0	10·7
	Mean height (ft.)	—	8·0	—	—	—	—		—	—	23·6	22·4	18·0
13–14	% Frequency	27·8	15·6	15·4	0	0	0		15·4	5·8	2·0	15·8	14·3
	Mean height (ft.)	31·0	18·4	23·3	—	—	—		24·5	22·5	46·0	31·7	21·0
12–13	% Frequency	16·7	15·6	3·8	0	10·3	2·5		15·4	11·6	16·3	23·7	21·4
	Mean height (ft.)	22·0	17·6	16·5	—	2·8	2·5		27·3	15·8	26·0	20·2	21·0
11–12	% Frequency	22·2	12·5	1·9	5·8	0	0		0	5·8	12·2	18·2	7·2
	Mean height (ft.)	21·5	15·0	11·0	15·0	—	—		—	19·8	22·0	17·8	18·0
10–11	% Frequency	27·8	28·2	3·8	20·0	13·8	5·0		11·5	20·6	16·3	18·4	28·6
	Mean height (ft.)	17·0	14·9	11·0	15·3	6·0	22·0		22·0	10·9	20·0	16·5	18·0
9–10	% Frequency	0	15·6	32·7	28·6	20·6	12·5		30·8	23·2	21·4	10·5	10·7
	Mean height (ft.)	—	12·0	15·8	13·5	6·0	12·6		14·3	10·7	15·1	19·8	11·0
8–9	% Frequency	5·5	3·5	32·7	28·6	38·0	32·5		7·7	32·4	18·4	5·2	7·2
	Mean height (ft.)	17·0	10·0	10·9	11·5	7·4	9·5		13·5	8·8	12·3	18·5	16·0
< 8	% Frequency	0	0	9·5	17·2	17·2	47·5		19·2	0	0	0	0
	Mean height (ft.)	—	—	6·2	6·7	4·7	8·4		8·3	—	—	—	—
Mean period (sec.)		11·4	11·3	10·8	8·6	8·9	8·1		9·8	9·9	10·9	11·8	11·0

within these height-ranges. The overall mean maximum height for each month is given in the last row.

Table 2 gives a similar survey of wave-periods, the period classes being greater than 14 sec., 13–14 sec., 12–13 sec., 11–12 sec., 10–11 sec., 9–10 sec., 8–9 sec., and less than 8 sec. The mean maximum height for waves falling in these period ranges is given, and in the last row the mean significant period for all the waves recorded during the month.

A comparison of this statistical summary with a similar one for waves recorded off Perranporth, Cornwall, during February 1946–January 1947 will be published shortly; but briefly, the comparison shows that the waves are much higher in the open ocean, the highest percentage frequency for waves of more than 20 ft. for any month at Perranporth being only 5 per cent. Longer wave-periods are, however, more frequent at Perranporth, waves with significant periods of more than 14 sec. being present for 45 per cent of the time during January 1947.

An explanation of the effect of shorter period and greater height may be found by considering the wave spectrum. It has been shown[2] that storm waves consist of a mixture of waves of various periods, and that the energy of the waves of shorter period does not increase indefinitely as the wind increases but actually tends to decrease, waves of longer period being favoured. Recent investigation has shown that this effect is not nearly so marked in the open ocean, where, as the wind increases in strength, the energy of the waves of shorter period continues to increase so that a greater proportion of the wave energy is contained in these periods. This effect would tend to reduce the mean period and increase the height. A more detailed account of this investigation will be published later.

I wish to thank the Director of the Meteorological Office and the Superintendent of the Marine Division for their co-operation; also the Master, Senior Meteorological Observer and crew of the *Weather Explorer* for making the observations.

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SYNTHETIC ACTIVITY OF A SINGLE EPITHELIAL CELL OF THE LACTATING GOAT UDDER

By K. C. RICHARDSON

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It would be interesting to have quantitative information about the average synthetic activity of individual cells of secretory organs in the animal body; but the work done by a single mammalian cell is not easy to estimate. The mammary gland is a secretory organ which possesses outstanding capabilities for the synthesis of protein (mainly casein), fat and carbohydrate (lactose). The development by one of us (K. C. R.) of a method for estimating the total surface area of alveolar epithelium in the goat udder makes it possible to calculate the average rate of secretion (that is, synthesis) of the three principal milk constituents by a single mammary epithelial cell in this species.

The average output of milk by the individual epithelial cells of the goat udder was calculated from the total area of epithelium lining the alveoli and intra-lobular ducts of a single mammary gland (the goat udder consists of two mammary glands), the average cross-sectional area of the individual epithelial cells and the average weekly milk yield of the gland.

The method for calculating the total area of secretory epithelium in a half-udder of the goat has already been described[1], together with results from a series of sixteen ovariectomized goats brought artificially into lactation by the administration of sex hormones and three control goats in normal lactation following pregnancy. The same sixteen experimental glands and one control have been used for the present estimations.

To determine the average cross-sectional area of the mammary cell, areas of alveolar epithelium cut tangentially to the wall of the alveolus were measured by outlining groups of cells cut in this plane and through the level of their nuclei at a constant magnification of × 1,200. The area of each group measured by a planimeter was then divided by the number of cells within the group and finally corrected for the magnification. Sufficient estimations were made from five sections of lobule-alveolar tissue, taken at random, for an average of 150 cells to be measured in each gland.

Table 1 gives the data from which the output of milk per cell per hour has been calculated. Taking the mean value for the average output of milk per cell per hour, 23×10^{-11} ml./cell/hr., and using average figures obtained by Rowland[2] for the composition of the milk of British Saanen goats from the same herd as follows: fat, 3·91 per cent; casein, 2·41 per cent; lactose, 4·07 per cent, the amounts of each constituent synthesized per cell per second calculated as outlined above are given in Table 2. In the case of lactose, the number of molecules synthesized per second can readily be calculated from this value. The figure given in the last column of Table 2 shows that the epithelial cell of the goat udder synthesizes about $4 \cdot 5 \times 10^6$ lactose molecules per second.

Table 1. MILK OUTPUT OF A SINGLE EPITHELIAL CELL OF THE LACTATING GOAT UDDER

Goat No.*	Weight of half udder after fixation* (gm.)	Surface area of total secretory epithelium* (m.²)	Average cross-sectional area of epithelial cell (μ^2)	Average weekly milk yield (l.)	Output of milk per cell per hour (ml. $\times 10^{-11}$)
258 b	610·0	11·78	78·5	5·2	21
264 b	184·5	2·99	109·9	1·7	16
271 b	290·0	4·76	101·0	1·2	15
273 b	428·0	7·97	188·7	2·5	26
323 b	458·5	6·41	122·8	1·6	18
383 b	735·0	10·15	122·3	4·1	29
391 b	236·0	5·10	76·3	2·0	18
250 b	396·5	7·06	123·0	2·6	27
289 b	517·5	10·74	86·5	4·1	20
270 b	324·0	6·39	115·1	2·4	26
257 b	744·0	14·05	86·3	5·4	20
326 b	841·0	16·72	111·0	5·8	23
384 b	558·0	13·25	146·5	4·2	28
394 b	278·5	6·45	132·3	2·2	27
316 b	916·0	15·61	68·3	4·7	12
328 b	497·5	11·34	114·6	2·7	16
401 a 401 b	1186·0	23·47	137·7	12·1	29
					Mean: 23

* See ref. 1

Table 2. RATE OF SYNTHESIS OF MAJOR MILK CONSTITUENTS BY A SINGLE CELL OF THE LACTATING GOAT UDDER

	Per cent in milk	μgm. synthesized/cell/sec.	Molecules synthesized/cell/sec.
Lactose	4·0	$2 \cdot 6 \times 10^{-9}$	$4 \cdot 5 \times 10^6$
Fat	3·9	$2 \cdot 5 \times 10^{-9}$	$4 \cdot 1 \times 10^{6*}$
Casein	2·4	$1 \cdot 5 \times 10^{-9}$	

* Saturated fatty acid molecules from butyric to palmitic, assuming all are synthesized from small molecules.

The problem of calculating the number of molecules of fatty acids synthesized per cell in a given time is a little more complicated, since goats' milk glycerides contain a 'spectrum' of fatty acids of chain-length from C_4 upwards. There is considerable evidence (see Folley[3]) that synthesis from acetate in the udder itself plays an important part in the formation of the fatty acids of milk fat, at least of the saturated series from butyric up to and including palmitic, though it is believed that oleic and stearic acids of milk fat arise principally from the blood glycerides. Taking the figures given by Gamble, Ellis and Besley[4] for percentages of the various fatty acids in the total fatty acids of goat milk fat and assuming that the total fatty acid content of goats' milk fat is of the order of 90 per cent, the numbers of molecules of each saturated fatty acid from butyric to palmitic synthesized by a single cell each second were therefore calculated on the assumption that the whole of these acids are synthesized in the udder from acetate. The total, just over 4×10^6 molecules per second, happens to be very close to the figure for lactose. If one accepts the mechanism for the synthesis of milk fatty acids postulated by Popják, French, Hunter and Martin[5], namely, that they are formed by successive condensation of 2-carbon units, and neglecting any utilization of preformed 4-carbon units entering from the blood which would scarcely affect the calculation, the figure obtained for the rate of synthesis of the saturated fatty acids (C_4–C_{16}) corresponds to about $21 \cdot 5 \times 10^6$ condensations/sec./cell.

No attempt has been made to calculate the rate of synthesis of casein molecules owing to uncertainty about the molecular weight of casein.

It should be pointed out that the figures given in Table 2 represent average rates of synthesis calculated over twenty-four hours. The rate of milk secretion is, however, not constant; it is relatively rapid just after milking and then slows down as the udder fills with milk. The maximum rates are therefore certain to be considerably greater than the average rates given in the table.

[Aug. 13.

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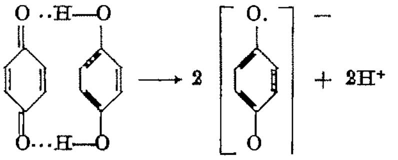
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Stabilization of Free Radicals by Adsorption: Detection by Paramagnetic Resonance

It is known that quinhydrones are weak acids and may therefore form ions in strongly alkaline solutions. Due to the loss of two hydrogen atoms of the quinhydrone compound, two identical semiquinone ions can be expected; for example:



(I) Quinhydrone (II) Semiquinone

These semiquinone ions, having an odd number of electrons, should be paramagnetic. Michaelis has proved the existence of free radical ions of this type during alkaline reduction of phenanthrene-quinone-3-sulphonate[1] by potentiometric and magnetic measurements. It would be difficult to demonstrate the existence of free radical ions in the case of many quinhydrones, for example, p-benzoquinhydrone, as they are too unstable in alkaline solution. It occurred to us, however, that it might be possible to stabilize such unstable radical ions by adsorption of quinhydrone on suitable basic surfaces. A sufficiently basic surface could have the same effect as the alkaline solution, and the adsorption might stabilize the free radicals formed.

To test this idea we adsorbed p-benzoquinhydrone on barium hydroxide octahydrate, using solutions in various non-polar solvents (dioxane, benzene). An intense blue colour appeared on the surface. Solutions of pure p-benzoquinone and pure hydroquinone gave rise to no colour on adsorption, nor was this colour formed when alumina or silica gel was used for adsorption of p-benzoquinhydrone.

Paramagnetic resonance[2,3] experiments on the coloured surface showed it to be paramagnetic. Our measurements were made on the powder at 90° K. Neither barium hydroxide nor solid p-benzoquinhydrone alone showed paramagnetism. The paramagnetic resonance consisted of a single absorption line, a few gauss wide and with $g = 2{\cdot}003 \pm 0{\cdot}001$. This is typical of the resonance obtained from a free radical. Thus it seems reasonable to conclude that our experiments demonstrate the formation and stabilization of free radical-semiquinone ions on an alkaline surface.

Since quinhydrone splits up into a rather complicated equilibrium system in solution[4], a similar situation may arise on the barium hydroxide surface, and other paramagnetic ions and molecular compounds may be present. Because the paramagnetic resonance spectra of different free radicals are so similar, we cannot conclude from our experiments that only ions of one type, such as (II), are formed.

It is noteworthy that anhydrous barium hydroxide is only slightly coloured by a solution of p-benzoquinhydrone. If, however, one adds a few drops of water to the solution, the deep colour appears at once. Thus it seems that the hydrate water molecules are necessary to promote adsorption and formation of ions. A similar case of the effect of water on the production of coloured surfaces has been reported by Schoenberg[5]. We think this is because the strong dipole moment of the water molecules facilitates dissociation.

We have also adsorbed three other quinone–hydroquinone systems on barium hydroxide and investigated the paramagnetism. Table 1 shows the combinations on which we have made measurements, dioxane being used as a solvent. In all cases a deeply coloured surface was formed. Paramagnetism was present in all cases, even with phenanthrenequinone when the corresponding hydroquinone was not used. Here the formation of two different radical ions is to be expected, but our experiments do not distinguish between different types of radical. Adsorbed anthrarufin and quinizarin did not show paramagnetic resonance. This is not surprising; paramagnetism is not expected, since these compounds can form a quinhydrone system within the molecule.

Table 1

Quinhydrone system Quinone	 Hydroquinone	Colour after adsorption	
p-Benzoquinone	p-Benzohydroquinone	Deep blue	Paramagnetic
Thymoquinone	Thymohydroquinone	Blue-green	,,
Phenanthrenequinone	Phenanthrenehydroquinone	Green	,,
Phenanthrenequinone	p-Benzohydroquinone	Blue-green	,,
Anthrarufin		Purple	No paramagnetic resonance
Quinizarin		Purple	,,

The paramagnetism found in our experiments indicates that the adsorbed molecules lose hydrogen ions to the alkaline surface. It is interesting that Weitz[6] found that the colourless triaminotriphenylmethanol (a weak base) is adsorbed on silica gel, which is acidic, with nearly the same colour as the corresponding dye salt. He ascribes this to the formation of ions by loss of hydroxyl ions to the surface.

Goldschmidt and Christmann[7] studied the reaction of quinhydrones with sodium methylate and obtained unstable blue products which contain about two sodium atoms per quinhydrone molecule. We consider it possible that Goldschmidt's products contain ions similar to the radical ions we have obtained on the coloured surfaces. In this case one should consider them as free-radical salts.

It may be that a stabilization of free radicals on a suitable surface occurs in biological systems. For example, Kaye and Stonehill[8] give polarographic evidence that many substances of physiological importance form unstable free radicals, and they stress the importance of these in biochemical processes. Such radicals might be stabilized by acidic or basic surfaces, for example, suitable proteins.

We are indebted to the University of Oxford for the award of a Pressed Steel Co., Ltd., Research Fellowship (D. B.), the British Council for the award of a scholarship (H. K.) and the Department of Scientific and Industrial Research for a maintenance grant (A. C. R.-I.) during the tenure of which these researches were carried out.

D. BIJL
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and
Dyson Perrins Laboratory,
Oxford.
July 8.

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Isotopic Exchanges and the Existence of Tricalcium Phosphate in Bone

THE problem of the physico-chemical constitution of the skeleton has received considerable attention in recent years[1-8]. Tracer experiments indicate that phosphorus-32 and calcium-45 appear promptly and in considerable proportions in the bony tissues, whence they are removed slowly[4-6]. These observations have led to an assumption that deposition of phosphorus-32 and calcium-45 in bony tissues is an exchange between bone and blood inorganic phosphate or calcium. Phosphorus-32 and calcium-45 have been used to study phosphate or calcium exchange between powdered bone and aqueous disodium hydrogen phosphate and calcium chloride solutions[7-9]. Different authors[6,10,11] have concluded that the principal bone component is not tricalcium phosphate but rather hydroxylapatite to which phosphoric ions are adsorbed in such a quantity that the ratio of calcium to phosphorus is equal to 1·94, which is the characteristic value for tricalcium phosphate. On the other hand, the findings of some workers[1,2] support the idea of the existence of tricalcium phosphate in bony tissues. The experiments reported here are an attempt to study the exchange mechanism of both phosphate and calcium between pure tricalcium phosphate and radioactive phosphate or calcium solutions. These experiments were also performed in order to show to what extent the isotopic exchange method can help to elucidate a particular problem of structural chemistry. (Calcium-45 was prepared by neutron bombardment in the pile at the Clinton Laboratories, Oak Ridge, Tenn., and phosphorus-32 at the pile at Harwell, Berks.)

In the first series of experiments, the tricalcium phosphate was prepared by mixing disodium hydrogen phosphate and calcium chloride in the presence of ammonia. Later, the tricalcium phosphate was prepared as follows: calcium oxide dissolved in water was added to dilute phosphoric acid with phenolphthaleine as indicator; the excess of calcium hydroxide was neutralized by one or two drops of dilute phosphoric acid. Phosphate was determined by the method of Fiske and SubbaRow. Calcium determinations were done by precipitation as calcium oxalate and titration by means of potassium permanganate. Radioactive measurements were made with a thin-wall end-window counter tube.

125 mgm. samples of tricalcium phosphate were exposed to 5 ml. of radioactive disodium hydrogen phosphate or calcium chloride solutions for increasing lengths of time up to sixty days. The sealed 'Pyrex' tubes containing the samples were rotated end to end continuously at 40 r.p.m. In most experiments the tests were repeated several times. Experiments were performed at 18°, 60°, 120° and 180°. The quantities of calcium or phosphorus in both phases were the same. 100 per cent of the calcium-45 and phosphorus-32 was in the solution initially and 0 per cent was in the tricalcium phosphate. At the end of each reaction period, solid and solution were separated by filtration; the same results are obtained when separation is performed by dialysis. The solid was dissolved in 5 ml. of hot 3 *N* hydrochloric acid and aliquots were taken for chemical and radioactive measurements. All the samples were counted after evaporation to dryness under an infra-red lamp. The extent of exchange was calculated in the usual manner from the specific activities of the two fractions. Some calcium phosphate samples were equilibrated for three days at 18° or 180° with radioactive solutions, at which time the latter were replaced with inert phosphate or calcium solutions and further equilibrated for an additional three days. The exchange was also studied with tricalcium phosphate ignited at 900°.

Typical results are shown in Fig. 1. For each temperature, the exchanged fraction increases rapidly in the first two hours; this rapid increase is succeeded by a much slower increase. Analytical determinations indicate that the deposition of calcium-45 and phosphorus-32 in the calcium phosphate had not been accompanied by a proportionate net deposition of the non-radioactive calcium or phosphate. No linear relationship was apparent when the logarithms of the differences between percentages exchanged at any time and at 'equilibrium' are plotted as ordinates

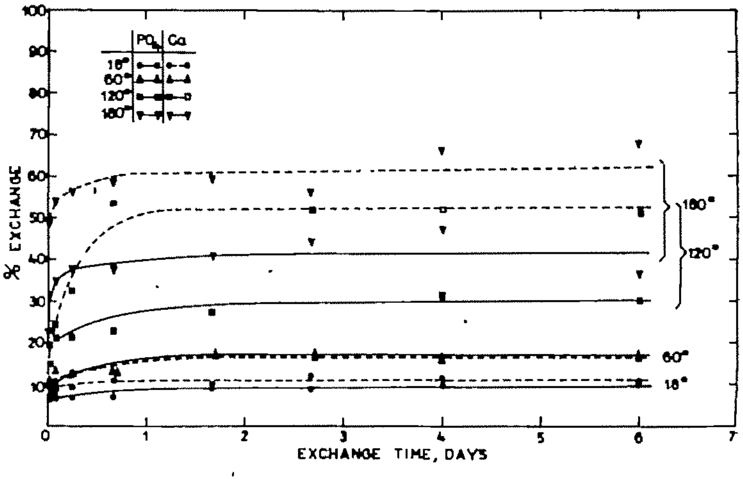

Fig. 1

against time. The exchange results do not obey a simple exponential law; it is possible to obtain curves analogous to radioactive decay curves.

The curves obtained indicate three processes to each of which corresponds a half-time for the exchange. The exchange percentages are increased with temperature. Temperature variations affect such processes as recrystallization and self-diffusion. At room temperature, the exchange could be attributed partly to adsorbed phosphoric ions ($\simeq$ 10 per cent); it cannot explain, however, the important exchange at higher temperatures. For temperatures higher than 60°, the calcium exchange is greater than the phosphate.

Results indicate a marked lack of reversibility, which is to be expected when recrystallization takes place. Ions fixed in the interior of the newly formed crystals are no longer available for exchange. Similar results were obtained by Neuman[8] with fresh bone, whereas ashed bone showed such a reversibility as reported by Falkenheim[7,9].

A lack of exchange is observed with tricalcium phosphate ignited at 900° and with large crystals of hydroxylapatite. Again, crystals are affected by heat treatment, which results in crystal growth and a more stable crystal lattice.

The time exchange curves were somewhat different for the individual phosphate preparations. Isotopic exchange, at least in the rapid exchange process, is concerned with crystal surfaces which will vary considerably for different calcium phosphate preparations. Also, heat treatment results in crystal growth, which reduces the crystal surface and at the same time the exchange. Furthermore, the exchange of both calcium and phosphate ions may involve other mechanisms such as recrystallization and self-diffusion.

When radioactive phosphate and calcium are administered to animals, it is clear that the mechanisms by which these ions are fixed by the skeleton are complex. It would be difficult to estimate the rates at which real exchange and both recrystallization and self-diffusion take place *in vivo*.

The lack of exchange by large crystals of hydroxylapatite, the same behaviour of both calcium and phosphate ions at 18°, and the important exchange observed at higher temperatures, seem to exclude that the exchange concerns adsorbed phosphate ions already present in the solid phase when experiments are started. Hence our results cannot support the assumption that the principal bone component is hydroxylapatite, which adsorbs phosphate enough to give a calcium/phosphorus ratio of 1·94.

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Isolation and Structure of an *N-iso*Butyldienediynamide from Pellitory (*Anacyclus pyrethrum* DC.)

THE roots of the North African plant *Anacyclus pyrethrum* DC. (pellitory) have been used in medicine since the time of Dioscorides, and mention of the drug is made in the B.P.C. 1934 (*Pyrethri radix*). It induces copious salivation when chewed and gives rise to an intense burning taste. In a recent investigation it has been found[1] that the crystalline sialogogue isolated by Gulland and Hopton[2] from this material, and named pellitorine (melting point 72°), is in fact a mixture of *iso*butylamides[3,4] of the general type

$$R.CH{=}CH.CH{=}CH.CO.NHCH_2CH(CH_3)_2. \qquad (1)$$

Hydrogenation and acidic hydrolysis yield a mixture of decanoic, dodecanoic and tetradecanoic acids which can be separated by reversed-phase partition chromatography. Its nature will be discussed more fully elsewhere. During the isolation of pellitorine, a new crystalline substance of melting point 121° has been obtained, which crystallizes from chloroform–petrol in white needles. Unlike pellitorine, it is but sparingly soluble in petrol, has no sialogogue effect and only low insecticidal activity towards the grain insect *Tenebrio molitor* L.

The new substance, 'anacyclin', has the empirical formula $C_{18}H_{25}ON$ (found: C, 79·7; H, 9·2; N, 5·2. $C_{18}H_{25}ON$ requires C, 79·9; H, 9·3; N, 5·15 per cent. Molecular weight (Rast) 284), and absorbs 6 mol. of hydrogen on catalytic hydrogenation to give dodecahydroanacyclin, melting point 66°. The infra-red spectrum (paraffin mull) indicates that this is a saturated monosubstituted amide (NH str. 3,310, 3,075; amide *A* carbonyl 1,641; amide *B* 1,548 cm.$^{-1}$), while the spectrum of anacyclin itself is characteristic of a monosubstituted amide conjugated with a diene system (NH str. 3,300, 3,060; amide *A* carbonyl 1,625; amide *B* 1,544; C=C str. 1,655, 1,612 cm.$^{-1}$). The ultra-violet absorption (λ_{max} 259 mμ, ϵ_{max} 33,500) is in agreement with data expected for a chromophore —CH=CH.CH=CH.CO.NH—. Hydrolysis of dodecahydroanacyclin gave *iso*butylamine (hydrochloride) and tetradecanoic acid (*p*-bromophenacyl ester), and its identity as *N*-*iso*butyltetradecanamide was confirmed by synthesis. Anacyclin itself gave *iso*butylamine on hydrolysis, so the structural problem resolves itself into placing unsaturation equivalent to four molecules of hydrogen in the chain of the acid fragment, and clarifying the stereochemistry.

Anacyclin gave an adduct with maleic anhydride (melting point 193° decomp.) which on catalytic hydrogenation absorbed five molecules of hydrogen. In this adduct the dienamide chromophore is eliminated, and when its ultra-violet absorption spectrum was determined, a series of bands became apparent (λ_{max} 227; 237; 252; 266; 281 mμ. ϵ_{max} 1,850; 1,300; 1,100; 1,000; 850). These are characteristic of a diyne containing about 4 per cent of enediyne impurity. Confirmation of acetylenic linkages was obtained from the presence of two weak C≡C str. bands in the infra-red (2,233 and 2,206 cm.$^{-1}$). Their weakness is consistent with lack of conjugation with a polar grouping. The maleic adduct had weak bands at 2,243 and 2,208 cm.$^{-1}$.

The position of the diyne system was determined by oxidative degradation with permanganate. This yielded *N*-*iso*butyloxamic and succinic acids, together with butyric acid (*S*-benzylthiuronium salt) and leads to structure (2):

$$CH_3(CH_2)_2.C{\equiv}C.C{\equiv}C.CH_2CH_2.CH{=}CH.CH{=}CH.CO.NHCH_2CH(CH_3)_2. \quad (2)$$

The formation of an adduct with maleic anhydride indicates a *trans-trans*-configuration for the 2 : 4-diene system. Unpublished reference data[1] obtained from a recent study of the four stereoisomeric *N-iso*-butyldeca-2 : 4-dienamides show that the position of the C=C stretching frequencies in anacyclin, the possession of a band at 996 cm.$^{-1}$ and the absence of one at 960–965 cm.$^{-1}$, are characteristic of the above configuration. The ultra-violet extinction coefficient of anacyclin is also in agreement. Anacyclin is thus *N-iso*butyltetradeca-*trans*-2 : *trans*-4-diene-8 : 10-diynamide.

If methyl deca-2 : 4-diynoate is semi-hydrogenated in the presence of quinoline, using lead-poisoned palladium catalyst[5], the main product is methyl deca-*cis*-2 : *cis*-4-dienoate[1]. When anacyclin is allowed to absorb two molecules of hydrogen under these conditions a waxy crystalline product can be isolated which, on the basis of the above information and its ultra-violet absorption, is formulated as *N-iso*butyltetradeca-*trans*-2 : *trans*-4 : *cis*-8 : *cis*-10-tetraenamide. This unstable compound is very soluble in light petrol, is a strong sialogogue and has a high toxicity towards *T. molitor*. The last finding is of considerable interest because of the light it throws on the structure and stereochemical requirements for a potent polyene-amide insecticide.

The insecticidal testing was carried out by Dr. M. Elliott and Mr. P. Needham, Department of Insecticides and Fungicides, Rothamsted Experimental Station.

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Isolation and Structure of Neo-Herculin from *Zanthoxylum clava-herculis* L.

Southern prickly ash bark (*Zanthoxylum clava-herculis* L.) contains a potent insecticidal substance, which was named herculin (m.p. 59–60°) by Jacobson[1] and claimed to have structure (I). This structure has been disproved[2,3] by syntheses of the four possible stereoisomers of (I), which have different physical characteristics and negligible physiological activity.

$$\text{(I)}\ CH_3CH_2CH_2.CH{=}CH.CH_2CH_2CH_2CH_2.CH{=}CH.CO.NHCH_2CH(CH_3)_2.$$

$$\text{(II)}\ CH_3CH{=}CH.CH{=}CH.CH{=}CH.CH_2CH_2.CH{=}CH.CO.NHCH_2CH(CH_3)_2.$$

A highly unstable but pure compound (m.p. 70°) named *neo*-herculin has now been isolated from the bark and shown to have structure (II). It is very toxic to *Tenebrio molitor* and houseflies and seems to be the major crystalline insecticidal substance present. *neo*-Herculin has the empirical formula $C_{16}H_{25}ON$ (found: C, 77·3; H, 10·2; N, 5·7. $C_{16}H_{25}ON$ requires: C, 77·65; H, 10·2; N, 5·65 per cent) and on microhydrogenation absorbs 3·75 mol. of hydrogen. A mono-substituted amide linkage is present (infra-red absorptions: NH, 3,260, 3,070; amide *A*, C=O, 1,626; amide *B*, 1,559 cm.$^{-1}$). *neo*-Herculin gave *iso*butylamine (hydrochloride, chloroplatinate) on acidic hydrolysis: this demonstrates that unsaturation is contained only in the acid fragment. The carbon skeleton is revealed by the identity of octahydro *neo*-herculin (m.p. 53–54°) with lauric *iso*butylamide.

Ultra-violet light absorption data ($\lambda_{max.}$ 259, 269, 280 mμ; $\epsilon_{max.}$ 31,500; 43,500; 36,200) demonstrate a conjugated triethenoid chromophore. Subtraction of the curve for α-elaeostearic acid leaves an absorption of λ 9,000 at ε 227 mμ, and this indicates that the fourth double bond is to be found α to the amide linkage. Its position is confirmed by the strength of the ethenoid stretching vibration at 1,670 cm.$^{-1}$ in the infra-red[2]. Location of the triene system in the chain was effected by ozonolysis, which yielded acetaldehyde. *neo*-Herculin is therefore N-*iso*butyl-dodeca-2 : 6 : 8 : 10-tetraenamide (I).

Infra-red observations suggest that the αβ-double bond is *trans*-, but the stereochemistry of the triene system cannot be completely defined. *neo*-Herculin does not give a crystalline derivative with maleic anhydride, so two contiguous *trans*- linkages are likely to be absent. The relatively low extinction coefficients in the ultra-violet are consistent with this view[4].

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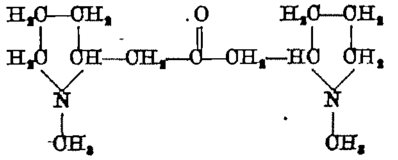
Cuscohygrine, a Normal Constituent Alkaloid of *Atropa belladonna*

In an earlier communication on alkaloids in germinating seeds of *Atropa belladonna*[1], we mentioned that a new alkaloid was the first to appear on paper chromatograms using Dragendorff's reagent. As this alkaloid was always found on chromatograms of extracts of fresh root material and no information about its nature was available, it seemed worth while to make a further investigation.

Starting with 20 kgm. dried roots, about 100 mgm. of a picrate was obtained, which was analysed: melting point, 215° C.; molecular weight, 230; elementary analysis, C, 44·7, H, 4·5, N, 16·1 per cent.



Cuscohygrine

These results, combined with decomposition experiments, which showed it to be a pyrrolidine derivative, led to the conclusion that the substance was cuscohygrine, hitherto only found accompanying coca alkaloids.

This fact was confirmed by comparison with synthetic cuscohygrine (chromatography).

Chromatographic analysis showed it to be present in the roots of the following species: *Atropa belladonna, Hyoscyamus niger, Datura stramonium, D. innoxia, D. ferox, D. metel, Scopolia lurida, S. sinensis, Physochlaina orientalis, P. physaloides* and *Mandragora officinalis*.

This discovery sheds a new light on the role of pyrrolidine derivatives in the biochemistry of the tropane alkaloids, which will be discussed elsewhere.

I wish to thank Prof. F. Galmovsky, University of Vienna, for providing a sample of synthetic cuscohygrine.

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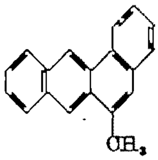
A Novel Synthesis of 4-Methyl-1 : 2-Benzanthracene

Of the various alkylbenzanthracenes, 4-methyl-1 : 2-benzanthracene aroused considerable interest through its pronounced carcinogenic activity[1]. The literature includes a few syntheses of this hydrocarbon[2], but these methods are laborious since they involve numerous steps. We have now worked out a new route to this hydrocarbon in four steps starting from 2-allyl*cyclo*hexanone and tetralin, based on the method developed by Mukherji and co-workers[3] for the synthesis of polycyclic aromatic hydrocarbons.



2-Allyl*cyclo*hexanone was made to react with tetralin in the presence of anhydrous aluminium chloride at 0–5° C., and 2-(β-methyl-β-(6-tetralyl)-ethyl)-*cyclo*hexanone (boiling point 210–215°/6 mm.; η_D^{32} 1·5578) was obtained in 70 per cent yield. Reduction of this ketone with aluminium *iso*propoxide in *iso*propyl alcohol gave the corresponding carbinol (boiling point 190–195°/3 mm.; η_D^{32} 1·5585) in almost quantitative yield. This carbinol was cyclized with concentrated sulphuric acid (1·84) to the corresponding dodecahydro-1 : 2-benzanthracene derivative (boiling point 190–195°/6 mm.; η_D^{30} 1·5600), which was smoothly dehydrogenated with palladium-charcoal (30 per cent) at 300–320° C. for 4 hr. to give 4-methyl-1 : 2-benzanthracene which (purified by regeneration from its picrate) crystallized from alcohol in pale yellow needles (melting point 123–124° C.; lit. (ref. 2*a*) melting point 124–124·6° C.).

The picrate crystallized from alcohol as brown-red needles (melting point 148° C.; calc. for $C_{25}H_{17}N_3O_7$: N, 8·91; found: N, 8·68; lit. (ref. 2*a*) melting point 148–149° C.).

The hydrocarbon gave a trinitrobenzene derivative which crystallized from alcohol as red needles (melting point 168° C.; calc. for $C_{25}H_{17}N_3O_6$: N, 9·23; found: N, 9·03; lit. (ref. 2*a*) melting point 163–164° C.).

Details of this work will be published elsewhere. The microanalyses were carried out by Drs. G. Weiler and F. B. Strauss (Oxford).

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Significance of Metallic Transfer in Orthopædic Surgery

In an earlier communication[1] attention was directed to the transfer of metal which can occur between a screwdriver tip and a screw head during the operation of screwing, and the possible significance this might have in orthopædic surgery was discussed. It was demonstrated by a radioactive tracer method that, whenever a screw is inserted, small fragments of metal are plucked out of the driver and remain adhering to the screw head. It was suggested that, although the amount of metal transferred is very small (about 10–100 μgm.), the particles may form corrosion centres and cause metal ions to pass into the surrounding tissue. This may cause tissue reaction and interfere with normal physiology even in cases where no gross corrosion is observed.

In our earlier work, the presence of abnormally high concentrations of iron in the tissues surrounding buried metals was demonstrated by staining microtome sections of biopsy specimens to give the prussian blue reaction. Recently, biopsy samples of such tissue have been analysed spectroscopically for us by Dr. A. H. Gillieson, of the Atomic Energy Research Establishment, Harwell. The quantities found were compared with the normal concentration of these ions in tissue[2]. All the samples were taken from regions adjacent to stainless steel plates and nails which had been buried in the body for three to four months. None of the cases showed visual evidence of corrosion. The results show that the tissues adjacent to parts of the metal handled with tools during its insertion are abnormally rich in the ions of its constituents. Concentrations up to five times normal were found. The tissues near unhandled parts of the buried metal, however, had ionic concentration not significantly different from normal.

These results confirm quantitatively the picture suggested by examination of the stained microtome sections of tissue, and show clearly that considerable quantities of the ions of the so-called inert metal pass into the surrounding tissues, and that this dissolution is greatest from regions which have been handled with tools during the insertion of the metal.

The amount of metallic transfer depends on the relative hardness and the specific nature of the contacting surfaces[3]. The effect of the hardness of the tool has recently been investigated quantitatively.

Samples of medical drivers and screws have been treated to alter their hardnesses, and the amounts of transfer occurring with various combinations have been measured. The table shows the relative amounts of transfer observed. These figures should be regarded as approximate only, as the amount of transfer showed large variations. All the samples of orthopædic drivers and screws examined had hardnesses of about 150 and 380 V.H.N. respectively, and the transfer under these conditions has been taken as unity. Clearly, the transfer may be reduced appreciably by increasing the hardness of the drivers or softening the screws.

DEPENDENCE OF THE RELATIVE AMOUNT OF TRANSFER ON THE HARDNESSES OF DRIVERS AND SCREWS

	Steel driver, 150 V.H.N.	Steel driver, 360 V.H.N.
Steel screw, 380 V.H.N.	1	$\frac{1}{10}$
Steel screw, 133 V.H.N.	$\frac{1}{2}$	$\frac{1}{16}$

It does not necessarily follow, however, that the smallest electrolytic action will occur when a hard tool is used; although a hard tool will reduce the metallic transfer, it will cause increased mechanical deformation of the oxide layer on the screw and may thus affect the inertness of the metal. Further experiments would be necessary to determine the relative importance of these two factors.

These experiments again indicate that some attention should be given to the tools used in orthopædic surgery, as well as to the buried metal.

We wish to thank Dr. A. H. Gillieson, of the Analytical Laboratory at Harwell, for his aid in the analysis of the biopsy samples.

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A Modified Wedge Method for exciting Shear Modes in Isotropic Media

THE wedge method developed by Bhagavantam and Bhimasenachar[1] has been very useful in the determination of elastic constants of solids. But very often it is found to be difficult to excite and identify the shear modes for the transmission maxima, as they are very weak and are of the same order of intensity as the spurious frequencies of the wedge. However, it has been pointed out[2] that, if small thin specimens are used, shear modes could also be excited, although feebly, due to edge coupling. Recently[3], it has been reported that shear modes cannot be excited in rocks which are coarse-grained and heterogeneous in composition. The method presented here describes a simple modification of the wedge method for exciting and identifying easily only the shear modes in isotropic media and thus overcoming the difficulties inherent in the normal wedge method.

The experimental arrangement consists of the usual Debye–Sears equipment for observing diffraction due to transmission maxima of the section under investigation using an X-cut quartz wedge as a continuous-frequency source. The modification introduced is that the specimen under investigation is placed at an angle to the incident sound wave-front instead of in contact with the wedge as in the usual method. By keeping the plate at an angle, the component of the impinging force that contributes to the shear stress on the specimen will increase and hence the shear modes can be excited intensely. By adjusting this angle to be greater than the critical angle for total reflexion of longitudinal waves in the plate, only transmission maxima due to shear modes are observed with an intensity equal to that of the longitudinal modes for normal incidence. The frequencies at which transmission maxima are observed correspond to the fundamental or harmonic of the shear modes in the plate placed at the appropriate angle. The shear velocity V' in the specimen is determined by using Rayleigh's expression for the condition of maximum transmitted energy at oblique incidence, namely:

$$\sin^2\varphi = (V/V')^2 - (V/2d\,.\,n/\nu)^2,$$

where φ is the angle of incidence of the sound beam on the plate, V the velocity of sound in the liquid in the diffraction cell, d the thickness of plate, n the order and ν the frequency of observed transmission maxima.

Results thus obtained for the shear velocities in some common metals and rocks are given in the accompanying table along with the values obtained by some other methods. All the sections are placed at an inclination of 25°.

Specimen	d (mm.)	$\frac{\nu}{n}$ (Mc./sec.)	Shear velocity (m./sec.)	Velocities obtained by other methods
Aluminium	0·83	2·859	2,843	2,820 (ref. 4)
Brass	0·80	1·651	2,032	2,024 (ref. 2)
Granite	1·18	1·164	2,113	2,370 (ref. 5)
Syenite	1·06	1·414	2,315	2,754 ,,
Shale	0·97	1·463	2,217	2,270 ,,

The advantage of this method is that no difficulty is experienced in identifying shear modes, as they are excited very intensely and the longitudinal modes are eliminated. The accuracy of these determinations is the same as in the normal wedge method. However, the large breadth of resonance present, particularly in coarse-grained rock sections, may lead to slight inaccuracy. But where it is very difficult to excite shear modes at normal incidence, this method is definitely advantageous. The method is at present limited to isotropic media. Full details will be published elsewhere.

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Formation of Compact Pieces of Grey Tin

In a previous communication[1] the formation of compact pieces of grey tin was announced. A spectrophotometrical analysis of the material used indicated the presence of mercury, a metal which does not occur in natural tin. Consequently, the presence of mercury must be responsible for the behaviour of this specific material. This fact led to an investigation of the properties of tin–mercury alloys.

According to the literature[2], addition of more than 2 atomic per cent mercury forms a two-phase system, the phases being tetragonal and hexagonal, the composition of this latter being given as $HgSn_{12}$. At 8 atomic per cent mercury, the tetragonal phase disappears.

We prepared tin–mercury alloys, in the range 0·03–6 atomic per cent mercury, by melting in vacuum. X-ray photographs, taken after annealing, showed the presence of the hexagonal phase already in alloys with more than about 0·2 atomic per cent mercury, that is, at much lower mercury contents than given in ref. 2.

All amalgams showed at − 20° C. an increased rate of transition as compared with that of pure tin (Johnson-Matthey). Above 0·2 atomic per cent mercury the grey tin formed is compact. X-ray photographs showed that the tetragonal tin phase is transformed into the cubic grey modification, whereas the hexagonal phase is still present after the transition in the two-phase system. It might be suggested that the hexagonal phase acts as a matrix, holding the particles of the grey tin together; but microscopical studies have provided so far no evidence in favour of this suggestion.

The presence of a few tenths per cent of mercury increased also the rate of transition of other samples of tin, among them commercial grade tin and even samples of tin containing a small quantity of lead, for example, 0·03 per cent, or 0·1 per cent bismuth. This latter is the more remarkable as these two metals themselves decrease the rate of transition. In all these cases compact pieces of grey tin were formed. Pieces measuring several centimetres in length and about 0·5 cm. thick were obtained in this way.

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External Metasomatism associated with Serpentine

After finding in Turkey that many geosynclinal serpentines appear to be submarine lava flows[1], we re-examined in Ayrshire the only known exposure of an actual contact between the Ballantrae serpentine and associated spilites. The evidence is difficult to disentangle, but it proved beyond doubt that the serpentine is earlier than the particular spilite concerned[2], not vice versa as had previously been supposed. Full publication has been delayed. Here we only wish to emphasize that the spilite, though the later of the two rocks, is strikingly altered for a distance of some few inches in from the contact, and that it is penetrated by some minute veins of serpentinous material, some of which also clearly cut the serpentine itself. Away from the contact the spilite is an olive-green rock, dappled with very pale grey, or whitish, felspars. In its altered border-zone, which has an almost abrupt boundary, it turns reddish, sometimes purplish, with areas that are much paler; and its felspars are completely pseudomorphed by dark green translucent material that appears darker, instead of paler, than the matrix.

Under the microscope, the red coloration of the altered base is seen to be due to a close precipitation of iron ore powder. The paler areas are rich in leucoxene. The pseudomorphed felspars are replaced by some mineral of the chlorite-serpentine category, which also seems to furnish the main constituent of the base.

One important conclusion which we drew was that the parent peridotite of the serpentine still contained fresh olivine when the spilite came into contact with it, for serpentinization of olivine seems to us the only possible source of the magnesian solutions responsible for the alteration of the spilite. Analogies with the development of white trap and of spilite itself are sufficiently obvious. The interest of the occurrence has been greatly enhanced by two subsequent descriptions of almost identical alteration in France. Vuagnat[3] has described the phenomenon in a spilitic pillow–lava–agglomerate with fragmental serpentine matrix in the Montgenèvre district of the High Alps, 180 km. south-south-east of Geneva; and Vuagnat and Jaffé[4] in a "conglomerate", as they call it, containing many spilitic fragments in a "sorte de purée de serpentine", 2 km. east-north-east of Gets in the Prealps, 40 km. east from Geneva. These authors are as clear as ourselves that the alteration in the spilitic material is due to interaction with magnesian solutions. As regards the origin of the serpentine of the matrix, they are non-committal. We are, however, assured that some of the fragments in the matrix of the Montgenèvre occurrence show the typical mesh-structure of normal serpentine along with the usual bastite plates.

The new work carried out at Geneva is backed by rock analyses. These confirm, what is self-evident, the metasomatic nature of the alteration of the spilitic material. They also demonstrate that the main mineral (or minerals) produced is aluminous, and therefore chlorite rather than serpentine.

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Measurement of the Refractive Index of Cytoplasmic Inclusions in Living Cells by the Interference Microscope

A method of measuring the refractive index of living cytoplasm by phase-contrast microscopy was recently developed by Dr. R. Barer and his associates[1,2]. This method consisted essentially of suspending cells in an isotonic protein medium of the same refractive index as the cytoplasm, which then, by phase-contrast, appeared to match the background in brightness and consequently was almost invisible. This formed the starting-point for the present investigation. Phase-contrast cannot normally be employed for the refractometry of cytoplasmic inclusions, since the refractive index of the cytoplasm that surrounds them cannot be varied at will like that of the medium in which the cells are suspended. When the cytoplasm matches the suspension-medium in brightness, a cell-inclusion that appears brighter will generally have a lower refractive index than the cytoplasm, and conversely; but no accurate quantitative estimate can be made.

With the interference microscope, on the contrary, it is possible to measure the actual phase changes produced by objects, and it recently occurred to me that, by its aid, the technique developed by Dr. Barer and his associates might be extended so as to measure the refractive index of cytoplasmic inclusions.

For the present investigation the double-refracting interference microscope of Messrs. Charles Baker was used, and the cytoplasmic inclusion chosen for testing the technique was the spherical *Nebenkern* in the developing spermatid of *Locusta migratoria*. This body is formed during spermatogenesis by the aggregation of all the mitochondria, and has the advantage of being a relatively large, nearly spherical body, lying in an almost completely clear cytoplasm. Also, since it consists mainly of protein and lipoprotein, a fairly close approximation of its water and solid content can be arrived at by assuming a refraction increment (α) of 0·0018 provided that its refractive index can be determined[1-4].

To prepare a suspension-medium that would have exactly the same refractive index as the cytoplasm of the cell, cells were suspended in suitable saline media to which varying amounts of bovine plasma albumin were added. The analyser of the microscope was turned to give a red background with unfiltered light from a ribbon-filament lamp. It was found that when the suspension-medium had a refractive index of 1·3535, the cytoplasm of the spermatids showed exactly the same red colour, and therefore nearly disappeared. This suspension medium was therefore used throughout. (By this method, a variation in the refractive index of the cell cytoplasm of 0·0009, or approximately 0·5 per cent of solid, could be detected without any difficulty.)

The *Nebenkern* was shown by the Becke test to have a refractive index higher than that of the cytoplasm. Under the interference microscope, it naturally appeared in a different colour from the cytoplasm and suspension medium. The phase-shift that caused this difference was measured with light from the same source but filtered through an Ilford 807 filter. This gave a narrow spectrum with (measured) maximum intensity at about 542 mμ. The 2-mm. double-focus objective was used. The analyser was first turned so as to darken the suspension medium and cytoplasm as much as possible, and then the phase-change due to the *Nebenkern* was measured by turning the analyser until the centre of the *Nebenkern* had become as dark as possible. From the measurement of the angle of rotation, it was possible to obtain a value for phase-difference to a fiftieth of a wave-length (or more accurately than this).

The *Nebenkern* being approximately spherical, its maximum depth along the optical axis of the microscope can be taken as being the same as that at right-angles to the optical axis. It is probable that in no case was the error of this measurement greater than 0·4 μ.

The refractive index, n, of the *Nebenkern* was calculated from the formula:

$$n = \frac{\theta}{360} \times \frac{\lambda}{t} + m,$$

where θ is the phase-change due to the *Nebenkern*, expressed as an angle, λ the wave-length of the light used (taken as 542 mμ), t the thickness (diameter) of the *Nebenkern*, and m the refractive index of the cytoplasm and suspension medium (1·3535, equivalent to about 10·7 per cent of solid).

Table 1 shows the values for the refractive index of the *Nebenkern* derived from measurements of this body in twenty different cells. The mean figure is 1·376. This suggests that the concentration of protein and lipoprotein in this cytoplasmic inclusion is on the average about 23 per cent. Even in adjacent cells, *Nebenkerns* having the same diameter were sometimes found to give appreciably different phase-changes; and this could indeed be expected, since the mitochondria only gradually coalesce to form a single body. Part of the variation in the refractive index of the *Nebenkern* was thus due to variation in the material itself. It is difficult to assess the actual error of the technique. Error is more likely to arise from measurement of the diameter than from measurement of phase-change. With objects as large as the *Nebenkern* the measurement of refractive index is unlikely to have been wrong by more than ± 0·004, or 2 per cent of protein.

Table 1

Locust No.	Diameter of *Nebenkern* (μ)	Phase-change (retardation in degrees)	Refractive index	Approx. per cent solid (assuming $\alpha = 0{\cdot}0018$)
1	4·2	66	1·3771	24 0
1	4·2	78	1 3814	26·0
1	4·2	76	1·3807	26·0
2	4·2	60	1·3750	22·5
2	4·2	68	1·3778	24·0
1	4·7	68	1·3751	22·5
1	4·7	72	1·3764	23·5
2	4·7	72	1·3764	23 5
2	4·7	74	1·3770	24·0
2	4·7	66	1·3745	22·0
2	4·7	78	1·3783	24·5
2	4·7	76	1·3777	24·0
2	4·7	58	1·3720	21·0
2	4·7	64	1·3739	22·0
2	5·3	68	1·3730	21·5
2	5·3	70	1·3736	22·0
2	5·3	76	1·3753	23·0
2	5·3	70	1·3736	22·0
2	5 3	64	1·3719	21 0
2	5·3	72	1·3742	22·0

I wish to thank Dr. J. R. Baker for letting me work in his laboratory and for his advice; and Mr. F. H. Smith, of Messrs. Charles Baker (the inventor of the instrument), for a valuable discussion. I am also indebted to Dr. I. W. Selman, of the Department of Biological Sciences, Wye College, for leave to carry out this work at Oxford.

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Cytology of the Scrophulariaceae and Orobanchaceae

In a previous communication[1], the occurrence of prochromosomes and of size differentiation in the chromosomes of *Rhinanthus minor* Ehrh. were described. Further work has led to the conclusion that the small chromosomes are constant in occurrence and number in *Rhinanthus minor* Ehrh., and that the basic number for the genus *Rhinanthus* is probably $x = 11$. This is the same basic number as the related genus *Euphrasia*, which also possesses a prochromosomal resting nucleus. No evidence of any size differentiation in the chromosome complement of *Euphrasia* exists (P. Yeo, private communication). Other members of the *Rhinanthus minor* aggregate, including *R. borealis* (Sterneck) Marshall, and dwarf plants like *R. perrieri* Chabert (with fuscous spotted corollas) from Shetland, have been found to possess the chromosome number $2n = 22$. Fourteen large chromosomes and a number not yet determined of smaller chromosomes have been observed in *R. calcareus* Wilmott and *R. stenophyllus* (Schur.) Druce. Continental *R. major* Ehrh. has been found to possess chromosomes similar in number and size differentiation to those of the *R. minor* aggregate shown in Fig. 1. Fagerlind[2], in 1936, described the eight smaller chromosomes in the diploid complement of *Alectorolopus* (*Rhinanthus*) *major*, and gave the chromosome number as $n = 11$ for this species.

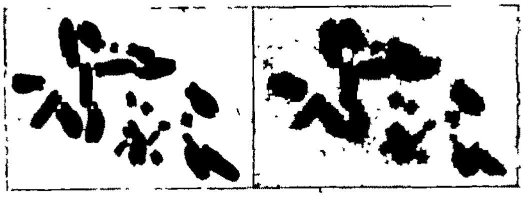

Fig. 1. Root tip chromosomes of *R. minor* Ehrh. at metaphase, showing size differentiation. × 1,500

Melampyrum cristatum L., a species morphologically related to *Rhinanthus* and *Euphrasia* (and like them a hemiparasite), has been examined cytologically. The resting nucleus of this species contains no prochromosomes, the chromatic material being contained in numerous small chromocentres. The diploid number for *M. cristatum* L. is $2n = 18$, which agrees with counts for other members of this genus. The chromosomes at meiosis appear to be of approximately uniform size.

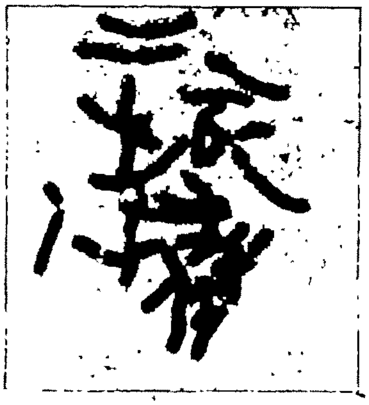

Fig. 2. Mitotic metaphase in the sporogenous tissue of an anther of *Orobanche purpurea* Jacq. The chromosomes are large and the centromeres are distinctly visible at this stage. × 1,500

Note added October 7. *Parentucellia viscosa* (L.) Caruel, formerly known as *Bartsia viscosa* L., another hemiparasitic member of the Scrophulariaceae, has been found to possess $2n = 48$ chromosomes, that is, it has the same basic number $x = 12$ as *Bartsia alpina* L., which is recorded[3] as possessing $2n = 24$ chromosomes.

Species of *Orobanche* in Britain shown to possess $2n = 38$ chromosomes include *O. minor* Sm., *O. maritima* Pugsl., *O. elatior* Sutton., *O. reticulata* Wallr., *O. picridis* F. Schultz, *O. hederae* Duby, *O. rapum-genistae* Thuill and *O. caryophyllacea* Sm. The above species of *Orobanche* are members of the subgenus *Osproleon* Wallr. *O. purpurea* Jacq. from Norfolk has been shown to possess the number $2n = 24$, counts having been obtained in both mitotic (Fig. 2) and meiotic preparations. *O. purpurea* Jacq. has been placed in the subgenus *Trionychon* Wallr., members of which differ from the subgenus *Osproleon* in their possession of two prophylls in addition to each bract. It has now been shown that there are cytological as well as morphological grounds for this division of the genus *Orobanche*.

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Systematic Position of the Genus *Oscillospira*

The bacterial nature of the genus *Oscillospira* has been the subject of some dispute; Delaporte[1] considered the group to be Myxophyceae adapted to a parasitic mode of life, which had lost some algal characteristics, and Pringsheim[2] considered it truly bacterial. It has recently been shown to possess typical eubacterial nuclear structures[3]. Pringsheim[2] reported that Robinow had demonstrated flagella, but these structures have not previously been illustrated. It has also proved difficult to demonstrate the existence of true cross-walls between the component cells. These characters constitute one of the most important cytological distinctions between bacteria and Myxophyceae[4].

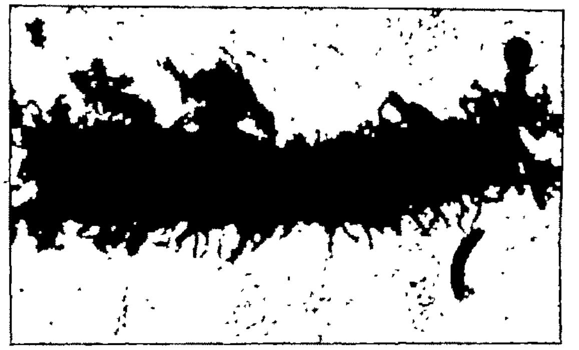

Fig. 1. *Oscillospira guilliermondi*. Kirkpatrick's flagella stain. Preparation made from guinea pig caecal contents, with other micro-organisms adjacent. × 650

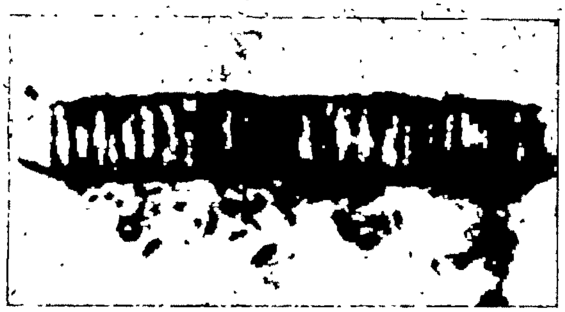

Fig. 2. *O. guilliermondii.* Trichome, consisting of numerous disk-like cells. Cross-walls stained by Hale's method. × 1,000

Both flagella and cross-walls of a distinctly bacterial character have now been demonstrated in *Oscillospira guilliermondii* in the cæcal contents of guinea pigs. Fig. 1 shows a trichome with numerous peritrichous flagella, stained by Kirkpatrick's technique[5]. Fig. 2 shows a similar trichome, in which the cross-walls have been demonstrated by Hale's phosphomolybdic acid–methyl green technique[6].

The demonstration of these structures establishes the eubacterial nature of *Oscillospira* beyond question, despite its relatively enormous size.

I wish to acknowledge the assistance of Miss C. M. F. Hale, who made the preparation shown in Fig. 2.

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Antiœstrogenic Potencies of Various Progesterone Derivatives with Oxidation at C_{11}

EVIDENCE has been given that certain antiœstrogenic potencies of progesterone such as the antifibromatogenic, antihysterotrophic and antiluteinizing ones are diminished by oxidation at C_{21}, C_{11} and C_{17}. Thus, deoxycorticosterone (C_{21}—OH) is less antifibromatogenic and less antiluteinizing than progesterone; dehydrocorticosterone, or substance *A* of Kendall (C_{11}=O), is less antifibromatogenic than deoxycorticosterone; 17-hydroxy-deoxycorticosterone, or substance *S* of Reichstein, is neither antifibromatogenic nor antihysterotrophic[1-4]. More recently, the workers of the Upjohn Co. have obtained various derivatives of progesterone by oxidation at C_{11} such as 11-keto-progesterone, 11-α-hydroxyprogesterone and 11-β-hydroxyprogesterone; these compounds, when tested in various ways, have been found to be only about 3–10 per cent as progestational as progesterone, or even less than that[5,6]. Our former knowledge of the diminution of the antifibromatogenic potency through oxidation at C_{11} has been obtained only in comparative work with deoxycorticosterone and dehydrocorticosterone[3]; this is why we thought it convenient to test the three new C_{11}-derivatives of progesterone mentioned as to their antifibromatogenic and antihysterotrophic potencies.

11-*Ketoprogesterone.* All animals had a pellet of œstradiol subcutaneously implanted. The specific steroid to be tested was administered by absorption from one or two pellets containing 40 and 80 per cent of the substance mixed with 60 or 20 per cent of cholesterol; the absorption-rate of pure 11-keto-progesterone was about three times that of progesterone. There was an antifibromatogenic and antihysterotrophic action in all groups as seen when compared with substances VIII–X (see table); but potency was much smaller than with progesterone (IV, V).

11-β-*Hydroxyprogesterone.* Pellets containing 40 and 80 per cent of this substance were used; absorption-rate of the pure substance was almost twice that of progesterone. Activity was very similar to that of 11-keto-progesterone.

11-α-*Hydroxyprogesterone.* The absorption-rate of the pure compound was three times that of progesterone; pellets containing 40 and 80 per cent of the substance were used. There was no antifibromatogenic potency; the fibrous tumoral effect was similar to that of animals receiving œstradiol only. There was a slight antihysterotrophic action. The difference between the two 11-hydroxy-stereoisomers is very remarkable. It may be remembered that a similar situation was found when studying the 17-hydroxy-corticoids: they are all 17-α and lack antifibromatogenic and antihysterotrophic potency[1,2]. The difference between testosterone-17-β and testosterone-17-α (or *cis*testosterone) also is remarkable: the latter showed no antifibromatogenic action with quantities three times those of testosterone[1,3].

Fig. 1 summarizes the comparative results obtained by various workers and also our group in experiments in which steroids with oxidation at C_{21}, C_{11} and C_{17} have been used. Not all the luteoid potencies have been studied so far in a satisfactory manner; a comparative study of the antiluteinizing potency of the C_{11} derivatives of progesterone is in progress.

EXPERIMENTS IN 77 CASTRATED FEMALE GUINEA PIGS RECEIVING DURING THREE MONTHS ŒSTRADIOL AND PROGESTERONE (P), OR 11-KETO-PROGESTERONE (11-KETO-P), OR 11-β-HYDROXY-PROGESTERONE (11-β-OH-P), OR 11-α-OH-PROGESTERONE (11-α-OH-P)

	Specific steroid	No. of animals	Œstrad. per day (μgm.)	Spec. steroid per day (μgm.)	Fibrous tumoral effect*	Coeff. Q_{a-s}*	Ut. weight (gm.)	Specific steroid No. of pell., percentage in mixture
I	11-keto-P	10	52	75 (62–86)	2·6 (1·5–5·5)	0·3	2·0 (1·1–4·2)	2; 40 per cent
II	11-keto-P	6	41	277 (253–318)	2·4 (1–5·5)	0·5	2·1 (0·7–4·5)	1; 80 „
III	11-keto-P	7	49	577 (522–626)	1·7 (1–3)	0·1	1·4 (0·7–2·9)	2; 80 „
IV	P	5	50	92 (83–106)	1·0 (1–1)	0	1·5 (1–2·3)	1/4; pure
V	P	10	47	200 (126–306)	1·2 (1–1·5)	0	1·4 (0·5–2·2)	1/2 and 1; pure
VI	11-β-OH-P	9	37	78 (60–96)	2·7 (1·5–7)	0·7	1·7 (1·1–2·3)	4; 40 per cent
VII	11-β-OH-P	6	45	490 (360–578)	2·2 (1–4·5)	0·2	1·9 (1·4–2·5)	2; 80 „
VIII	11-α-OH-P	14	55	74 (55–127)	4·6 (1·5–9·5)	1·2	5·8 (3·1–9·6)	4; 40 „
IX	11-α-OH-P	4	44	270 (250–293)	5·5 (2·5–9)	1·5	3·7 (3·1–4·2)	1; 80 „
X	11-α-OH-P	6	47	460 (424–497)	5·0 (2–8)	1·5	2·8 (1·7–3·6)	2; 80 „

* Lipschutz, A. and Maass, M., *Cancer Research*, 4, 18 (1944).

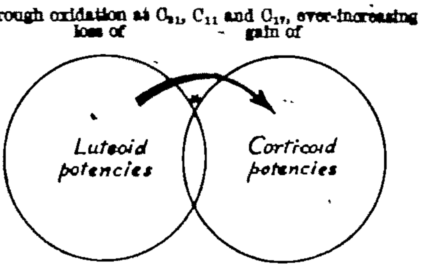
Through oxidation at C_{21}, C_{11} and C_{17}, ever-increasing:
loss of
gain of
Luteoid potencies
Corticoid potencies

Fig. 1. Luteoid potencies: (1) progestational; (2) antioestrogenic: (a) antifibromatogenic; (b) antihysterotrophic; (c) antiluteinizing

Thanks are due to Drs. A. C. Ott and W. W. Byrnes, of the Upjohn Company, Kalamazoo, Mich., for a liberal supply of the steroid compounds and for information about some of their luteoid potencies.

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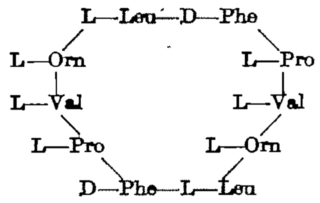
Gramicidin *S*: Relationship of Cyclic Structure to Antibiotic Activity

GRAMICIDIN *S* is a polypeptide antibiotic elaborated by a strain of *Bacillus brevis*[1]. Its postulated structure, well substantiated by experimental results[2], is that of a cyclic decapeptide of the following nature[3]:



The peptide contains a five amino-acid sequence which appears twice. It also contains an amino-acid of the D ('unnatural') configuration, D-phenylalanine, and an amino-acid rarely encountered in naturally occurring peptide structures, L-ornithine.

Harris and Work[4], in order to investigate the structural characteristics of this peptide which might be responsible for its antibacterial activity, synthesized several model non-cyclic peptides and derivatives, including three pentapeptide derivatives having the proper sequence. In one case L-phenylalanine replaced the D-isomer. None of these compounds was found to have more than negligible antibacterial activity. It was concluded that the activity does not seem to be directly related to the presence of D-phenylalanine or L-ornithine but that "the biological activity of gramicidin *S* is intimately related to its cyclic structure". This conclusion is repeated in a review by Bricas and Fromageot[5].

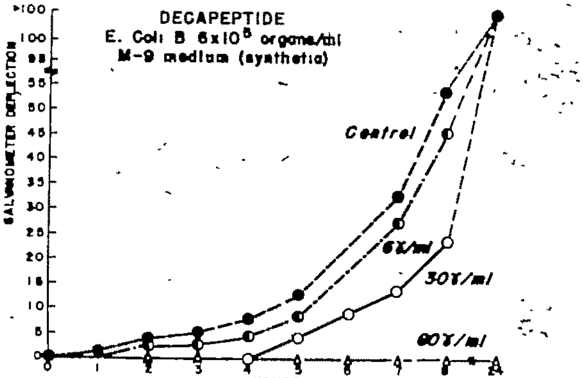


Fig. 1

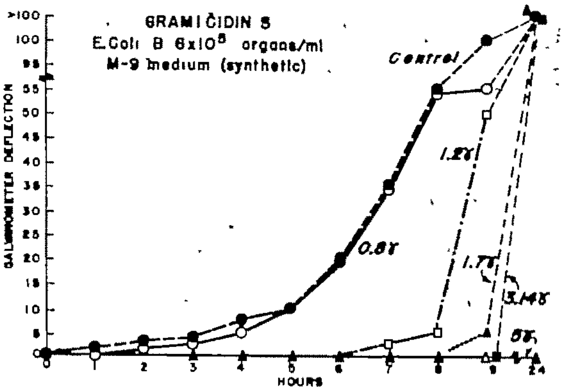


Fig. 2

Erlanger, Sachs and Brand[6] have synthesized, among other related peptides, the straight-chain decapeptides: H. Val – *p*. Tos. Orn – Leu – Phe – Pro – Val – *p*. Tos. Orn – Leu – Phe – Pro. OMe. HCl (L–L–L–D–L)$_2$ and H. Val – Orn – Leu – Phe – Pro – Val – Orn – Leu – Phe – Pro. OH. 3HCl (L–L–L–D–L)$_2$. The latter is identical in structure and sequence with gramicidin *S* except that it is acyclic. The former is, in addition, substituted with a *p*-toluenesulphonyl group on the δ-amino group of each ornithine. The unsubstituted peptide has been found to be biologically active against *Staph. aureus* and *E. coli*. The tosylated compound and other smaller peptides[6] including the pentapeptide H. Val – Orn – Leu – Phe – Pro. OH. 2HCl (L–L–L–D–L) are inactive.

Figs. 1 and 2 compare the antibacterial activity of the decapeptide with that of gramicidin *S* against *E. coli*. In a synthetic medium with an inoculum of 600,000 organisms/ml., the peptide is bactericidal in a concentration of 60 γ/ml. Under identical conditions, 5 γ/ml. of gramicidin *S* gave a similar effect. At lower concentrations both substances increase the length of the lag period. Preliminary work indicates that the surviving organisms possess enzymes capable of destroying or neutralizing the compound. This enzymatic capacity is lost after a single transfer of the organism in fresh medium.

Similar findings were obtained with *Staph. aureus*, the bactericidal concentrations being 3 γ/ml. for gramicidin *S* and 120 γ/ml. for the decapeptide, respectively.

Unless it is assumed that the modes of action of gramicidin *S* and the decapeptide differ, despite their great similarity in structure, one is forced to the conclusion that the cyclic structure is not directly or intimately related to activity. The lack of activity of the pentapeptide rules out the specific influence of D-phenylalanine or L-ornithine, although these amino-acids may be essential to an overall structure possessing activity.

The greater activity of gramicidin *S* may be due to a lesser susceptibility to destruction by bacterial enzymes. A cyclic structure can be attacked only by endopeptidases, and the presence of D-phenylalanine and L-ornithine would materially decrease the number of enzymes capable of hydrolysing this compound. On the other hand, the straight-chain compound is also susceptible to amino- and carboxypeptidases.

Work is continuing with the aim of correlating antibacterial activity more closely with molecular structure.

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[1] Gause, G. F., and Brazhnikova, M. G., *Lancet*, ii, 715 (1944).

[2] Consden, R., Gordon, A., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, 41, 596 (1947). Battersby, A. R., and Craig, L. C., *J. Amer. Chem. Soc.*, 73, 1887 (1951). Sanger, F., *Biochem. J.*, 40, 261 (1946). Hodgkin, D. C., Cold Spring Harbor Symposia, 14, 65 (1949).

[3] Abbreviations are discussed in ref. 6. In general, the first three letters are used to designate the amino-acid residue, for example, Leu = leucyl residue.

[4] Harris, J. I., and Work, T. S., *Biochem. J.*, 46, 196, 582 (1950).

[5] Bricas, E., and Fromageot, C., "Adv. Prot Chem.", 8, 1 (1953).

[6] Erlanger, B. F., Sachs, H., and Brand, E., *J Amer. Chem. Soc.*, 76, 1806 (1954).

Intracellular Sites of Metabolism of 3 : 4 Benzpyrene in Mouse Liver

PREVIOUS work[1] has shown that after intravenous injection of colloidal 3 : 4 benzpyrene the bulk of the carcinogen is held in the liver. Excretion takes place over approximately twenty-four hours, the hydrocarbon having undergone metabolic oxidation to one or other of two compounds labelled BpX_1 or BpX_2. These are oxidation products and have been characterized by physical methods and analogy with known derivatives of other polycyclic hydrocarbons as being: 8(OR_1) – 9(OH) – 8,9 dihydro 3 : 4 benzpyrene and 8(OR_1) – 9(OR_2) – 8,9 dihydro benzpyrene respectively. The groups R_1 and R_2 are, at present, unidentified radicals. It has also been found[1,2] that during metabolic oxidation the products derived from 3 : 4 benzpyrene are firmly bound within the tissues where they are formed.

Working upon these facts, we have endeavoured to trace the sites at which oxidation occurs. Groups of 6–8 mice have been injected intravenously with 0·05 mgm. of benzpyrene as a colloid in water. At intervals up to 24 hr. they have been killed, the livers removed, homogenized in Tyrode solution and separated centrifugally into nuclei, mitochondria, microsomes and supernatant. Each fraction has been extracted for benzpyrene metabolites, using the method devised by Weigert[3]. Final purification has been by column chromatography on silica. Estimation of the metabolites was by absorption spectra over the range 340–430 mμ and confirmed by the fluorescence spectra.

Under these conditions the metabolite BpX_2 has been found in all four fractions at time intervals of 2¼, 4, 8, 12, 17 and 24 hr. after injection of the hydrocarbon. Over the same time intervals BpX_1 was only found in the supernatant fraction. Unchanged benzpyrene was regularly found in the nuclear, mitochondria and microsome fractions, but could only be detected in trace amounts in the supernatant fractions.

Since it is possible to argue that the metabolites were adsorbed to the different fractions during the homogenization or centrifuging, a further series of experiments was undertaken. Batches of untreated liver were fractionated as previously and each fraction was then suspended in Tyrode solution containing colloidal benzpyrene. They were placed in the incubator at 37° C. in total darkness, this latter condition being imposed by the necessity for avoiding any photosensitizing action by the hydrocarbon. After periods of up to 2½ hr. incubation, they were extracted as previously and examined for metabolites. BpX_2 was obtained from all four fractions and BpX_1 from the supernatant only. These results show that metabolism must occur within the fractions themselves.

The penetration of benzpyrene into all parts of the cell and its engagement in chemical activity at various sites closely parallels the findings of Danielli[4] and his co-workers with regard to nitrogen mustard. These workers concluded that the action of this compound, which is also carcinogenic, is 'diffuse', and it now appears that benzpyrene behaves in similar fashion.

A detailed account of this work will be published elsewhere.

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Nitrogen Fixation by Soil Yeasts

SINCE the discovery by Starkey and De[1] of the soil bacterium *Azotobacter indicum*, which is capable of fixing atmospheric nitrogen under acid conditions, many unsuccessful attempts have been made to isolate this species from acid soils in western Europe. In one such attempt, preliminary experiments had suggested that the soil of a *Betula* – *Calluna* heath in Kent contained organisms able to fix atmospheric nitrogen, but attempts to isolate these organisms by the 'still culture' enrichment method failed. This method is not suited to the isolation of organisms present in acid soil in very small numbers: for such organisms continuous perfusion of a large volume of soil with selective media is a far superior method.

Columns of heath soil (pH 4·5 approx.) taken from the *A*1 horizon of the podsol beneath *Calluna vulgaris* were continuously perfused with media containing a carbon source but no source of fixed nitrogen. On different occasions mannitol, benzoate, various esters and alcohols were used. The perfusate and the soil were sampled at intervals for micro-organisms by streaking on a medium of composition similar to that of the perfusate. Various fungi and bacteria appeared on the plates, particularly on the mannitol plates; on individual transfer to new medium in an atmosphere free from ammonia all failed to grow, with the exception of two yeasts from the mannitol perfusate, which grew slowly but steadily. These two yeasts, one (non-sporing) resembling a *Saccharomyces* and one a pink *Rhodotorula*, were inoculated into nitrogen-free mannitol-phosphate liquid medium and periodically aerated with ammonia-free air; growth was steady and after fourteen days a considerable deposit of yeast had formed. Assessment of nitrogen-content by the micro-Kjeldahl method showed a high gain compared with controls, a gain well above the errors of estimation and corresponding to a rate of fixation (on different occasions) of up to 4 mgm. nitrogen per gm. of mannitol originally available. An interesting feature of these nitrogen-starved yeasts was the presence of large oil globules in the cells and a very sparse retention of dye when stained by Gram's method.

In the course of further extensive investigations by Chayen, using perfusion enrichment followed by isolation on nitrogen-free media, a large number of yeasts have been isolated from the *A*1 horizon of the same *Calluna* heath soil. A representative sample of these was tested for ability to grow in aerated nitrogen-free media under conditions ensuring the rigid exclusion of atmospheric ammonia; some twenty isolates grew under these conditions. Tests for increase in fixed nitrogen by micro-Kjeldahl estimation on the whole culture gave significant gains; for one *Rhodotorula* these gains corresponded to the fixation of 1–3 mgm. of atmospheric nitrogen per gm. of glucose available. Further tests on this *Rhodotorula* and on another isolate, using an isotopic nitrogen technique, are described in the following communication by Roberts and Wilson.

In addition to the nitrogen-fixing yeasts, two quite distinct strains of nitrogen-fixing bacteria of the genus *Azotobacter* have been isolated using mannitol as the perfusate. These bacteria are distinct from previously described 'species' of *Azotobacter*, including *A. indicum*. This work, with descriptions of the organisms and their growth under differing experimental conditions, will be published in detail elsewhere.

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[1] Starkey, R. L., and De, P. K., *Soil Sci.*, 47, 329 (1939).

A METHOD has been developed in this laboratory whereby the rate-constant of the nitrogen-fixation process is obtained solely from isotope abundance measurements[1]. At the suggestion of Metcalfe and Chayen, we have applied this method to certain soil yeasts isolated by Chayen and have confirmed their observations that these organisms are capable of taking up molecular nitrogen (see preceding communication).

Cultures of two yeasts, *Rhodotorula* (I) and *Saccharomyces* (II), were studied; they were thought to have nitrogen-fixing capacities 1/10 and 1/50, respectively, of that of *Azotobacter*. An atmosphere consisting of oxygen, argon and nitrogen, the latter containing 32·0 atom per cent excess of nitrogen-15, was circulated through duplicate cultures of the yeasts in a medium free from combined nitrogen. The cells were actively budding immediately prior to the experiment. At the end of four hours, the cells were harvested, subjected to Kjeldahl digestion, and the ammonia produced converted to nitrogen by reaction with sodium hypobromite. The isotope abundance in these samples was determined by means of a mass spectrometer; the abundance of nitrogen-15 in ordinary air was 0·41 per cent.

Culture	Atmosphere			Percentage nitrogen-15 in cell nitrogen	
	p_{N_2}	p_{O_2}	p_A	(i)	(ii)
I	0·17	0·40	0·30	1·38	1·41
II	0·04	0·40	0·40	0·45	0·48

These results show clearly that the yeasts, especially I, had taken up molecular nitrogen. Moreover, the extent to which fixation occurred was consistent with expectations based on total nitrogen determinations.

We are indebted to the Royal Society for a grant with which the isotopic nitrogen used in this experiment was purchased, and to Dr. G. A. Meek, who performed the isotope analyses. One of us (T. G. G. W.) is indebted to the Middlesex Education Committee, and to Glaxo, Ltd., for financial assistance.

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[1] Pethica, B. A., Winter, E. R. S., and Roberts, E. R., *Biochim. et Biophys. Acta*, 14, 85 (1954).

Acceleration of Flowering in Non-vernalized Chrysanthemums by the Removal of Apical Sections of the Stem

IT has been shown that plants of *Chrysanthemum morifolium* 'Sunbeam' (incorrectly termed 'Indian Summer'), raised from basal cuttings taken from parent plants grown and flowered at high temperatures, require a period of low temperature or vernalization in order that normal stem elongation and rapid flowering may occur. Without such a period of low temperature these plants grown in high temperature conditions (> 60° F.) fail to elongate normally and are considerably delayed in flowering[1].

If an apical section of the stem is removed, however, the two or three lateral shoots thus induced to develop do not show the rosette habit and diageotropic growth characteristic of the main axis, and flower rapidly (see Fig. 1).

Non-vernalized plants of 'Sunbeam', from cuttings taken on December 30, 1953, were grown at temperatures above 60° F. in natural day-length conditions until June 15, 1954. On this date the plants, which had laid down approximately fifty leaves, were cut back to twenty-five, thirty-five or forty-five leaves, or left intact, and were placed immediately in short-day (10-hour) conditions. The laterals, which developed as a result of removal of the apical sections, elongated normally and rapidly produced macroscopically visible buds. The main axis of the intact

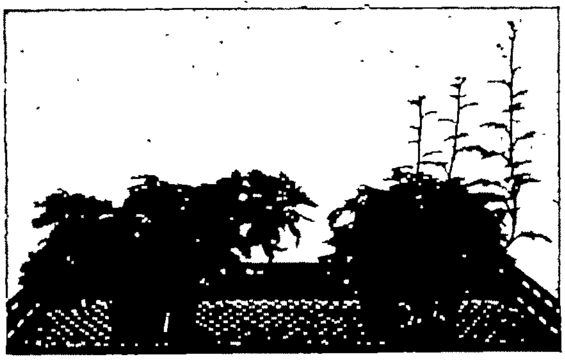

Fig. 1. Non-vernalized plants of 'Sunbeam' after seven weeks of short-day conditions. Left, intact plant; right, plant cut back to 25 leaves

plants continued to show rosetting and diageotropic growth, and flowered only after a considerable delay. The acceleration of flowering is shown by the decreased number of weeks to bud (from the date of commencement of the short-day treatment) of the distal lateral of the cut-back plants compared with the terminal bud of the main axis of the intact plants (Table 1). The number of leaves laid down on the terminal laterals of the cut-back plants and the approximate number of leaves laid down on the main axis of the intact plants, from the commencement of the short-day treatment to flowering, is also shown in Table 1. The increase in internode elongation of the lateral shoots is also apparent.

Removal of apical sections from non-vernalized plants of 'Sunbeam' resulted, therefore, in accelerated flowering and normal elongation of the internodes on the distal lateral shoots when the plants were grown in short-day, high-temperature conditions, and apparently removed the source of some substance normally inhibiting flowering and internode elongation in such non-vernalized plants. The production of a single inhibiting substance by the vegetative apex of non-vernalized plants preventing both internode elongation and flowering would appear to be too simple a hypothesis; but it seems likely from these results that, in this variety, some inhibiting substance is produced by the apex of the main axis which is not produced, or produced to a lesser degree, by the apices of the lateral shoots which develop when apical dominance is removed.

Another variety, 'President', which entirely fails to flower when not vernalized and shows extreme rosetting[2], did not show the same response to removal of an apical section of the stem. A slight increase in elongation of the internodes of the lateral shoots was observed initially, but afterwards the rosetted habit was resumed and the lateral shoots failed to flower except in two instances (16·5 per cent of the plants). In no case did plants flower on the main axis. In this variety, which shows a more extreme type of behaviour (rosetting and failure to flower) in the non-vernalized condition, the inhibiting effect is apparently re-imposed in the lateral shoots when the apical sections are removed in short-day conditions. Evidence from a further experiment, as yet incomplete, suggests that if a sufficient number of long-day cycles is given after decapitation, the inhibition is not completely re-imposed and some lateral shoots are able to elongate, and will afterwards flower when placed in short-day conditions. These experiments will be reported in more detail elsewhere.

Table 1. EFFECT OF REMOVAL OF APICAL SECTIONS OF THE STEM ON FLOWERING AND INTERNODE ELONGATION IN *Chrysanthemum morifolium* 'SUNBEAM'

	Intact plants*	Cut back* to leaf No. 25	35	45	L.S.D. at $P = 0·05$
No. of weeks to bud from commencement of short day	12·00	8·25	7·00	6·25	2·64
No. of leaves formed from commencement of short day to flowering	36·00	15·75	15·75	13·75	10·64
Mean internode length (cm.)	0·60	1·13	1·09	1·66	0·52

* Figures for intact plants refer to the main axis. Figures for cut-back plants refer to the distal lateral only.

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Sept. 28.

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[1] Schwabe, W. W., *J. Exp. Bot.*, 1, 329 (1950).

[2] Vince, D., *J. Hort. Sci.* (in the press).

Occurrence of *Haplosporangium parvum* in the Lungs of the Mole (*Talpa europaea*)

DURING the spring of 1947 and again in 1953, large numbers of dead and dying moles were found on the Berkshire Downs, and examination (by A. McD.) of many of these and of others trapped at the same time showed evidence of pneumonia. Lesions of a granulomatous nature, varying greatly in size, were scattered throughout the lungs, often protruding above the surface, and histological examination showed these reactions to be invariably associated with the presence of a central thick-walled spherule, 100–200 microns in diameter (Fig. 1). Material from these animals was examined in the course of a survey of animal mycoses sponsored by the Agricultural Research Council, and the spherules were recognized as bearing a close resemblance to those found in *Haplosporangium parvum* Emmons and Ashburn infection in small mammals, hitherto only reported from North America by Emmons and Ashburn[1] and Dowding[2].

Fresh material from the Berkshire epizootic not being available, a number of moles trapped in the Exeter district were examined (by P. K. C. A.) during May 1954, through the kind co-operation of the Devon Agricultural Executive Committee, and, from lesions similar to those described above, typical *Haplosporangium parvum* was isolated in culture. Of thirty-one apparently healthy moles from Devon and

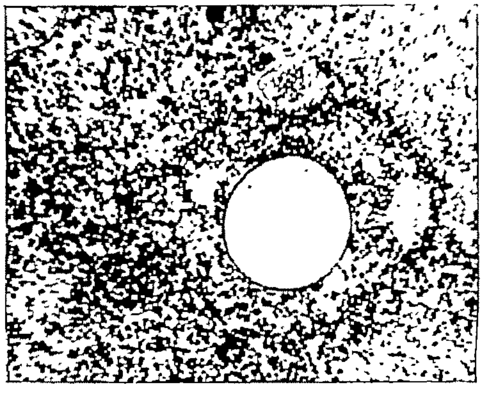

Fig. 1. Section of mole lung showing thick-walled spherule. × 100

Berkshire, twenty-five had spherules present in varying numbers in the lungs. The isolate has the 'granular type' of colony described by Carmichael[3], forms conidia 3–4 microns in diameter and, with a spherule diameter of 100–390 microns, agrees well with the northern strain of the fungus (Dowding[2]). This appears to be both a new host species and the first record for Europe, although we believe *H. parvum* is now known in several other parts of the world.

The role, if any, of *Haplosporangium parvum* in the periodic fluctuations in the mole population of Britain, which occur about every six years (cf. Elton[4]), is undoubtedly complicated by the additional presence in those lungs we have examined of a nematode (species not yet identified), and at least one pathogenic aerobic actinomycete (*Nocardia* sp.). The significance of these organisms, especially in apparently healthy animals, is in no way understood.

Herbarium specimens and cultures have been deposited at the Mycological Reference Laboratory, London School of Hygiene and Tropical Medicine, and at the National Microbiological Institute, Bethesda, Maryland.

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[1] Emmons, C. W., and Ashburn, L. L., *Pub. Health Rep. Wash.*, 57, 1715 (1942).

[2] Dowding, E. S., *Can. J. Res.*, 25, 195 (1947).

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Transmigration of Unborn Mice

The evidence on transuterine ('internal') migration, that is, the passage of ova down the oviduct and uterine horn of one side into the uterine horn of the other side, has recently been summarized by Boyd and Hamilton[1]. They found no record of the phenomenon in any rodent on which relevant observations had been made (rabbit, guinea pig, rat and field vole). Young[2] has, however, since demonstrated its occurrence in the rat.

In the course of fertilized egg transfers, we have found that transuterine migration of fertilized eggs can also occur in mice. Fertilized eggs were collected from immature albino females, $2\frac{1}{2}$ or $3\frac{1}{2}$ days after they had been artificially induced to ovulate[3] and mated to albino males. The eggs were injected by the method of Fekete and Little[4] into the upper part of the left uterine horn of adult females mated $2\frac{1}{2}$ or $3\frac{1}{2}$ days previously. Shortly before term, the recipients were killed and the contents of their uteri examined. Since the recipients and their mates were homozygous for full colour, embryos derived from transferred eggs could be distinguished from the native embryos by eye colour.

Of twelve embryos derived so far from eggs transferred $2\frac{1}{2}$ days after ovulation, one was found implanted in the right (uninjected) horn. Of thirty-four derived from eggs transferred at the $3\frac{1}{2}$-day stage, three were found in the right horn.

It is possible that the phenomenon does not occur in normal pregnancies, and that these transmigrations were assisted by the pressure of the fluid medium in which the eggs were injected. Conclusive evidence would be provided by the injection of unfertilized eggs into the *bursa ovarii* and their fertilization in the host animal. By the time that such eggs arrived in the uterus, the hydrostatic condition of the two sides of the reproductive tract would surely have become equalized. An experiment of the required type was recently performed by Runner and Palm[3]. Of twenty embryos derived from transferred eggs, none was found implanted on the uninjected side. But the numbers involved are small and there is no significant discrepancy between this result and our own.

We are in receipt of a research grant from the Agricultural Research Council, which we gratefully acknowledge.

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July 26.

[1] Boyd, J. D., and Hamilton, W. J., Chapter 14 of Marshall's "Physiology of Reproduction", 2, 3rd edit. (Longmans, 1952).

[2] Young, A., *Proc. Roy. Soc. Edin.*, B, 65, 105 (1953).

[3] Runner, M. N., and Palm, J., *J. Exp. Zool.*, 124, 303 (1953).

[4] Fekete, E., and Little, C. C., *Cancer Res.*, 2, 525 (1942).

Morphological Basis of Quality in Tea

The possibility of distinguishing morphological characteristics that will help in the recognition of strains of tea capable of producing enhanced quality in the manufactured product is of importance to tea producers and research workers in regions outside Assam. The pioneer work of Dr. W. Wight and Mr. P. K. Barua[1] is consequently of particular interest.

While recognizing that such work is only in a preliminary stage, there appears to be some confusion in the interpretation of the data between the concepts of the statistical significance and importance respectively to be attached to the values of the correlation coefficients under consideration.

The high significance of the correlation between pigmented plants and hairy plants indicates that the value of 0·493 has not arisen fortuitously; but it gives no indication of the importance of the value itself as a measure of association. The correlation coefficient is not equally sensitive throughout its range to differences in degree of association, relatively small variations in value in the high range being of more importance than much greater ones at the other end of the scale.

A more sensitive estimate of predictability can be derived from the function $1 - \sqrt{1 - r^2}$. For a correlation coefficient of 0·493 the predictability index is 0·13. The analogous figure for the correlation coefficient of 0·76 between taster's valuation and leaf hairiness is 0·35.

While the possibility of concentrating 35 per cent of the total variation in a common association with a single morphological characteristic is suggestive, it scarcely merits the statement that "hair can be taken as a reliable index of quality".

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Tea Research Institute of East Africa,
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June 1.

[1] *Nature*, 173, 630 (1954).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 1

British Occupational Hygiene Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Third Conference—"Radiation Hazards in Industry".

University of London (at King's College, Strand, London, W.C.2), at 5 30 p m.—Prof. Dorothy Emmet. "Role, Function and Vocation" (Further Lectures on November 8 and 15.)*

University of London (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. Rex Knight: "Children's Needs and Interests—Contemporary Psychological Theories of Motivation". (From a series of seven lectures on "The Bearings of Recent Advances in Psychology on Educational Problems".)*

Society of Chemical Industry, London Section (joint meeting with the Food and Microbiology Groups, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 30 p m.—Dr. A. Pollard "Newer Aspects of Cider Research"; Mr. F. W. Beech and Mr J. G. Carr: "Problems Involved in the Isolation and Classification of Cider Micro-organisms".

Tuesday, November 2

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Mr. H. G. Jenkins and Mr. H. E. Miles: "The Use of Phosphors as Light Sources"; Mr. T. Thorne Baker: "Daylight Fluorescence—Its Nature and Applications".

Arthur Stanley Eddington Memorial Trust (at the Arts' School Lecture Theatre, Bene't Street, Cambridge), at 5 p.m.—Prof. H. Dingle: "The Sources of Eddington's Philosophy" (1954 Eddington Lecture).

Institution of Electrical Engineers, Measurements Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Boreholes—Instrumentation for Measurements at Depth".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. David M. Watson: Presidential Address.

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. H. S. Rainbow: "Design of Small Jet Engines".

Tuesday, November 2—Thursday, November 4

British Weed Control Council (in conjunction with the Ministry of Agriculture and Fisheries, Department of Agriculture for Scotland, Ministry of Agriculture for Northern Ireland, Agricultural Research Council, Colonial Office, Association of British Insecticide Manufacturers, British Agricultural Contractors Association, National Association of Corn and Agricultural Merchants, and the National Farmers' Union, at the Majestic Hotel, Harrogate)—British Weed Control Conference 1954.

Wednesday, November 3

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. Shirley: "The Disturbed Strata on the Fox Earth Coal and Its Equivalents in the East Pennine Coalfield"; Mr D. A. Bassett: "The Silurian Rocks of the Talerddig District, Montgomeryshire".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. G. E. P. Box and Mr. S. L. Andersen: "Permutation Theory in the Derivation of Robust Criteria and the Study of Departures from Assumption".

Society for Analytical Chemistry, Biological Methods Group (in the Meeting Room of the Chemical Society, Burlington House, Piccadilly, London, W.1) at 6.45 p.m.—Meeting on "The Biological Evaluation of the Purity of Water and Effluents".

Thursday, November 4

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. D. McKie: "French Contributions to Science".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. B. B. Boycott and Prof. J. Z. Young, F.R.S.: "A Memory System in *Octopus vulgaris* Lamarck"; Mr. G. Hoyle: "Neuromuscular Mechanisms of a Locust Skeletal Muscle".

Mineralogical Society (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. M. J. Kelley, Sir Gordon Radley, Mr. G. W. Gilman and Mr. R. J. Halsey: "A Trans-Atlantic Telephone Cable".

Research Defence Society (in the Physiology Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Sir Geoffrey Jefferson, C.B.E., F.R.S.: "Man as an Experimental Animal".*

University of London, British Postgraduate Medical Foundation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. W. T. J. Morgan: "The Chemical Basis of Blood Group Specificity in Man". (From a series of lectures on "The Scientific Basis of Medicine".)*

Institute of Metals, London Local Section (at the Royal School of Mines, South Kensington, London, S.W.7), at 7 p.m.—Prof. A. G. Quarrell: "Trends in Metallurgy".

Chemical Society (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. J. A. Christiansen: "On Open and Closed Sequences in Reaction Kinetics".

Friday, November 5

Physical Society (in the Lecture Room, Royal Astronomical Society, Burlington House, London, W.1), at 5 p.m.—Prof. A. C. B. Lovell: "The Development and Use of Large Radio Telescopes" (Duddell Lecture); Dr J. S. Courtney-Pratt: "Some New Methods of Fast Photography" (Charles Vernon Boys Lecture).

Saturday, November 6

Association of School Natural History Societies (in the Lecture Hall, British Museum (Natural History), Cromwell Road, London, S.W.7), at 11 a.m.—Annual Exhibition.*

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. H. St. George Gray: "The Lake Villages of Somerset (Glastonbury and Meare)".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (with a degree in agriculture or equivalent qualification, and with sound experience in practical work) in Agriculture, at the Cumberland and Westmorland Farm School, Newton Rigg, near Penrith—The Director of Education, 5 Portland Square, Carlisle (November 3).

Lecturer (preferably with experience in soil mechanics and geology) in Engineering, at Constantine Technical College, Middlesbrough—The Director of Education, Middlesbrough Education Committee, Woodlands Road, Middlesbrough (November 3).

Lecturer (woman) in Biology, at Manchester Training College—The Chief Education Officer (83/L), P.O. Box 480, Education Offices, Manchester (November 4).

Assistant, Grade A (with graduate or equivalent qualifications), at the College of Commerce and Technology, Sheffield, to teach physics in national certificate courses in chemistry and metallurgy, in advanced level classes for the general certificate of education, and in various City and Guilds courses—The Director of Education, P.O. Box 67, Leopold Street, Sheffield 1 (November 6).

Scientific Officer or Senior Scientific Officer (qualified bacteriologist or chemist with sound bacteriological training) for work on disinfection involving a study of chemical sterilizers, including methods of laboratory evaluation—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading, quoting 54/6 (November 6).

Technician (preferably with photographic experience) in the Zoology Department—The Registrar, University College of Wales, Aberystwyth (November 6).

Research Student (with the B.Sc. (Special Chemistry) degree of the University of London) in Chemistry—The Principal, Brighton Technical College, Brighton (November 8).

Lecturer (with a degree and/or other recognized professional qualification, and advanced knowledge of some branch of thermodynamics or gas dynamics, and of the theory and performance of propulsion units, and some practical experience of one or more modern propulsion systems) in the Department of Aircraft Propulsion—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks (November 12).

Demonstrator (with special qualifications and interests in mineralogy and petrology) in the Geology Department—The Registrar, University College of North Staffordshire, Keele, Staffs (November 13).

Assistant (preferably with qualifications in ecology or mycology) in Botany—Joint Clerk to the University Court, Queen's College, Dundee (November 15).

Head of the Department of Agriculture, Senior Lecturer in Tropical Agriculture, Lecturer (Grade A) in Animal Husbandry, Lecturer (Grade B) in Horticulture, Lecturer (Grade B) in Workshop Practice (Agricultural), and Farm Manager, at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 15).

Coal Survey Officer (with a good honours degree or equivalent in a science subject, preferably with a sound background in geology and chemistry), in the Ayrshire Coalfield of Scotland, for work which will involve a detailed study of the structure and physical and chemical properties of the coal seams of the area—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/860 (November 16).

Lecturer in Chemistry—The Principal, University College, Galway, Ireland (November 19).

Lecturer in Anatomy and Histology—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (November 20).

Lecturer (preferably with palæontological research and field experience) in Geology, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, November 19).

Lecturer in the Department of Pathology—The Registrar, The University, Leeds 2 (November 20).

Physicist, Biophysicist or Physical Chemist, Senior Research Officer or Research Officer grade (with a university honours degree in science with physics or chemistry as a major subject, or equivalent qualifications) in the Biochemistry Unit, Wool Textile Research Laboratories, Commonwealth Scientific and Industrial Research Organization, Parkville, Melbourne, Victoria, to participate in an extensive research programme concerned with the structure of fibrous proteins, polypeptides and related compounds by X-ray, infra-red and optical techniques—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 462/51 (November 20).

UNIVERSITY LECTURER (preferably with veterinary or medical qualifications) IN THE DEPARTMENT OF ANIMAL PATHOLOGY, to undertake teaching and research in metabolic and nutritional diseases—The Secretary, Appointments Committee of the Faculty of Biology "B", Department of Pathology, University of Cambridge, Tennis Court Road, Cambridge (November 20).

BRITISH INSULATED CALLENDER'S CABLES LTD RESEARCH STUDENT (with a good honours degree in engineering or physics), for research into the mechanical properties of powdered materials in relation to their use as electrical insulators—The Registrar, King's College (University of London), Strand, London, W.C.2 (November 22).

ANALYST IN THE DEPARTMENT OF AGRICULTURE to participate in a special research project—The Registrar, The University, Leeds 2 (November 30).

CHAIR OF AIRCRAFT ELECTRICAL AND ELECTRONIC ENGINEERING—The Principal, College of Aeronautics, Cranfield, Bletchley, Bucks (November 30).

SENIOR LECTURER IN ORGANIC CHEMISTRY, and a SENIOR LECTURER (preferably with primary interest and experience in either the theory of machines or machine design) IN MECHANICAL ENGINEERING, at the University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

PROFESSOR OF PHYSICS at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

CHAIR OF GLASS TECHNOLOGY—The Registrar, The University, Sheffield 10 (December 11).

BIOMETRICIAN for duties which include the design of experiments in all phases of tobacco production, together with the analysis of data and related statistical practice—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

DIRECTOR (with high scientific attainments, preferably in fields related to soils or crops, combined with administrative experience involved in the organization and running of a research institute or university department, and preferably with experience of tropical conditions) OF THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION, Muguga, near Nairobi, Kenya—The Director of Recruitment (H.M. Overseas Civil Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.196/161/02 (December 31).

MEDICAL RESEARCH FELLOW (medical graduate with some experience and success in research), for investigations in some aspect of virology, bacteriology, hæmatology or histopathology—The Director, Institute of Medical and Veterinary Science, P.O. Box 14, Rundle Street, Adelaide, South Australia (December 31).

ASSISTANT LECTURER IN (Agricultural) ENGINEERING—The Principal, Shuttleworth College, Old Warden Park, Beds.

BRADFORD DYERS' ASSOCIATION RESEARCH FELLOW (with high qualifications in science), to undertake research in tinctorial chemistry, textile chemistry or an allied subject—The Principal, Technical College, Bradford 7.

ENGINEERS, CHEMICAL ENGINEERS or PHYSICISTS (with a good university degree, and preferably with industrial experience), for training as Reactor Technologists—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, Lancs, quoting 694.

GRADUATE CHEMIST as technical assistant in the Patents Division—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

HORTICULTURIST (with a degree in horticulture or equivalent, and a working knowledge of fruit and vegetable crops, and preferably with experience of the marketing of perishable vegetable crops), to take charge of the Horticulture Section of the Department of Agriculture, Cyprus—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/17/05.

LIBRARIAN AND INFORMATION OFFICER (graduate with library qualifications and experience)—The Director, Scott Polar Research Institute, Cambridge.

RADIO ENGINEER (with experience of high-power broadcasting transmitting equipment, and preferably with an engineering degree or other professional qualification), to be responsible for the operation and maintenance of the 20 kW. and 1 25 kW. transmitters, and two 250-Watt R.C.A. transmitters of the Dar es Salaam Broadcasting Station—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.178/8/05.

REGIONAL TRIALS OFFICER (with a degree in botany or agriculture or equivalent qualification, with practical experience in crop production)—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

SENIOR SCIENTIFIC OFFICER (Operational Research) (with a first- or second-class honours degree in mathematics or physics or equivalent qualifications, and with at least three years postgraduate experience of industrial operational research), with the U.K. Atomic Energy Authority, Risley, to assist and advise operational research groups in the laboratories, particularly on the use of mathematical, especially statistical, methods, and to collaborate with these groups when their investigations cover fields outside the immediate scope of the work of their laboratories—The United Kingdom Atomic Energy Authority, Industrial Group Headquarters, P.O. Box 19, Risley, Warrington, quoting 693.

TEA OFFICER (with a wide experience of all aspects of tea growing and manufacture under commercial conditions, and a thorough knowledge of the marketing of tea) in Mauritius, to implement plans for developing the tea industry, to advise planters and manufacturers on improved methods of production, and to take charge of the Tea Experiment Station and of any other Government plantations, and a Government Tea Factory, if and when constructed—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/52/05.

REPORTS and other PUBLICATIONS

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National Union of Journalists. Freelance Directory, 1954. Pp. 56. (London: National Union of Journalists, 1954.) [178

Privy Council. Medical Research Council Special Report Series. No. 281: Compressed Air Illness: an Investigation during the Construction of the Tyne Tunnel, 1948–50. By W. D. M. Paton and D. N. Walder. Pp. iv+44+1 plate. (London: H.M. Stationery Office, 1954.) 5s. net. [178

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 2, Vol. 18, No. 5: Purification of Oysters in Simple Pits. By H. A. Cole. Pp. 12+4 plates. (London: H.M. Stationery Office, 1954.) 2s. net. [178

Working Out a Permanent Agriculture in Central Africa: Compost and Cultivation Replace Burning and Shifting. By N. H. Porritt. Pp. 8. (London: Soil Association, 1954.) [178

Rural Life Journal. Vol. 1, No. 1, August 1954. Pp. 12. (London: Institute of Rural Life at Home and Overseas, 1954.) 6d. [178

Ministry of Health. Reports on Public Health and Medical Subjects. No. 95: Mortality and Morbidity during the London Fog of December 1952. (Report of a Committee of Departmental Officers and Expert Advisers appointed by the Minister of Health.) Pp. iv+61. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [178

Privy Council. Medical Research Council Special Report Series. No. 286: The Separation of Protein Fractions from Human Plasma with Ether. By R. A. Kekwick and Margaret H. Mackay. Pp. vii+75+5 plates. (London: H.M. Stationery Office, 1954.) 6s. net. [178

Transactions of the Royal Society of Edinburgh. Vol. 62, Part 3, No. 16: Caradocian Trilobites from Mudstones at Craighead Quarry, near Girvan, Ayrshire. By Ronald Pearson Tripp. Pp. 655–694+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 15s. [178

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National Research Council, Canada. Climatological Atlas of Canada. Prepared by Morley K. Thomas. (A joint publication of the Division of Building Research, National Research Council, and the Meteorological Division, Department of Transport, Canada.) (N.R.C. No. 3151.) (D.B.R. No. 41.) Pp. 255. (Ottawa: National Research Council, 1954.) 2 dollars. [98

Berichte des Deutschen Wetterdienstes. Nr. 12: Graphisches Rechnen mit Feldern skalarer und vektorieller Grossen in der Meteorologie. Von Elfriede und Hans Burckhardt. Pp. 38+96 tables. (Bad Kissingen: Deutschen Wetterdienstes, 1954.) [98

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Deutschen Wetterdienst, Seewetteramt. Einzelveröffentlichungen Nr. 4: Klimatologie der Nordwesteuropäischen Gewässer. (In der Abteilung Maritime Meteorologie, bearbeitet unter Leitung von Prof. Dr. E. Kuhlbrodt.) Teil 1: Temperatur des Oberflächenwassers und Temperatur-Differenz Luft-Wasser. Bearbeiter Dr. H. J. Bullig und Dipl. Met. P. Bintig. Teil 2: Windverhältnisse. Bearbeiter Dr. H. Markgraf und Dipl. Met. P. Bintig. Pp. ii+59. (Hamburg: Deutscher Wetterdienst, 1954.) [98

United States Department of Commerce. National Bureau of Standards. Supplement to National Bureau of Standards Circular 509: Bibliography of Books and Published Reports on Gas Turbines, Jet Propulsion, and Rocket Power Plants, January 1950 through December 1953. By Ernest F. Fiock and Carl Halpern. Pp. iv+110. (Washington, D.C.: Government Printing Office, 1954.) 50 cents. [128

United States Department of Agriculture. Leaflet No. 358: Powder-Post Beetles in Buildings: What to do About Them. Pp. 8. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [128

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Proceedings of the California Academy of Sciences, Vol. 28, No. 6, (July 9, 1954): Further Studies of the Behaviour of the Pacific Sardine (*Sardinops Caerulea*) in an Electric Field. By Anatole S. Loukashkin and Norman Grant. Pp. 323–337. (San Francisco: California Academy of Sciences, 1954.) [128

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SCIENCE AND THE PRESS

THE growth of interest in the presentation of science in the Press during the past four or five years is noteworthy. The Royal Society Scientific Information Conference in 1948 stimulated a keener interest in the presentation of science to scientists; thus, for example, there was a discussion on the presentation of technical information at the Birmingham meeting of the British Association in September 1950, various scientific and learned societies have issued fuller guidance for the writers of papers presented to them for publication, and the Presentation of Technical Information Discussion Group has been formed as a sequel to Prof. R. O. Kapp's lectures on the subject at University College, London. Interest in this aspect has been recently quickened by the stress laid on the importance of effective communication in order that the utilization of the results of research by industry may be expedited.

Here, however, we are concerned also with the second aspect of the subject—the presentation of science to the public. Discussion of this aspect has tended to centre in Great Britain around the function of the British Association and the manner in which the annual meeting of that Association could best facilitate the exposition or interpretation of science to the non-specialist—if not indeed to the general public. It is increasingly manifest that the use made of scientific advances, and ultimately the continuance of adequate support for scientific research, depend upon the existence of a climate of opinion which understands sufficiently the nature of scientific work and the conditions under which it is most fruitfully carried out. It is also becoming recognized that there are widespread fears about science and the effect of its activities, springing essentially from ignorance, and that the persistence of that ignorance may affect the future of science itself.

Several papers in the *New Zealand Science Review*, published by the New Zealand Association of Scientific Workers, discussed three years ago these questions, particularly the improvement of presentation of scientific papers and the relations between science and the Press; and a long article by Prof. I. B. Cohen in *Impact of Science on Society* in the summer of 1952 discussed the education of the public in science, considering, however, the general educational aspect, rather than the appropriateness or effectiveness of the particular vehicles—the written word, radio or television—by which that education is to be achieved. Early this year in his Clayton Memorial Lecture, "The Public Influence of Broadcasting and the Press", Sir William Haley, commenting on the more enduring effect of the printed word compared with the spoken word, indicated the supreme importance of the Press if it set out to use its opportunities for influencing and improving public understanding.

Those opportunities and the whole technique of presentation in the Press have been discussed more fully in two recent papers, both entitled "Science and the Press". The first of these, which was delivered by Mr. L. J. F. Brimble before the Royal

Society of Edinburgh on January 11, received wide publicity at the time and has now been published. The second, by Mr. W. E. Dick, editor of *Discovery*, appears in *Impact* of September (Unesco, 19 Avenue Kléber, Paris, 16), and discusses further some of the points raised by Mr. Brimble as well as reviewing the part which the printed word has played in the development of science itself.

It is one of the merits of Mr. Dick's article that he puts the relations of science and the Press in their historic perspective. He does not over-stress the importance of the printed word as a means of communicating scientific knowledge, as is sometimes done by protagonists of mechanical devices for recording, classifying, filing and disseminating scientific and technical information. Even to-day, personal contact and discussion have a value not merely in stimulating thought and the flow of ideas but equally in the exchange of the residual information which is liable to be missed by abstracting and indexing systems.

This factor deserves more weight than it often receives in considering how far it is worth while extending the field of an abstracting system, and it is worth stressing here because the relations between science and the Press are best discussed on such a practical basis and not in terms of theory. They will, in fact, vary according to the conditions of the period under consideration and the influence of other means of communicating knowledge. Both, however, are, as Mr. Dick reminds us, intimately concerned with the freedom of the Press, and if the struggle for a free Press was waged by men of letters rather than by the scientists, it is on the latter that the onus lies for defending that freedom against encroachment to-day.

Mr. Dick points out that the establishment of writing as a professional activity of the first importance dates from the French Encyclopædia of the early eighteenth century. From that time the Press has been indeed a Fourth Estate, able to contribute its full share to the advancement of knowledge, whether in science or in other fields. Scientific periodicals soon became the main method of communicating the results of research and the indispensable tools of the scientific worker, though societies like the Royal Society for the Encouragement of Arts, Manufactures and Commerce, the Lunar Society, the Manchester Literary and Philosophical Society and the Royal Institution also forged links between industry and science in Britain. By the beginning of the nineteenth century, daily newspapers were well established and there were also some vigorous periodicals. Journalists with a good sense of what interested the public began to record events in the world of science, and this tendency was encouraged by the formation of various associations aimed at strengthening the ties between the world of science and the general public, such as the Deutsche Naturforscher-Versammlung and the British Association for the Advancement of Science.

These associations recognized that the help of the Press was indispensable for the purpose just indicated; but they also aimed at providing a common meeting ground for all scientific specialists. This function has steadily increased in importance with the growing fragmentation of science, and in recent years particularly, the mounting costs of publication have set limits to the economic production of highly specialized periodicals with only a restricted circulation; indeed, the cost of publication of its journal may to-day absorb as much as thirty per cent of the annual income of a scientific or technological society.

This position, and the difficulty of securing effective coverage of such literature by abstracting bureaux, have led to suggestions that the scientific paper is no longer the most appropriate means of recording and disseminating scientific knowledge. Mr. Dick comments, however, that any attempt to rationalize scientific publication would involve one great danger that the multiplicity of periodicals has practically eliminated. When there were only a few scientific periodicals, some first-class scientists, such as Joule and F. W. Lanchester, found great difficulty in getting novel work published. There is always a distinct risk that the most conscientious editor or editorial board will fail to recognize the true value of a paper in the Joule or Mendel class. It is rightly maintained that the advantage to the truly original scientific thinkers of a rich variety of periodicals to which they can submit their work offsets the embarrassment to searchers of the literature caused by such variety.

If, however, we are to indulge in such variety, it is essential that, as both Mr. Brimble and Mr. Dick insist, we should give more attention to the preparation and presentation of scientific and technical papers themselves. Even a genius may fairly be expected to take some care that prolixity and careless writing do not increase what may well be the inherent difficulty of following an original and unfamiliar idea. "Slovenly writing", wrote Bishop H. H. Henson, "is nothing but bad manners in composition", and though that precept might be heeded above all by the scientist who attempts to expound his results to the general public, it equally applies in the presentation of his work to his fellows, whether specialist in his own field or not. Mr. Brimble strongly deprecates the tendency to rush into print and, without discussing the controversial question of the most appropriate means and place for the publication of detailed research results, it may be asserted that the length of most scientific and technical papers would probably be reduced and their clarity and value enhanced if, as he suggests, before submitting a communication, every scientist satisfied himself that he had said what he wanted to say, and in the minimum number of words, and that it was worth saying at all.

Quite apart from the saving of space, the improvement in quality resulting from such general practice could be most important. "Wherever," wrote George Stuart Gordon, in "Anglo-American Literary Relations", "a man has fairly set down the best that he knows about the thing he knows best, and in words that tell his meaning, there, always, will be literature." To the extent to which the specialist achieves that ideal, he will solve, by and large, the problem of communication, whether to his fellow scientists or to his fellow citizens in general.

The operative clause is "in words that tell his meaning", and its significance is well illustrated by Mr. Dick's reference to Charles Darwin's "On the Origin of Species". It was written as a scientific treatise for Darwin's fellow scientists, but reached a far bigger public than either author or publisher foresaw. Darwin made no concession to popular appeal beyond lucidity of thought and of expression, and his success with this one book may be fairly attributed to his plain, unpretentious but most lucid style. There is thus a tradition of good writing among British scientists which may well make us hesitate to accept the pronouncement that the study of modern science destroys the ability to write good English. Weakness in this respect may well arise, not so much from the study of science, as from defects in education: it is not the scientist alone who mars his exposition by jargon. The tendency is widespread and deeply embedded, despite onslaughts ranging from those of Sir Arthur Quiller-Couch to Sir Winston Churchill. None the less, the use of jargon has dangers, as both Mr. Dick and Mr. Brimble emphasize, and the success of the "Origin of Species" as a best-seller far beyond the confines of the scientific world is a striking demonstration of the fallacy that a scientist is bound to rely on jargon. The book contained a new theory of evolution, the main points of which were not easy to grasp, and it was packed with unfamiliar details. Everyone, however, with any pretensions to being cultured read it, and many thoroughly grasped the main points of Darwin's theory.

In the face of this and other instances, it cannot be maintained even to-day that the important concepts of science are beyond ordinary comprehension. The task of communication, however, demands a greater effort at clarification than the scientist frequently troubles to make; but unless he makes that effort his work cannot be expounded or interpreted even to his fellow scientists. Still less can the task of explanation to the general public be carried out by himself or anyone else. As Dr. Barbara Wootton recently remarked, in her presidential address to the annual conference of Aslib, efficient communication, in the social sciences or in any other field, is only possible on the basis of common experience, and it is not only in the social sciences that the use of jargon introduces pitfalls. Jargon is peculiarly liable to cause the confusion to which Dr. Wootton refers. Such words tend to bear one meaning to the scientist and another meaning—possibly several different meanings—to other scientists or to non-scientists, and serious misunderstandings arise even in the physical sciences, where there is less risk than in the social sciences of discussions about words being confused with discussions about the things which the words are supposed to represent.

From the point of view of communication, however, the use of jargon should be eschewed because of the way in which it contributes to the emotional entanglements which Dr. Wootton rightly characterizes as the most serious consequence. That is also the main reason why, though the interpretation and exposition of science to the general public must be carried out by co-operation and understanding between scientists and the Press, the major responsibility for it must lie on the scientist. However much they may value and seek the co-operation of the Press, scientists to-day have a public duty to see that their work is clearly explained at the appropriate stage to the public.

As Mr. Dick remarks, the public is entitled to a reasonable amount of information about all researches supported from public funds, and it is now better appreciated that the presentation of such information has a close bearing on its utilization for some practical purpose in industry. Even for independent or privately financed research, a reasonable degree of publicity is desirable from the point of view of science itself, as Prof. Kirtley Mather has indicated. Publication for the non-scientist is an issue of public importance and can vitally affect the advance of science itself. It can no longer be regarded as a matter of privilege to be granted as, when and if the scientist so decides. What is the appropriate stage may be a matter of judgment, and of discussion; but it should no longer be an arbitrary decision.

Both Mr. Brimble and Mr. Dick in these two papers have much to say that is helpful to the scientist and to the Press in regard to this task of popular exposition and interpretation. Mr. Brimble stresses, for example, the importance of the scientist being readier to co-operate and more accessible to the Press; and part at least of the value of both papers lies in the extent to which they should remove some causes of misunderstanding and friction. Mr. Brimble, for example, paid a generous tribute to the improvement, almost out of all recognition, of British newspapers, by and large, in their presentation of scientific news and their interpretation of scientific discovery, and to the intellectual leadership in the ordinary newspaper; the Press is still the most effective moulder of public opinion, and sound opinions must be based on knowledge of the facts. This tribute gives the greater force to his criticism of some general failings, which sometimes hinder men of science from co-operating as freely as they might otherwise do. Chief of these failings is the lack of appreciation that the very essence of science is accuracy, and that the checking and counter-checking necessitated thereby make it very rare for science to give what can be described as 'hot' news. The same point is made by Mr. Dick, who remarks that there is room for compromise here. Both papers should at least help scientists to realize the relatively low proportion of erroneous reports which appear in a daily newspaper, in spite of the pace at which the collection and publication of news proceeds. A sense of proportion, above all in regard to details, should go far to facilitate harmonious working.

While that suggestion applies particularly to the scientist, the question of factual accuracy is one which concerns scientist and journalist equally. If the Press takes to heart Mr. Brimble's second major criticism, and is readier to admit and correct an error when under no legal pressure, much would be done to establish the conditions of confidence and mutual respect essential for effective co-operation. A reputation for accuracy depends at least in part on the readiness to acknowledge and correct inadvertent slips or errors. Such a reputation is a priceless asset which once lost is hard indeed to regain. There is an aside on the Press in Dr. R. M. Hutchins's brilliant little book, "The University of Utopia", on which a journalist might well reflect in this connexion. The Utopians, writes Dr. Hutchins, are a people trained to criticism, and since the blandishment of propagandists and advertising men would leave them unmoved, there is no point in indulging in it and there were no propagandists or advertising men in that happy country.

A third criticism made by Mr. Brimble also bears very closely on the vital question of the public relations of science and the maintenance of full freedom of investigation and communication with which both press-men and scientist are so closely concerned. He deprecates the tendency to expect leading men of science to commit themselves, immediately a new scientific discovery of paramount importance is made, to opinions concerning its human implications. Prematurely to do so is liable to impair rather than to improve and restore the public confidence upon which the continuance of public support of science ultimately depends.

Such reasons as these therefore demand much greater attention to this task of exposition and interpretation by scientists in general, and it is to be hoped that the misappropriation of the word 'communication' into a narrow technical field which Dr. Wootton deservedly castigated will not impede progress in this wide task of improving the communication of scientific knowledge to the world in general. Such misappropriation is perhaps particularly liable to hinder that more generous attitude to the scientific expositor which has been urged in these columns for many years. As Mr. Brimble remarked, it is very important that the expositors and interpreters of science as represented by science writers should be sure of the appreciation and support of their professional colleagues to which they are entitled.

When all that is possible has been done to improve the relations and co-operation between scientist and the Press, a large share of the responsibility for the interpretation and exposition of scientific discovery to the general public must rest upon such professional science writers. Some may be scientists, specially gifted as expositors or interpreters; some may be journalists by training, with special interest in or understanding of science or some branch of science; but from whatever side they have approached it, their position is essentially the same, and their success depends on a clear understanding of the public they are attempting to reach, the limitations of that public, and of the subject they are to expound. Only on that basis can their ability to assess values, and to interpret facts in language understood by all, make any real contribution to the public understanding of science. That task demands in its exercise the same qualities of mind and unswerving loyalty to truth as are demanded in laboratory or field investigations; nor can we expect men and women of the calibre which exposition and interpretation, as distinct from propaganda, demand to come forward in the numbers needed, unless their fellow scientists accord them the honour and respect they deserve and co-operate whole-heartedly with them in that task.

FREEZING AND DRYING BIOLOGICAL MATERIAL

Biological Applications of Freezing and Drying
Edited by R. J. C. Harris. Pp. xii+415. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1954.) 10 dollars.

FREEZING and freeze-drying are two techniques the practical development of which would have been impossible without advances in refrigeration technology. While extreme low temperatures can only be attained by liquefied gases, the relatively easy maintenance of 'deep-freeze' temperatures has made possible the preservation of delicate material such as spermatozoa and blood corpuscles. But low temperatures introduce new problems, particularly those of thermal and osmotic shock: because slow cooling reduces osmotic shock at low temperatures, especially in the presence of glycerol, most living cells survive slow cooling better than rapid or ultra-rapid freezing. Where survival of cells is unimportant, as in tissue sections or preparations for electron microscopy, rapid freezing has many advantages, and fixation at temperatures below −100° C. produces fewer ice-crystal artefacts in sections. A new method is described in this book for freeze-drying preparations for the electron microscope; in some cases the morphology of the freeze-dried and air-dried material differs, but in others, such as tobacco mosaic virus, the appearances are similar.

Dehydration after freezing is compatible with survival only for small organisms such as bacteria and yeasts, and there is no evidence of survival of mammalian cells with a water-content reduced to 10 per cent. Conflicting results have followed the experimental use of freeze-dried cornea; success has only been achieved in the rat, where the small size of the cornea may enable a non-viable graft to act as a skeleton for the ingrowth of host cells from the periphery. In rabbits such ingrowths would take longer, and may be too late to overcome the opacity developed in the centre of the graft. Freeze-dried blood vessels have been successfully grafted in dogs; but these, like grafts of freeze-dried nerve which do not elicit the homograft reaction, may be successful merely because they provide a scaffold for cells from the living tissue.

Plasma has been successfully freeze-dried for so long that the use of the dried product is accepted not only as equivalent but even as superior to stored liquid plasma. Repeated freezing and thawing of plasma results in instability of plasma proteins, but a single thawing may occur without loss of essential properties before freeze-drying. The useful life of dried plasma varies with the degree of secondary drying, that is, with the residual moisture content and with the type of packing. The British transfusion bottle has an aluminium cap and a rubber washer; since rubber is permeable to water vapour the vacuum is best replaced by a dry inert gas. In the United States the evacuated container is placed in a tin which is also evacuated.

The volume under notice contains articles by fifteen authors, and deals with theoretical and practical aspects of freezing and freeze-drying of antibiotics, bacteria, viruses, blood products, milk and foodstuffs, and the preservation of living tissues. It also deals with the simple apparatus needed to apply freeze-drying techniques to dead tissue for histological work. There are inevitable inequalities in the different articles, but the book should be read by all who use freezing or freeze-drying. Apart from the line-drawings and micrographs, the illustrations are of extremely poor quality. S. T. COWAN

BEGINNINGS OF A WELFARE STATE

Studies in the Social Services

By Sheila Ferguson and Hilde Fitzgerald. (History of the Second World War: United Kingdom Series.) Pp. ix+367. (London: H.M. Stationery Office, and Longmans, Green and Co., Ltd., 1954.) 22*s.* 6*d.* net.

PROF. R. M. TITMUSS ends his penetrating social history of the Second World War, "Problems of Social Policy", by saying, "The disturbances to family life, the separation of mothers and fathers from their children, of husbands from their wives, of pupils from their schools, of people from their recreation, of society from the paths of peace . . . have left wounds which will take time to heal and infinite patience to understand". This present book, which although not written by Prof. Titmuss conforms closely to plans made by him, is, like its predecessor, a valuable contribution to our knowledge of family strengths and weaknesses, as revealed in a period of serious and prolonged strain; knowledge which is vital to the wise ordering of social policy. Except for the study of the nursing service, which, interesting as it is, does not really fit into the pattern of the book as a whole, the book is centred on the family. It starts with the family as it was in 1939, already reduced in size by the decline in the birth-rate during the previous half-century, and therefore with fewer members to call on for support and help in times of crisis, and discusses the strains to which it was subject—strains such as the dispersal of individuals, and, in bombed cities, whole neighbourhoods, the mobilization of husbands and fathers, the "unparalleled mobilization of women, and in particular, married women"—and how they were met.

Dislocation of family and neighbourhood life meant that there were many things which the family could no longer do for itself, and what the family and neighbourhood could no longer do for themselves the State must help them to do. The growing recognition by the Government and its various departments that it must help the family bear its responsibilities if women's efforts to "keep their homes together in the face of every adversity" were to be successful comes out in all the studies of which the book is made up. It is shown, for example, in the development of the emergency maternity service from a safety to a welfare measure, and in the new and extended functions which the Government assumed in connexion with the welfare of young children, both of which developments are here discussed at some length. Moreover, this participation by the State in family responsibility was, with some hesitation and certain exceptions, offered to all families who cared to take advantage of it; and these studies confirm the view expressed in "Problems of Social Policy", that one of the most far-reaching changes in social policy and administration which took place during the war years was the increasing readiness of the State to assume responsibility for warding off distress not only from the poor but also from all classes of society. Hence social service benefits came to be regarded by all concerned as among the rights of citizenship, a conception which is fundamental to the Welfare State as we know it to-day.

In general, one gains the impression from these studies that "the social stability of families as a whole, and of the nation as a whole was, under the circumstances, remarkable". Breakdowns inevitably occurred, however, and, as originally planned, this book would have contained studies of at least three symptoms of family breakdown—the war-time increases in juvenile delinquency, divorce and illegitimacy. Unfortunately, limitations imposed by the publication time-table only permitted the inclusion of one study, that of illegitimacy. This provides the material for two of the most interesting chapters of the book, chapters which demonstrate that the more careful examination of relevant statistics may lead to conclusions about the nature and extent of a social problem very different from those generally accepted. Thus, while the remarkably rapid rise in the number of illegitimate maternities from 26,569 in 1939 to 64,743 in 1945 has led to generalizations about the lowering of moral standards, especially among young people, the authors show that this contention cannot be supported if we relate these statistics to those relating to pre-marital conceptions. The war-time rise in illegitimate maternities was accompanied by an almost equally dramatic fall in the percentage of irregularly conceived maternities afterwards regularized by marriage; and, in fact, it was not until 1945 that the percentage of maternities conceived out of wedlock to all maternities rose above the pre-war figure. Moreover, when analysed according to the age of the mother, it was found that it was among the women over twenty-five rather than among their younger sisters that the rise had taken place. No attempt is made by the authors to arrive at a confident explanation of the situation thus revealed; this, they state, must await "a much more searching analysis of all the social, economic and psychological factors concerned in contemporary attitudes to sex relationship and marriage".

Despite its inconclusiveness, this sentence exemplifies a breadth of outlook which is characteristic of the book as a whole. Nowhere are war-time problems and policies studied in isolation; instead, we are continually brought back to the consideration of fundamentals of social need and national policy. Hence, although the studies contained in the book are specific and limited, they are likely to be of long-term value to both student and administrator.

M. P. HALL

YEAST TECHNOLOGY

Yeast Technology
By John White. Pp. xvi+432+17 plates. (London: Chapman and Hall, Ltd., 1954.) 55s. net.

THIS volume makes a welcome addition to the already large literature of commercial yeast technology. The author states in his preface that it is largely the outcome of a series of papers communicated by him to various journals, and in its general make-up it certainly bears unmistakable traces of its origin. There is a good deal of needless repetition which could have been obviated by more careful editing.

The greater part of this book is concerned with the manufacture of bakers' yeast on a commercial scale, as well as the important questions of quality of the product and biological control. From a reading of these chapters it is obvious that the author is a master of his subject. They could not well be bettered, and should be studied by every beginner entering the field of commercial yeast production. Unfortunately, when the author strays from his chosen field his touch is by no means so sure. The chapters on yeast genetics and food and fodder yeasts, for example, should either be entirely omitted or very greatly expanded. The chapter on yeast genetics as it stands at present is too scrappy and inadequate to be of any real service to a beginner. The treatment of brewers' yeast is also not very adequate. The chapter on this subject has been contributed by Dr. C. Rainbow, and it is clear that he has been hampered by lack of space; but he has certainly used the space he has been allowed to good purpose. In another edition this chapter should also be very greatly expanded. It would, for example, have been of great help to the practical brewer to be given more details of how to select his pitching yeasts and how to maintain his stock cultures in an active state.

The main purpose of this volume is to describe the commercial manufacture of bakers' yeast; and this is done with a wealth of detail in the early chapters and should be of the greatest value to beginner and experienced worker. The remaining chapters, apart from those on yeast genetics, food and fodder yeasts and brewers' yeasts, are concerned with such important subjects as yeast nutrients, structure and consistency of yeasts, aspects of yeast physiology and disposal of effluents from yeast factories. There are also chapters on the effect of aeration and temperature on yeast growth, and these will repay careful study.

The chapter on the microbiological control of yeast growth processes is particularly well done; but in another edition the author should give full details of how stock cultures of bakers' yeast are maintained and how fresh cultures are selected.

The information on the behaviour of bakers' yeast during panary fermentation is up to date and should be studied by every baker, even if he has only a rudimentary knowledge of chemistry. It may prevent him from laying the blame at the yeast manufacturer's door for his own mistakes.

The publishers are to be congratulated on the general make-up of this book; the quality and clearness of the various illustrations and diagrams are excellent and leave nothing to be desired. Apart from the criticisms which have been made—and they are all of a minor character—this book can be strongly recommended and should be acquired by everyone interested in this subject.

E. BARTON-WRIGHT

COSMIC EVOLUTION

Stars in the Making
By Cecilia Payne-Gaposchkin. Pp. xii+160+67 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1953.) 25s. net.

THE early writings of Dr. Payne-Gaposchkin (then Miss Cecilia Payne) provided much of the empirical knowledge that was used to test the theoretical predictions made by the late E. A. Milne and his contemporaries in their classical researches on stellar atmospheres. She has since become a leading worker on variable stars. In the present book she ranges over a wider field and addresses herself to a wider class of readers than in her previous writings. In doing so she reveals a talent for brilliant and stimulating exposition.

Dr. Payne-Gaposchkin calls her theme the drama of cosmic evolution. In her first two chapters on "The Actors" she gives a vivid description of the physical variety of the stars and of the physical conditions of interstellar material. The next three chapters describe "The Scene" that is witnessed by astronomical observation. In the reviewer's opinion, this is the best part of the book and includes much information that has not before been presented in a popular account. It deals with the physical characteristics of double stars, clusters of stars and the strikingly different stellar sequences found in galactic and in globular clusters, with galaxies and, particularly informatively, with the comparative study of the Milky Way galaxy and the Andromeda nebula, and with Baade's two stellar populations and the varying manner of their occurrence in different galaxies. Most of the collection of sixty-odd splendid plates at the end of the book illustrate this section. Several important observational advances in the past two years would have permitted some statements to have been made in a more categorical form had they been available when the book was being written.

The "Drama" itself has to be inferred from the analysis of this scene. Dr. Payne-Gaposchkin marshals the inferences that can be made about the ages of various astronomical systems and then seeks to show that other general indications are compatible with these in suggesting a certain evolutionary sequence. Many of her ideas are in keeping with some current trends in astronomical thought (though she does retain the now generally rejected fission theory of the origin of double stars). However, one would wish to see the ideas brought into closer relationship with theories of stellar structure at one extreme, and with some theory of the formation of galaxies at the other, before venturing an opinion upon them.

Dr. Payne-Gaposchkin likens her undertaking to trying to reconstruct the story of a film from the array of still pictures displayed outside a cinema. Her own reconstruction will provoke lively curiosity—even if the display does not yet carry the announcement, "coming shortly".

W. H. McCREA

OBSERVATIONS ON THE COLLAGEN SYSTEM*

By Prof. J. T. RANDALL, F.R.S.

Wheatstone Physics Laboratory and Medical Research Council Biophysics Research Unit,
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ALTHOUGH it is impossible for one group of workers to examine more than a few fundamental features of so complex a biological system, I wish to emphasize the need for an integrated outlook if we are to reach a proper understanding of the nature, structure and function of connective tissues. The physicist, in thinking of connective tissues, almost automatically concentrates his attention on the structural properties of the fibrous collagen; the biochemist likewise tries to characterize the protein by a precise analysis or to determine, perhaps, what sugars are present in the ground substance. The histologists and pathologists are aware more than any of us that these are but facets of the whole problem. Collagen fibres are a characteristic feature of all connective tissues and their derivatives, cartilage, bone, and lymph nodes. But all connective tissues are composed of four main constituents: cells, fibres, matrix or ground substance, and intercellular fluid. It is too often forgotten that the cell is the focus and origin of all tissues. If we are to reach a better understanding of the collagen system, more attention must be paid to the fibrogenic cells, to which the fibres and ground substance in all probability owe their origin. Here I shall consider three main types of problem: first, some biological and biochemical studies of fibrogenesis; secondly, physical investigations of collagen structure by means of X-ray diffraction and the electron microscope; and thirdly, the mechanism of precipitation of fibrous collagen from *in vitro* solutions.

Fibrogenesis

While it is recognized that development of fibrous material occurs outside the cell, the origins and early fibrogenesis of collagen fibrils have remained uncertain since the time of Schwann. Does the fibrous component of the connective tissues originate within the cytoplasm of the fibroblasts, on the cellular surface, or in the regions which lie between the cells? If the fibrils originate in the intercellular medium, it has to be decided whether they are formed or developed with the aid of a specific cellular secretion; such a secretion may itself be precipitated in the form of fibrils, which later develop into much larger entities and bundles. Alternatively, the postulated secretion may interact with the intercellular medium to form a fibrous complex.

By the use of the embryos of the fowl and of the rat, and particularly in tissue culture, the living fibrogenic cells have been examined by phase and ciné-microscopy. Fixed cells have been studied intact and as thin sections in the electron microscope, and cytochemical tests and biochemical assays have been carried out. Two types of structure have been observed: cytoplasmic filaments 100–500 A. in diameter, and cytoplasmic granules 0·5–3 μ in size. It is not known at present whether the filaments have any direct connexion with the cytoplasmic tubules and lamellæ observed by other workers in different types of cell. The filaments have been found in the four main types of cell associated with the rapid formation of collagen: in osteoblasts of the metatarsus periosteum and of membrane and endochondrial bone; in young osteocytes; in fibroblasts of tendon sheaths and the perichondrium; and in chondroblasts of hypertrophic cartilage. In the fibrous sheath of developing bone, the young osteocytes contain these structures, and no clear division can be seen between the cell boundary and the matrix. These observations are suggestive: but it is not yet known whether the filaments are collagenous; they may consist of some core material on which collagen is laid down. Although the filaments are a characteristic feature of the fine-structure of fibrogenic cells, they may not be concerned directly in the production of collagen.

Miss S. Fitton Jackson, who has made the observations I have described, has also directed attention to cytoplasmic granules in these cells. These had been observed previously by Fell and others but largely ignored owing to the ease with which they may be lost in the fixation process. The granules may be seen most readily in the living cell. Detailed studies show that the granules are complex in structure, and staining shows the presence of polysaccharide after removal of lipids and glycogen; the granules also stain characteristically for protein but do not respond to the Janus green stain for mitochondria.

From these and other observations it is reasonable to conclude that the granules are largely composed of an acidic polysaccharide–protein complex and show indications of phosphatase activity; possibilities of the presence of other components and enzymic activities cannot at this stage be excluded. Bottle cultures of almost pure strains of osteoblasts are providing material for detailed biochemical investigation by R. H. Smith. The granules may have a secretory function and be concerned either in the elaboration of the ground substance or of simpler molecular systems. There is at present no connexion between the cytoplasmic granules and filaments, but this possibility cannot be ignored.

Structure of Collagen

It is well known that collagen fibres possess a degree of structural organization found in few, if any, other proteins. About twelve years ago, electron microscope studies revealed an axial macroperiod of $\sim$ 640 A., which has since been confirmed in collagens of widely different biological origin. This macroperiod has been found to be subdivided into a number of striations generally alternating in density. The macroperiod has been confirmed by low-angle X-ray diffraction, an aspect studied in great detail by Bear. High-angle X-ray studies reveal an imperfect fibre diagram which has been known for about thirty years. This diagram relates to the configuration and structure of the individual polypeptide chains or protofibrils, and differs in important ways from the characteristic diagram of the keratin–myosin–epidermin–fibrinogen group. Many models for the protofibril structure have been proposed, especially in recent years, but no satisfactory solution has yet been reached. As I shall show, new data are being obtained almost continually, suggesting new lines along which the investigations may proceed towards the complete derivation of the structure.

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* Substance of the 6th Procter Memorial Lecture delivered in the University of Leeds at the Annual Meeting of the Leather Trades' Chemists Association, September 24.

Although little is known about the structural arrangement within the 640 A. period, sub-bands of smaller size are frequently observed in electron micrographs. P. M. Cowan, A. C. T. North and I have recently obtained some evidence from coherent and diffuse X-ray scattering at small angles for the existence of a sub-unit of dimensions 220 A. along the fibre axis and 40–90 A. at right-angles. Attempts are also being made by R. E. Burge to relate the electron microscope results to the X-ray results by a determination of the density function for unstained and unshadowed pictures. In undried native fibres the unit also appears to be greater than that of the individual protofibril, as shown by the equatorial reflexions of quite large spacing obtained recently by North. These reflexions are not observed if the fibre is dried thoroughly and then re-wetted.

North has also obtained much improved high-angle diagrams by the technique of stretching; these results cannot be discussed in detail here. They are, however, remarkable for two things. First, the improved diagrams point much more strongly than any previously obtained to a helical configuration of the protofibrillar unit; it is the details of the helical configuration which are still baffling. Secondly, a comparison of the fibre extensibility with that derived from the low- and high-angle diagrams supports the suggestion of Bear that two types of region exist in the fibre and that these regions differ in their degree of order.

The absence of meridional reflexions between the equator and the 2·95 A. arc on the X-ray diagrams of stretched specimens, and the relationship 1/2·95 − 1/4·27 = 1/10·14 between the spacings of the strong layer lines, would be expected from a helical configuration with a unit repeating at heights of 2·95 A. and a pitch of either 10·14 A. or 4·27 A. The repeating unit may consist of one or more residues. The 10 A. pitch could be produced by (i) a single chain having a lead of 10 A. and about 3⅓ units per turn; (ii) two intertwined helices each having a lead of 20 A. and about 6⅔ units per turn; (iii) three intertwined chains each with a lead of 30 A. and 10 units per turn. (i) and (iii) each has an approximate pseudo-period of 30 A. and (ii) one of 60 A. A 4 A. pitch might similarly be produced by one, two or three interwoven helices with leads of 4 A., 8 A. and 12 A., respectively. The observed spacings have been indexed according to layer lines of a 30 A. period, but the fit is not exact. In practice, a helical structure may have a very long pseudo-period to which these systems of small layer-line indices would be approximations.

Mechanism of Collagen Precipitation

The precipitation of collagen from acid solution has been known for many years, and recent interest in the subject arises from the discovery that such precipitates may contain fibrils with substantially the same structure as the native material. The study of the conditions under which such fibrils are formed *in vitro* is likely to be of importance in the general study of fibrogenesis, on which we are engaged, and of long-chain polyelectrolytes. Broadly speaking, four types of precipitate have been found: (i) gels which contain no fibrils; (ii) fibrous precipitates of collagen induced by the addition of simple salts or *p*H changes; the detailed structure of these fibrils is very similar to that of native collagen; (iii) fibrous precipitates induced by the use of complex molecules (anions), such as acid glycoprotein, chondroitin sulphate, etc.; the periodicity of such fibrils is not characteristic of native collagen and ranges from 2000 to 3000 A.; (iv) if small amounts of adenosine triphosphate are added to collagen solutions, not fibrils but segments are produced of similar periodicity to the fibrils of (iii).

F. O. Schmitt's laboratory has been largely concerned in the study of types (iii) and (iv), and F. C. Kelly has recently carried out interesting experiments on the interrelationships of various precipitates. Collagen molecules in acid solution at a *p*H of ~ 3 are probably random coils with a net positive charge arising from the excess of charged arginine, histidine and lysine groups over the negative carboxyl groups of glutamic and aspartic acids. As the *p*H rises to that at which precipitation may occur, it is likely that the molecules become helically coiled, under which condition roughly one charge of each sign exists per turn of each chain of the helix.

Mr. F. Booth and I have been investigating theoretically the conditions for the precipitation of long, thin, charged molecules, and it turns out that collision dynamics may be ignored and the problem investigated by a study of van der Waals and electrostatic interactions. At the present time, the helical model referred to above in which positive and negative charges alternate along the length of the helix has not been completely worked out, but it is clear that the step-wise distribution of charge may be important. More detailed work has been done on the interaction of long thin molecules with a smooth charge distribution. If molecules attract each other in all relative positions, the resulting precipitate would have no ordered structure. On the other hand, if attractive forces exist only when the molecules are parallel to each other, the precipitate would be fibrous. Van der Waals forces will always tend to orientate neighbouring molecules so as to bring them parallel.

An interesting feature of the models already studied is that, when the net force is attractive, there will be a turning moment tending to align the molecules, and this moment increases rapidly as the angle between the molecules decreases. I have recently shown experimentally that collagen fibrils of normal characteristics may be produced by nothing more complicated than a change of *p*H. This adds weight to the argument that collagen precipitates appear to be controlled by the van der Waals and electrostatic interactions of neighbouring molecules. Thus a rise of *p*H reduces the net positive charge to the point where overall attraction and precipitation result. Precipitation by salt arises from drastically reduced Coulomb interaction, due to increased screening by the ionic double layer.

In the more complex instances of fibrous-long-spacing and segment-long-spacing precipitates, we must be careful not to assert that the interaction results in a purely collagenous precipitate. This seems highly unlikely, and the evidence at present suggests that these systems are complexes of collagen with an interacting anion.

It seems significant that structure in great variety exists in all these precipitates, and it is not unlikely that the phenomenon of structure arises from some as yet unknown peculiarity of collagen. The details of structure depend more on the nature and stereochemistry of the interacting molecules.

In concluding this account it is a pleasure to pay tribute to the enthusiastic efforts of the colleagues whose work I have largely described, and the invaluable support of the technical staff of the laboratory.

TREE GROWTH ON ACID SOIL

A JOINT session of Sections K (Botany) and K* (Forestry) of the British Association devoted the whole day at Oxford on September 7 to a symposium on "The Interactions between Acid Soils and Forest Trees". Biologists whose joint research interests covered a wide variety of subjects combined with practical foresters in an attempt to solve, or at least to re-state in simpler terms, the problems of establishment and maintenance of forests on heathy and peaty soils.

Mr. M. V. Laurie, chief research officer of the Forestry Commission, opened the discussion by presenting the forester's point of view, based upon the thirty-five years experience of the Commission. He pointed out that much of the land at present available for reafforestation in Britain is acid and that two classes of problems therefore exist. First, the problems concerned with the effects of acid soil on the establishment and growth of trees; and secondly, those concerned with the effects of the trees themselves upon soil fertility. Soil is the working capital of the forester and he has therefore a duty of maintaining it, undiminished in productivity, in perpetuity while producing the right crop of the highest quality.

On the land available, the solution of the problems of tree establishment consumed much of the early effort of the Commission. Preliminary treatments such as ploughing, draining and the application of fertilizers are effective on many sites; but the degree to which they are valuable and the magnitude of the improvement in tree establishment that they produce are not easily predictable. The full interpretation of the results of early successes and failures demands not only long-term experiments on a large scale but also the co-operation of experts. The effectiveness of mixtures of Sitka spruce and Japanese larch or pine, the beneficial effects of broom on spruce growth and the universally adverse effect of heather on all tree species must be interpreted by ecological experimentation. The stimulation of many species by phosphate on sites where lime and nitrogenous fertilizers are ineffective requires the co-operation of physiologists and microbiologists for explanation. Microbiologists, too, must assist in helping to determine the rival claims of organic manures and composts as against balanced applications of artificials. All these problems concerned with forest establishment are in the process of being solved with the help of specialists, but the long-term question of fundamental importance—the effect of trees on the soil—remains.

The vigorous forests of young conifers which have been established are undoubtedly changing the soil. In the place of the much modified heath soils, acid woodland mor with a deep layer of needles is being produced. It is held by many ecologists that mor conditions lead to serious soil degeneration. Two points must be considered in this regard. First and foremost, the demand for timber is mainly a demand for pine and spruce. A supply of poor-quality hardwood, even if such a crop prevented mor formation, would not be economic. Secondly, it would seem that what we believe to be natural northern coniferous forest exists almost exclusively on mor or podsolized soils as a self-regenerating natural forest.

Dr. G. W. Dimbleby, of the Department of Forestry, Oxford, was opposed to the view that mor conditions should be allowed to develop in newly established forests. He stated that podsol and its attendant raw humus layer form an undesirable medium for the growth of forest in Britain and it is, moreover, avoidable. Dr. Dimbleby described the work of a research team in Oxford which had undertaken fundamental research on many aspects of tree nutrition. The team concentrated its attention on areas in Yorkshire, where tree establishment on high-level heather moors is beset with great difficulty. It has often been stated that these moors are a natural ecological climax. This view has been shown to be erroneous by the study of the soil surfaces and profiles beneath bronze-age earthworks. On the surface below these artificial mounds, charcoal of birch and oak is found on the sites of hearths. The soil surface is rich in the pollen of hazel, oak, lime and alder and lacking in heather pollen. The soil profile below is typical of a brown forest mull. Indeed, the podsol profile of the heath goes over the top of the earthworks and is undoubtedly of more recent development. The vegetation and the soil have undergone a change from mixed deciduous forest on brown earth to heath on podsol since bronze-age times, and evidence suggests that man's activity in cutting, burning and grazing is the cause. Nowadays, when burning and grazing are prevented, birch and pine may seed themselves into the heaths. Of these, birch becomes established, its roots break through the iron-pan of the podsol and its leaf litter and the detritus from associated plants convert heather mor to mild humus so that a forest soil with a vigorous fauna becomes established. Pine, on the other hand, fails to break the pan, and the mor conditions and bad drainage are exaggerated, and acidity and poor nutrient status are maintained.

The effects of birch in this sequence are essentially similar to the effects of soil treatment. Ploughing causes breakage of the pan and improves drainage and aeration. Mulching and manuring temporarily simulate the beneficial nutritional status of mull. If pine is planted this improvement is reversed; and leaching and podsolization develop with the accumulation of deep needle litter in which vast stores of minerals, which would otherwise be available, are locked.

The beneficial effects of birch and other species under which brown earth develops can probably be partly interpreted in terms of the behaviour of their litter during breakdown. The cellulose in the walls of the mesophyll of heather and mor-producing species is protected from breakdown by a resistant layer of a tannin–protein complex which is laid down upon them as they die. This is usually lacking in species not producing mor and, indeed, admixtures of birch litter or extracts of it can be used to stimulate breakdown of mor.

Prof. L. G. Romell, of Sweden, who was guest speaker, discussed the formation of mor. He pointed out that the humus turnover in mull soils is not faster than that in mor, and indeed the amount of organic matter is often higher in them. Moreover, when mor is isolated and stored, loss of organic matter and release of available nitrogen occur. The form of the curves relating these changes with time of storage is such as would be expected when a material high in nitrogen content is available for decomposition. The application of lime to decomposing mor in storage increases the rate of loss of organic matter but decreases the rate of release of available nitrogen. The immobilization of nitrogen in the presence of lime is due in part to reaction of ammonia with quinoid complexes in the humic matter.

The examination of a mor profile shows it to be characterized by a great concentration of roots, mycorrhizas and mycelia. Acidity is not, however, a diagnostic character of mor because mull may have a similar pH range. In beech soils, mor develops inevitably as the forest ages, so that liming and forest treatment cannot arrest the change from mull to mor. In the time of P. E. Muller (who first used the terms 'mor' and 'mull' in their present sense) mor was widespread in Denmark; now it is rare. The old beech stands are gone, and in the young forests mull exists in its stead. Similar parallelisms between mor development and the age of stands are found throughout the spruce forests of Sweden.

The factors affecting the development of mor have been analysed by ecological experiment. Addition of nitrogenous manures causes stimulation of ground flora and tree growth on mor soil. Other fertilizers have little effect. The death of trees from natural causes or felling is followed by a quick response, and dense ground flora develops. Trenching experiments where roots are cut have similar effects, producing dense ground flora, high nitrogen and phosphorus content of vegetation and the disappearance of the mor profile. All these experiments, taken in conjunction with estimates of the release of available nitrogen during storage, indicate that the prime factor in mor formation is nitrogen starvation. The intensification of competition for nitrogen by roots and mycelia as a stand ages leads to formation of mor, decrease of ground vegetation and slow growth of trees. Such a view of the mechanism of formation of mor, although it runs counter to many accepted teachings, explains more closely the ecological and experimental data.

The wide experience of Prof. Romell and the intensive researches of the soil nutritional team described by Dr. Dimbleby seemed, therefore, in full agreement concerning the relative productivity of mor and mull and the need to prevent development of mor. Suitable sylvicultural measures could prevent its development, and these were dealt with in subsequent discussion.

Dr. S. D. Garrett described work done at the Botany School, Cambridge, on the microbiology of acid soils with respect to soil-borne disease. He took two examples where there is an apparent correlation between pH and intensity of disease. Both in the case of *Fomes annosus* butt-rot of pines and spruces and in *Pythium* disease of seedling roots, disease is less intense in acid than in alkaline soils. The diminution of the damage caused by *Fomes* on acid soils can be ascribed to an effect of pH upon the soil micro-flora rather than upon the pathogen or host. *Fomes* spreads inside and along the surfaces of living roots and passes from host to host by root contact. Rapid advance along the root-surface, leading to widespread disease, is possible on alkaline soils, because *Trichoderma viride*, a virulent antagonist of *Fomes*, is absent. On acid soil only an internal spread of *Fomes* is possible, and the disease is of less importance. *Pythium* diseases of seedling conifers are also less intense on acid soils and in this respect they contrast with similar diseases of crucifers. The effect of pH may here be ascribed to a direct effect on the host and not upon the pathogen. The ecological optimum of conifers lies on the acid side of neutrality, so that they resist the disease on acid soils.

Although these examples illustrating the causes of increase or decrease of virulence with soil conditions appear simple when the final conclusions are reached, they are based upon wide ecological surveys in which apparent correlations, many of them spuriously giving the impression of causation, are observed. Such observations must be followed by detailed controlled plot and laboratory experiments.

Dr. J. L. Harley, of the Department of Botany, Oxford, also discussed soil microbiology in an attempt to fit work on the physiology of mycorrhiza done in Oxford into its ecological perspective. The concentration of roots and mycelia in the mor profile described by Prof. Romell is easily observable in beechwoods in Britain. Estimates of weights of absorbing roots in various horizons of mull and mor confirm the intense colonization of the *F* and *H* layers of the latter. These roots are mainly mycorrhizas and are completely clothed in a tissue of fungus through which all nutrients entering the tree must pass. Observations on spruces by Wilde in America and on beech in Oxford show that similar subsurface aggregation of roots can be induced by treating even highly nutritive soils with excessive surface layers of organic material. Following the aggregation of roots, starvation symptoms can develop. The conditions in which mycorrhizal roots show their greatest development are these conditions of intense competition for nutrients. It is possible with beech, as has been shown in Sweden and America for pine and spruce, to vary the intensity of mycorrhizal infection by arranging a deficient supply of nutrients in the soil while ensuring rapid photosynthesis and carbohydrate production. The ecological conditions of intense mycorrhizal formation are those in which growth-rate may be small. Indeed, an inverse correlation of growth and mycorrhizal infection is often observed in natural conditions. Such correlations provide no evidence concerning the functioning of mycorrhizal organs, which must be sought in laboratory experiments.

If conventional physiological methods of studying nutrient absorption by roots are applied to mycorrhizal roots, it is readily shown that they accumulate salts in their tissues. The rates of accumulation of phosphate, ammonia and the alkali metals are rapid, and the mechanism of absorption is linked with metabolic activity. The rate is very sensitive to temperature, oxygen supply and the presence of metabolic poisons. It is very rapid in oxygen concentrations approximating to that in air and, in some conditions, is closely correlated with oxygen consumption in respiration. Comparisons of the rate of absorption of minerals by mycorrhizal and non-mycorrhizal roots of beech and pine show greater rates of accumulation into mycorrhizas of all salts tested. The mycorrhizas may therefore compete on more level terms than uninfected roots with the mycelia and other roots in the soil. The primary destination of the salts absorbed is into the fungus, and phosphate in particular accumulates in the fungal layer at first, so that during absorption the supply of phosphate to the host tissue is no greater in mycorrhizal than non-mycorrhizal roots.

Two mechanisms have been studied by which the ions trapped by the mycorrhizal sheath of fungus can be made available to the host. First, it has been shown by direct observation and photographic record that beech mycorrhizas have a life-period of about eight months only. Hence there is a periodic release of mineral-rich organic matter into the actual rooting region of the host. Secondly, there is in the tissues a metabolic turnover of phosphate, sensitive to oxygen and temperature, the net result of which is the movement of phosphate from fungus to host during periods when the rate of uptake is low. Hence, during periods of rapid release of minerals from newly fallen litter, nutrients may be trapped and accumulated in the fungal layer of mycorrhizal roots and, in the subsequent periods of slower mineral release, phosphate and perhaps other minerals are passed to the host. Laboratory physiological experiments, therefore, are providing a credible picture of the functioning of mycorrhizas in ecological conditions.

Dr. L. Leyton, of the Oxford Forestry Department, described detailed work on mineral nutrition of conifers which has been carried out in the same areas as that described by Dr. Dimbleby. His description of the soil profiles of sitka spruce forest in Yorkshire was exactly comparable with that of previous speakers, and his analysis of mor and mull again emphasized the deficiencies of available soil nutrients, especially of nitrogen. Significant increases of growth were obtained by the application of nitrogenous manures, and little increase was obtained with phosphate. Dr. Leyton described the technique of analysis of foliage to determine the nutrient status and mineral deficiencies of the site. On untreated soils, needle weight and nitrogen content are positively correlated, and the effects of the use of nitrogen fertilizers, removal of heather and mulching owe their efficacy in promotion of growth to increase of available nitrogen. Application of phosphate only affords a secondary stimulation.

The humus layer contains as much as 2 per cent of dry weight as nitrogen, so reasons were sought as to why this is not made available. Calcium deficiency is very marked, and it is possible that microbiological activity is limited by this factor. On the other hand, the soils in question are often water-logged in winter and dried out in summer. This adverse water régime may be counteracted by mulching, which results in a rapid increase of microbiological activity in the rooting layer.

The method of needle analysis has proved very valuable in this study, for it can be used to predict as well as to follow the effects of soil treatments on trees of any size. In all cases where treatments improve growth, an immediate response in needle colour and weight precedes increased growth. The needles of the following year's crop are laid down in the buds of the current year, so that although immediate growth response to treatment is not observable, the constitution of the needles provides a satisfactory basis of prediction of growth in the future.

With these set papers as a background, the whole subject was discussed. Prof. Romell pointed out that the effects of liming are complicated because of the stimulation of white rot fungi above pH 4·5, and the lack of effect of lime treatments mentioned by Mr. Laurie and others might be explained by the trapping of nutrients by them. He asked about the stimulation of turnover in mor by hardwood litter, and Dr. Dimbleby and Mr. Murphy stated that it can occur and is associated with increase of faunal activity. Dr. Dimbleby spoke strongly in favour of developing stands of mixed tree species, but Mr. Hiley emphasized that adequate thinning of conifers would encourage ground flora, the detritus of which would have the required effect of reversing the tendency to formation of mor. He also described how mor develops under old oak stands and how felling of such stands and replanting with conifers may give rise to mull with an *Oxalis* and *Rubus* ground-flora. Dr. Harley pointed out that such a change might be the result of felling and planting rather than an effect of the conifers themselves. Mr. Laurie showed that there are still untouched problems concerning the factors leading to the aggregation of roots so characteristic of mor. He asked if some of the known effects of mycorrhizal and other fungi on the growth and branching of roots could be a factor in the process. Dr. Harley and Dr. Leyton suggested that a study of oxygen supply and water supply in the surface soil layers would perhaps be a better first approach to these problems, as both these factors greatly affect root-growth and activity. Prof. W. H. Pearsall, who was in the chair, commented that although there was clearly evidence that many of those present disagreed on various grounds with the planting of conifers on many sites in Great Britain, no battle had developed on this subject. The first problem in reafforestation, he said, is to make difficult sites productive and then to ensure that their soil tends to change towards mull rather than away from it. Britain is a region of brown forest soils, and present policy should be to re-establish them. No doubt it was felt that such a discussion would lead the meeting away from biology into economics, for in spite of this challenge no battle developed.

The meeting was a highly successful discussion of a most important subject, and indeed was a hard but valuable day's work for those who took part.

ANIMAL BEHAVIOUR

AT the recent meeting of the British Association in Oxford, Sections D (Zoology) and J (Psychology) held a joint discussion on "Animal Behaviour", which was attended by some four hundred members. The discussion dealt with the study of animal behaviour as it is practised by Konrad Lorenz and other zoologists who follow his lead. These investigators usually refer to themselves as ethologists, and the first two papers presented some of the features of their method, some of their findings, and some of their theoretical concepts. The third paper was given by a psychologist, who considered some of the relations between ethology and psychology.

Dr. N. Tinbergen (Department of Zoology and Comparative Anatomy, University of Oxford) opened the discussion with a paper on the bearing of the ethological study of animal behaviour on the study of human behaviour. He began by stressing the need for restraint in making comparisons between animals and men, and by saying that, in his view, the importance of Lorenz's work, and of ethology generally, lies not so much in any new theory of behaviour that has been put forward as in its particular type of approach. This approach sets great store on careful observation and description of the behaviour being studied; on qualitative analysis as a prerequisite of quantitative measurement; on study of the whole behaviour in question, not merely of one particular part or phase or aspect; and on the preservation of a proper balance between study of the causation of behaviour and study of its evolution and survival value.

He then discussed certain aspects of the study of inborn behaviour—behaviour "as it appears before conditioning and other learning processes set in". Each animal has a limited repertory of movements, each of which is characterized both by its causes (internal and external) and by its overt motor-pattern. Ethology investigates both characteristics. In connexion with the begging response of the herring gull chick, for example, it has been shown, in relation to the stimuli, that, in eliciting the begging response, the red patch on the parent's beak (or a similar patch on a cardboard dummy) is of great importance, and that here, as elsewhere, "only very few of the receivable outside messages are influential"; and it has also been shown, in relation to the response, that it is an innate motor-pattern, since it is exhibited before the chick can have practised it and is non-modifiable and difficult to condition.

Similar studies of human behaviour are far more difficult, and often inadmissible. Yet there are perhaps indications of inborn mechanisms—specific responses to specific stimuli—in certain anti-predator reactions of human beings, in the infant's reaction to the mother's smile, and in other behaviour patterns.

Dr. Tinbergen also referred to ethological work on motivation. The motivation expressed in a movement can be recognized, he said, by the form of the movement, by the effect of the movement and by the specific factors attending its occurrence. Often there is mixed or ambivalent motivation, as in the alternating movements of attack and escape to be seen in animals and in boxers. There are also 'displacement activities'. These are patterns of behaviour that "do not belong to the motor pattern of the instinct that is activated at the moment of observation"; they are expressions of some other instinctive drive, and they act as outlets for a surplus of motivation, the discharge of which through the normal paths is in some way prevented—as when the aroused but baulked fighting instinct of domestic cocks finds an outlet in food-pecking movements. Although displacement activities are by no means rare in man, and may well have an important bearing on neurotic behaviour, they are not as easily identified in man as in animals, because, whereas a true displacement activity is always an innate pattern, in human behaviour learned patterns, like lighting a cigarette, or handling keys or handkerchief, also often function as outlets for displaced motivation.

In the second paper, Dr. R. A. Hinde (Ornithological Field Station, Department of Zoology, University of Cambridge) sketched five of the ways in which learning modifies inborn behaviour—"behaviour which appears without previous specific practice", as, for example, the 'mobbing' response of chaffinches to owls, which is elicited by a stuffed tawny owl in young chaffinches that have never seen an owl.

First, learning brings about changes in the stimuli that elicit a particular inborn response. Many studies, such as those of Wallace Craig and of W. H. Thorpe and F. G. W. Jones, indicate the importance that early experience may have in the development of behaviour that appears at first sight to be inborn. A particularly dramatic example of the effect of learning on the stimuli eliciting a response is provided by 'imprinting', as when the greylag gosling follows, and behaves towards, the first relatively large moving object that it sees as though it were its parent. In Dr. Hinde's view—and in this he differed from Lorenz—this process is probably not fundamentally different from other forms of learning.

Secondly, learning affects the stimuli which "guide the orientation of behaviour". Here only a few cases have been analysed; but, to take one example, Tinbergen has shown that the digger wasp makes a 'locality study' on leaving its nest, and learns the position of the nest in relation to certain landmarks (a ring of pine cones in one experiment); with the result that, if the landmarks are moved, the wasp repeatedly goes to the new position that they indicate, not to the real nest.

Thirdly, learning sometimes changes the motor-pattern of inborn behaviour. Such modification (except in the intensity of the response) is rare, if not impossible, in the inborn movements used by animals in locomotion, preparing food, nest-building, fighting, courting, and so on; but it occurs extensively in the movements underlying vocal utterances. The bullfinch, for example, can be taught to add whole new tunes to its repertoire.

Fourthly, there is the question of changes, due to learning, in consummatory stimuli—the stimuli to which the animal is particularly responsive while carrying out the instinctive or consummatory act in an inborn pattern of behaviour. Little is yet known about this kind of modification, but it would seem that it must be involved in 'imprinting', and must also be related to 'secondary reinforcement' as understood by Hullian learning-theorists.

Fifthly, Dr. Hinde referred to changes in responsiveness to a constant stimulus, and, particularly, to his work on the waning of the 'mobbing' response in adult chaffinches confronted with a stuffed predator. It has been shown, he said, that underlying this waning of responsiveness there are certainly two processes—one more or less independent of the stimulus and subject to fairly rapid recovery, the other specific to the stimulus and producing a more or less permanent decrement—and probably a third, which is linked to the stimulus and subject to rapid recovery.

In the last part of his paper, Dr. Hinde directed attention to three aspects of behaviour, which, he said, "are brought home rather more forcibly to the field ethologist than they are to the laboratory psychologist". These were: (*a*) that the nature, as well as the complexity, of the things an animal can learn seem often to be determined by its constitution; (*b*) that learning often occurs in animals without any of the conventional rewards, such as food, water or escape from pain, and in circumstances where "the perception of a particular situation seems to act as a reinforcing agent"; and (*c*) that animals are curious, and the analysis of this curiosity is "one of the most urgent problems awaiting both ethologist and psychologist".

To Prof. R. Knight (Department of Psychology, University of Aberdeen) had been assigned the task of discussing aspects of ethology that seemed of special interest to psychologists. He began by referring to matters about which ethologists and psychologists are agreed. Thus they both accept the comparative study of behaviour, including the comparison of animal and human behaviour, as possible and useful. In 1951 Dr. Tinbergen wrote of "the almost universal misconception that the causes of man's behaviour are qualitatively different from the causes of animal behaviour", and no doubt this belief still has its adherents; but psychologists, no less than zoologists, may now be taken to accept the view that the comparative method is as appropriate in the study of behaviour as in anatomy, embryology, physiology or biochemistry. Again, both psychologists and ethologists proceed on the principle that behaviour, in Dr. Hinde's words, "is mediated by the nervous system, and every particular pattern of behaviour is mediated by a particular nervous mechanism or pattern of nervous activity".

The main differences, Prof. Knight suggested, between ethologists and many psychologists, especially American psychologists, relate to theory. Some of the difficulties that psychologists see in Lorenz's theoretical system have been expressed by D. O. Hebb and (though he is not himself a psychologist) by D. S. Lehrman, of the American Museum of Natural History.

Three of these difficulties may be put in the form of questions. First: Is the ethologists' use of the comparative method sufficiently strict? It would appear that Lorenz and Dr. Tinbergen do not always confine their comparisons to what is truly homologous, but are sometimes apt to assume that functionally similar behaviour patterns must be caused by fundamentally similar mechanisms; whereas in fact there is plenty of evidence that, at different evolutionary levels, functionally similar behaviour patterns often depend on mechanisms that are very different in origin and fundamental structure.

Second: Are the ethologists' criteria of innateness satisfactory? They ascribe innateness to all behaviour that appears without previous specific practice, and, in particular, to any behaviour pattern that appears in animals that have been raised in isolation from fellow-members of their species and prevented from performing the particular pattern in question. But, as Lehrman has pointed out, an animal isolated from others and prevented from practising a particular behaviour pattern is "not necessarily isolated from the effects of processes and events which contribute to the development of the particular behaviour pattern"; and cases (for example, the nest-building of pregnant rats) can be given of behaviour which satisfies the ethologists' criteria of innateness but is demonstrably dependent on the animals' previous experience.

Third: Are the ethologists on the wrong tack in looking for unitary, autonomously developing behaviour patterns? For heuristic and other reasons, many psychologists are averse from an approach which regards the development of behaviour as involving the maturation of specific behaviour patterns and of specific mechanisms underlying them. They prefer an approach which, while acknowledging the importance of the physical growth of various structures, regards the development of behaviour as a process in which at each stage new patterns of nervous activity, and consequently new patterns of behaviour, emerge from interaction within the organism and between the organism and its environment.

In the subsequent discussion, Dr. W. H. Thorpe (Department of Zoology, University of Cambridge) said that, in his view, Lorenz's theoretical scheme has greatly stimulated, clarified and simplified the study of behaviour. He referred particularly to its concept of the 'innate releasing mechanism', to its division of behaviour into flexible appetitive behaviour and the relatively rigid consummatory act, and to its distinction between 'directing' and 'releasing' stimuli. He also said that, although Lorenz's theory does take considerable account of innate or inborn behaviour, it is not anti-learning; indeed, it not only accepts the usual kinds of learning but also adds another—'imprinting'. Prof. C. W. Valentine (formerly of the Department of Education, University of Birmingham) said he wished to make it clear that not all psychologists, particularly in Great Britain, are unsympathetic to the idea of instinctive drives and inborn patterns of behaviour. Although the word 'instinct' has for many years been under a ban in American psychology, it is now beginning to reappear, and innate impulses and actions, as well as other constitutional factors, are receiving increasing attention in recent American work in educational and developmental psychology. Prof. T. H. Pear (formerly of the Department of Psychology, University of Manchester) welcomed ethology and its experimental field-studies of birds and a variety of other animals as helping to "break the domination of psychology by American laboratory studies of the rat"; but, while psychologists are right, he said, to be interested in animal behaviour, they must not let this interest so obsess them that they neglect the study of "civilized and sophisticated men and women".

REX KNIGHT

PAUL SABATIER, 1854–1941

By PROF J. R. PARTINGTON, M.B.E.

PAUL SABATIER, the centenary of whose birth fell on November 5, was born of a modest family in Carcassone in 1854. In 1874 he passed high on the lists in the entrance examinations for the École Polytechnique and the École Normale Supérieure. His place (fourth) on the list of the Normale was higher and he chose to go there. In 1877 he was top of the list of graduates in his class. After a year as professor at the Lycée at Nimes, he had the good fortune to become assistant to Berthelot at the Collège de France, where he took his doctorate in 1880 with a thesis on the metallic sulphides. After a year at Bordeaux, he became assistant professor of physics, and in 1883 of chemistry, at Toulouse, becoming professor of chemistry there in 1884 at the early age of thirty. In Toulouse, in spite of an offer to succeed Moissan at the Sorbonne in 1908, Sabatier stayed for the rest of his life, and died there on August 14, 1941, aged eighty-seven*. He became dean of the faculty of science in 1905. He was an excellent and very popular teacher, and long after his retirement, in fact nearly to the end of his life, he continued to lecture. He became *correspondant* of the Academy of Sciences in 1901 and the first non-resident member in 1913. He was Nobel laureate in chemistry in 1912, Davy medallist of the Royal Society in 1912 and foreign member of the Society in 1918, doctor *honoris causa* of the University of

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* *C.R. Acad. Sci., Paris*, 213, 281 (1941); *Obituary Notices of Fellows of the Royal Society*, 4, 63 (1942–44); *J. Amer. Chem. Soc.*, 66, 1615 (1944).

Pennsylvania in 1926, and Franklin medallist in 1933.

Sabatier's early work was in physical and inorganic chemistry, some of it in collaboration with his pupil, Jean Baptist Senderens. He first obtained pure hydrogen disulphide by vacuum distillation in 1886, discovered new metallic nitrides, and studied nitrosodisulphonic acid. He also made thermochemical measurements. His most famous work, begun in 1897 and occupying him for thirty years, was a study of the applications of heterogeneous catalysis in organic chemistry, of which he published a summary in his book, "La Catalyse en Chimie Organique", 1912. Although platinum had long been used as a contact mass, and the associated Dutch chemists in 1796 had found that alcohol vapour when passed over heated alumina is decomposed into ethylene and steam, little or no application of catalysis in organic reactions had been made. Sabatier became interested in this field by Mond's work on nickel carbonyl, and he used nickel, as well as other finely divided metals such as copper, as catalysts.

At that time there were two theories of heterogeneous catalysis. Faraday in 1833 had suggested a physical theory that one or more of the reacting gases was condensed by attraction on the surface of the metal. William Charles Henry in 1836 and de la Rive in 1838 had proposed a chemical theory that intermediate compounds, for example, oxides of metals, were formed and decomposed. Sabatier soon proved that the specific action of catalysts strongly supports the chemical theory. He showed that different contact masses produce different reactions. Formic acid vapour passed over heated zinc oxide gives only hydrogen and carbon dioxide, but when passed over heated titanium oxide it gives only steam and carbon monoxide. Chromic oxide can act both in oxidation and in dehydrogenation and dehydration reactions. Heated alumina decomposes alcohol into ethylene and steam, metallic molybdenum and zinc oxide decompose it into acetaldehyde and hydrogen. Sabatier postulated the formation of different intermediate compounds, each with its own mode of decomposition, and he also clearly recognized that some organic reactions are reversible; and in cases where intermediate compounds cannot be isolated, there may be a production of surface compounds (chemisorption), thus linking the two theories of catalysis, the physical and chemical. Recent work has largely confirmed his views.

Sabatier's catalytic hydrogenation technique, carried out with relatively simple apparatus, was applied to the preparation of a large number of organic compounds. He clearly saw the technical importance of his work and took out several patents; but for some reason he did not extend the method to hydrogenation in the liquid phase. This was first studied by Ipatiev and led to a revolution in the fat industry by the hydrogenation of oils with a nickel catalyst.

Sabatier was responsible for opening out a new field in organic chemistry, and his clear appreciation of the importance of physical and inorganic chemistry in that branch of the science was most fruitful. The influence of his great master, Berthelot, with his wide interests, was clearly apparent in all Sabatier's work, and infused new life into organic chemistry at a time when it was becoming stereotyped.

Sabatier's personal qualities were greatly appreciated by his colleagues. Although able to lecture only in French, he was always welcome abroad. He was one of the great school of French chemists, and his contributions to the science were both extensive and important. The centenary of his birth was marked by commemorative meetings held in Toulouse during November 4–5.

OBITUARIES

Mr. J. P. Bushe-Fox, C.B.E.

JOCELYN PLUNKET BUSHE-FOX died on October 15 at the age of seventy-four, having been ailing for some time and unable to take part in archæological affairs. Archæology had been his great interest in life and the subject of his life-work. His education at St. Paul's School, with its fine classical tradition, influenced his choice of field, and it was to Romano-British archæology that he turned, after a brief interlude in Egypt.

He was one of the ablest of the young men whom Haverfield gathered about him for the initial exploration of the Roman site at Corbridge, Northumberland, and, strongly influenced by the then recent work of James Curle at Newstead, he began the study of stratified pottery of all kinds as a criterion for dating the sites upon which it was found. His Corbridge contribution was not so weighty as those which came later, but it still remains of value to students of the site and subject.

Under the ægis of the Society of Antiquaries, his excavation of two Iron-Age sites, at Swarling and Hengistbury Head, and of the Roman town at Wroxeter (*Viroconium*), laid foundations which have often been obscured by the important superstructures built upon them and have never failed. His work has stood the test of time and the challenge of later developments remarkably well.

His largest task, however, was undertaken after the First World War, in which he served with the distinction and ability of one who came of Irish military stock. He entered the Ancient Monuments Department of H.M. Office of Works (now the Ministry of Works) and undertook on behalf of the Society of Antiquaries the excavation of the Roman site at Richborough. This was a task of unprecedented complication, involving many levels often heavily robbed. The main lines of the history of the place were sorted out in four brilliant reports, in which the most notable feature, in what may appropriately be called the Bushe-Fox tradition, was the meticulous care devoted to the stratified pottery and small objects. Structurally, the most notable achievements were the definition of the great triumphal monument and of the supply-base which preceded it and occupied the Claudian invasion bridge-head.

No other worker has nine research reports of the Society of Antiquaries to his credit; no other perhaps the genial patience and scholarly perseverance to produce their like. They mark an age, and a standard of individual effort which deserves record, admiration and respect. I. A. RICHMOND

Dr. Anthony L. Levy

ANTHONY LEWIS LEVY lost his life on August 21, in a mountaineering accident on Mt. Olympus in the State of Washington, after he had successfully rescued an injured companion from a glacial crevasse.

Born in Romford, Essex, in 1924, Levy attended Brentwood Grammar School, Essex, and the Imperial College of Science and Technology, London, receivin his B.Sc. in 1944 and his doctorate in 1947. During the Second World War he worked on the chemistry of penicillin, research which led him to the development of methods for the stepwise degradation and synthesis of peptides. After the War, he continued his research at the Imperial College, London, under the direction of Sir Ian Heilbron and Dr. A. H. Cook, and in 1949 he was awarded a Rockefeller Foundation fellowship to work under Prof. K. Linderstrøm-Lang at the Carlsberg Laboratories, Copenhagen. From 1951 until his death he was an invaluable member of the Hormone Research Laboratory at the University of California, Berkeley. During this period, he developed a new solvent system for the two-dimensional chromatography of amino-acids on buffered papers, which has been widely adopted. His recent discovery of a new method for the quantitative microanalysis of amino-acids in proteins and peptides represents an outstanding advance in the field, and had already gained him world-wide recognition. Just before his death, he was engaged in research involving the structure and possible synthesis of adrenocorticotrophic hormone.

His former teacher, Sir Ian Heilbron, in a letter of sympathy to Levy's mother, wrote, "His most recent work was quite outstandingly brilliant, and Science, the world over, is the poorer by his passing". But the loss of this young biochemist is measured in terms not only of science, but also of humanity. His quick enthusiasm, his zest for life, and his warm generosity established him firmly in the affections of all who knew him, and he is sincerely mourned by all his colleagues and friends.

C. H. Li

NEWS and VIEWS

Jôkichi Takamine (1854–1922)

Jôkichi Takamine, the discoverer of the active principle in chemically pure form of the suprarenal glands, was born in Takaoka, Japan, a century ago on November 3, 1854. He was educated at Osaka, Kyoto and Tokyo and, after graduating in technology at the Imperial University of Japan in 1879, went with a government scholarship to the University of Glasgow, studying the chemistry of brewing at Anderson's College. On his return to Japan he was appointed chief of the Chemistry Division in the Department of Agriculture and Commerce, but resigned two years later to devote himself to industry. He developed the first superphosphate works in Japan, the Tokyo Artificial Fertilizer Company, and discovered the starch-digesting enzyme takadiastase. The remainder of his career was spent mainly in the United States where, in addition to his scientific activities, he wielded considerable political influence, being recognized as the unofficial representative of Japan. Joining Parke, Davis and Co., of Detroit and New York, in 1898, he began his search for the active principle of the suprarenal glands, a task which had been unsuccessfully attempted by some of the world's leading physiological chemists, and in 1901 he succeeded in obtaining adrenalin (as he called it) in stable and pure crystalline form. Takamine played a prominent part in developing Japanese industry and technical education and in establishing the Imperial Research Institute. A firm believer in the role of medicine as a civilizing force in Asiatic countries, he strove to promote better understanding between the country of his birth and that of his adoption. Recipient of many honours and a cultured, public-spirited and charming personality, Takamine died in New York City on July 22, 1922, at the age of sixty-eight.

Conference of Czechoslovak Archæologists

The "Ninth Working Conference of Czechoslovak Archæologists", organized in Prague during September 25–30 by the Czechoslovak Academy of Sciences, included visitors from Britain, East and West Germany, Hungary, Poland and the U.S.S.R., as well as Bohemia, Moravia and Slovakia, and the themes were treated from a general Central-European point of view. (Before 1945, Czech archæology had tended to be rather excessively Bohemian, partly of course because Moravia and Slovakia were far less well explored.) The central theme was the chronology of early Slav settlement, as determined largely by pottery. Poulík from Moravia opened with an able restatement of the traditional thesis of Pič, adjusted to accommodate the enormously augmented data, according to which early Slav pottery, and therefore its makers, is to be derived from the Lusatian urnfields of the Late Bronze Age. But this thesis was stringently criticized in a lively debate. The visitors were also able to see several early Slav oppida, excavated with superb technical skill so as to disclose the remarkable wooden constructions in their ramparts and the plans of wooden houses enclosed therein, as well as the encampment of mammoth hunters at Pavlov, near Dolni Věstonice, later in date than the classic Gravettian site, but, like it, yielding clear hut plans, a rich industry in flint, bone, antler and ivory (not distinctively Magdalenian in character) and interesting art objects. They also visited the new archæological institute established at Nitra by the Slovak Academy of Sciences; the institute is well equipped, and already stocked with a wealth of relics derived from scientific excavations in this rich metalliferous region that had previously been represented in the archæological record only by stray finds.

Rumford Bicentenary: Celebrations in Boston

The Rumford bicentennial issue of the *Proceedings of the American Academy of Sciences and Arts* (82, No. 7, 249; December 1953) is the complete record of the scientific and biographical papers presented at the symposium which marked the two hundredth anniversary of the birth of Benjamin Thompson, Count Rumford, and which was held at the Academy in Boston during March 26–28, 1953 (see *Nature*, 170, 954 (1952); 171, 538, 540 and 947 (1953)). In the introductory article by Harlow Shapley, chairman of the Rumford Bicentennial Committee, the celebrations are described and the illustrated bill of fare of the birthday banquet, which was compiled by Prof. Sanborn C. Brown, is reproduced. Prof. Brown also directed the preparation of the various models of the inventions and contrivances of Count Rumford which were on exhibit and delivered the Rumford Bicentennial Lecture, the text of which is included in the bicentennial issue and which also appears in

American Scientist (**42**, 113; January 1954). The texts of the speeches made at the presentations of the Rumford Medals to Peter Debye, Norman F. Ramsey and Lars Onsager follow, and then the papers delivered at the three symposia on recent developments in thermodynamics, in atomic spectroscopy and in nuclear physics. These include articles by P. W. Bridgman on thermodynamics, Sir Alfred Egerton on the management of flame, Sir Francis Simon on helium and the range of stability of the solid state, E. M. Purcell on line spectra in radio astronomy, M. Siegbahn on nuclear spectroscopy, and V. F. Weisskopf on phase transitions in atomic nuclei.

National Central Library: Report for 1953–54

The thirty-eighth annual report of the Executive Committee of the National Central Library, covering the year ended February 28, 1954 (pp. 28; from the Library, London), records an increase in the Treasury grant-in-aid from £31,250 to £32,000. In the reconstruction of the Library, of an expenditure of about £105,626, £95,495 had fallen on the War Damage Commission and the Board of Trade. The library stock increased during the year by 4,423 (of which 2,472 were by purchase) to about 141,000. Applications received for loans from or through the library decreased from 100,049 in 1952–53 to 93,653, of which 71·71 per cent were successfully handled (71·21 per cent in 1952–53); total issues were 95,626 volumes, of which 17,285 were to university libraries, 10,307 to special outlier libraries, 5,845 to government departments, 5,278 to industrial and research organizations, and 14,641 to adult classes, 10,658 of these last-named being issued through adult class organizations. In the regional library systems 395 municipal, 56 county, 20 university and 84 special libraries are now co-operating, and loans totalled 169,925 within the systems and 26,689 outside them. Taking the view that membership by every public and county library of a regional system is essential to the structure of national interlending, the Executive Committee has adopted the principle that no public or county library shall be able to use the inter-loan services of the Library except as a member of its appropriate regional system. Although loans to university libraries were 755 less than those of the previous year, 24,072 books were lent by university libraries compared with 23,905 in 1952–53. Loans to and from foreign libraries again increased: 2,531 volumes were lent to forty-one countries and 1,158 borrowed from nineteen countries, France continuing to be the only country lending considerably more than it borrows and coming second to Germany as a lender of books to Britain. The Outlier Union Catalogue of books expanded faster than in recent years, and considerable progress was made in compiling the Union Catalogue of printed material in the Russian language in the libraries of the United Kingdom.

Social Problems of Handicapped Children

According to official estimates, there must be between 350,000 and 500,000 handicapped children of school age in England and Wales. All these children require special education or treatment because of some mental or physical disability. Partly because there is no awareness of the size of the problem, few members of the general public realize the difficulties that have to be faced by these children and their parents. They do not know that there are many active voluntary organizations working in this field, while even these organizations themselves are sometimes unaware that their good work is perhaps being duplicated somewhere else. To present the problem of handicapped children as a whole, Mrs. Peggy Jay has written a pamphlet called "Making our Way", which is published by the National Committee for the Defence of Children, London (pp. 12; 1954; 6*d*.). Copies can be obtained from Dr. Simon Yudkin, 23 Tillingbourne Gardens, London, N.3). The booklet shows how much has still to be done before every handicapped child can be said to be receiving all the medical attention and special education that will enable it to develop as fully and happily as its disability will allow.

Australian and New Zealand Association for the Advancement of Science: Brisbane Meeting

The report of the twenty-eighth meeting of the Australian and New Zealand Association for the Advancement of Science, held in Brisbane in May 1951, has only recently been received (Vol. 28; pp. 199. Brisbane: Government Printer, 1951). Besides Sir Kerr Grant's presidential address, "Old Questions and New Answers—Men Who Found Them", in which he reviews the contributions of Einstein, Minkowski, Planck, Rutherford, Bohr and Eddington to the concepts of space, time and atomic structure, it includes the presidential addresses to Sections, Dr. D. P. Mellor's Liversidge lecture, "Some Recent Developments in the Chemistry of Metal Complexes", and the addresses given by a Unesco delegation, which included Dr. E. B. Ford and Prof. C. H. Waddington, at two symposia on evolution. The longest of these latter addresses is that by Dr. Ford on the experimental study of evolution. Most of the presidential addresses are concerned with aspects of science of particular interest in Australia and New Zealand, though not necessarily to the extent of the review of Australian plant products given by Dr. L. H. Briggs to the Chemistry Section. Those of Dr. E. R. Walker on economic science and public policy, H. T. Parker on the scientific approach to the problems of teaching, Dr. B. J. Grieve on viruses and physiology of the host plant, Prof. R. H. Thorp on modern pharmacology and its influence on medicine and pharmacy, Dr. R. M. C. Gunn on cyclic changes in spermatogenesis in rams, and Dr. F. C. Courtice on extravascular protein and the lymphatics are at least of equal interest to scientific workers elsewhere. It is unfortunate, however, that there is not uniformity in format from year to year in reference volumes of such merit: the present volume is quarto, whereas the succeeding volume reverts to octavo. The inconvenience to the librarian and other users is obvious.

Rice Breeding and Genetics

In a monograph under the above title, K. Ramiah and M. B. V. N. Rao have given a comprehensive account of the rice plant and its utilization in India and elsewhere (Sci. Monograph No. 19, Indian Counc. Agric. Res.; pp. 360; 1953; Rs. 17.8 or 27*s*.). Although the central feature and aim of the monograph is to deal thoroughly with the breeding, genetics and cytology of rice, and to review in detail all relevant information, this volume also contains much of more general interest in that it touches upon such topics as the origin, antiquity and taxonomy of rice, the wild races and species, their botany and development, and so on. Special chapters are devoted to the application of genetics to the improvement of the crop, methods of selection, and agricultural aspects and prospects in India. A very large section of the monograph is devoted to the genetics of rice, the inheritance of pigmentation, morphological, physiological and quantitative characters, correlations, linkage, mutations and cytology, each receiving detailed treatment. The factor of quality, as befits its importance, is discussed in its several aspects. The central aim of all this work is, of course, to improve rice production in a region where it is virtually the staple food. Here the authors make comparisons with rice production in other large-producing countries, especially those in which high yields are obtained, and conclude that much can be achieved in India by the appropriate use of fertilizers. "That India has not been able to increase her production substantially is certainly not due to lack of experimental research or scientific knowledge. The most significant reason appears to be the wide gap between research and extension. The cultivator does appreciate the value of scientific knowledge but still he cannot make use of it." The monograph is well illustrated, with some good coloured plates.

Seismology in New Zealand during 1951–53

THE readings of seismograms obtained at thirteen New Zealand observatories (including Suva, Fiji) for the periods January–March and April–June 1951 have been published for the Geophysics Division of the New Zealand Department of Scientific and Industrial Research (pp. 16 and 13, respectively. Wellington: Government Printer, 1953). Earthquake epicentres follow a familiar pattern, as they also do for 1952. In the publication dealing with "Earthquake Origins in New Zealand during 1952" (Seism. Obs. Bull., *S*-98 ; pp. 4+1 map. Wellington: Government Printer, 1953) it is stated that most of the epicentres in 1952 lay between latitudes 37° and 43° S., and there were no epicentres north-west of Karapiro. Isoseismal lines are given for the earthquake of August 28, 1952, with epicentre near Havelock North (greatest intensity, 6 +). The provisional seismological bulletins for July and August 1953 show that the greatest local earthquakes, on July 4 and August 1, both had instrumental magnitude 5·3. The former affected central and western parts of North Island (Tokaanu region), and the latter had an epicentre near lat. 44·8° S., long. 175·8° W.

Museum of Applied Arts and Sciences, Sydney: Report for 1953

THE annual report for 1953 of the Museum of Applied Arts and Sciences, Sydney (pp. 14; published by the Museum, 1954), records the activities of this well-known institution under the energetic directorship of Mr. A. R. Penfold. Although the display side of the Museum is by no means neglected—such exhibits as one demonstrating the energy released by an atomic blast and another of a working compound condensing engine and boiler under steam bear ample witness to this—an impressive amount of scientific work has been accomplished. Such subjects as the establishment of plantations of commercially valuable eucalypts and tea trees in Australia, the effect of modern synthetic fibres on the Australian wool industry, and technical advice concerning paints and varnishes are an indication of the practical use to the nation of the resources of this Museum.

Swedish Physics Conference of September 1952

THE sixth general physics conference of the Swedish National Committee for Physics was held in Stockholm during September 25–27, 1952. As it took place at the same time as the international instruments and measurements conference and exhibition, those attending the physics conference were able to participate in the sessions of the instruments conference, and members of the instruments conference in two of the sessions of the physics conference. The guest lecturers were Prof. E. Bak and Mr. J. R. Anderson, who spoke on microwave spectroscopy and special microwave measurements; Prof. E. Laurila on measuring instruments employing feed-back; and Prof. S. Westin on a new electric calculating machine and on geotechnical measurements with strain gauges. The secretary of the physics conference was Dr. Sven Benner, of the Radiophysics Laboratory at the King Gustav V Jubilee Clinic, Gothenburg. Short summaries of the other papers presented to the conference are printed in the January number of *Arkiv for Fysik* (7, 73; 1954).

Survey of Field Theory: Physical Society Meeting in Birmingham

THE autumn meeting of the Physical Society will be held in the Poynting Physics Building, University of Birmingham, during December 13–14, the subject being "A Survey of Field Theory". The meeting, which is being organized by Prof. R. E. Peierls, will consist of series of lectures on the interactions between mesons, nucleons, photons and electrons, and, since no specialist knowledge will be assumed, it is hoped that they will be suitable for experimentalists with a general knowledge of quantum mechanics and for theoreticians who do not specialize in field theory. Prof. Peierls will both give an introduction to the proceedings and sum up at the end. The papers will be as follows: fields and particles, by Dr. P. T. Matthews (Birmingham); interactions between fields, by Dr. A. Salam (Cambridge); the state of knowledge of the properties of π-mesons, by Dr. P. T. Matthews (Birmingham); and phenomena involving mesons and nucleons at high energy, by Dr. G. Feldman (Birmingham). Those who are not members of the Physical Society may attend, on completing an application form obtainable from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

University of Leeds

THE following appointments have been made in the University of Leeds: A. Richardson, lecturer in the Department of Electrical Engineering; Dr. J. H. Robertson, Brotherton lecturer in the Department of Inorganic and Structural Chemistry; Dr. P. Feltham and Dr. R. Shuttleworth, lecturers in metallurgy in the Department of Coal Gas and Fuel Industries with Metallurgy and Chemical Engineering; D. Payne, lecturer in agricultural chemistry; and Dr. D. Dowson, lecturer in the Department of Mechanical Engineering. The title of emeritus professor has been conferred on Prof. J. W. Harvey, on his retirement from the chair of philosophy, and on Prof. A. N. Shimmin, on his retirement from the chair of social studies. Recent gifts to the University include the following: £3,900 over three years to the Department of Botany from the Nuffield Foundation for research under the direction of Prof. R. D. Preston on the molecular structure of the cell walls of plants; £1,000 a year for two years to the

Department of Colour Chemistry and Dyeing from the Bradford Dyers' Research Association, this being a renewal of a grant for a research fellowship; a recurrent grant of £800 a year to the Department of Experimental Pathology and Cancer Research from the Medical Research Council for research into the possible carcinogenic fractions from tobacco tar; £3,000 to the Department of Mining from the North-eastern Division of the National Coal Board, this being a renewal of the annual grant, and £3,475 from the National Coal Board for special research projects in the Department; £2,000 to the Department of Psychology from the Department of Scientific and Industrial Research for a research project on the comprehensibility of technical reports; £1,100 a year for two years to the Department of Textile Industries from the Bradford Dyers' Association, Ltd., this being a renewal of a grant for a research fellowship, and £450 a year for seven years from the Dunlop Rubber Co., Ltd., London, for a research scholarship.

Institution of Naval Architects: Scholarships

THE Institution of Naval Architects has made the following awards for 1954: Institution of Naval Architects Scholarship in Naval Architecture to J. C. Sainsbury (H.M. Dockyard, Devonport); Vickers-Armstrongs Scholarship in Naval Architecture to A. R. Mountfield (Cammell Laird and Co., Birkenhead); and Yarrow Scholarship in Marine Engineering to G. W. Pinhey (H.M. Dockyard, Devonport). The scholarships are tenable for three years, the Vickers-Armstrongs one being worth £220 a year and the other two £175 a year. In each case the recipient has elected to study at King's College (University of Durham), Newcastle upon Tyne.

Royal Society of Edinburgh

THE following have been elected office-bearers and members of council of the Royal Society of Edinburgh: *President*, Prof. James Ritchie; *Vice-Presidents*, Prof. R. C. Garry, Prof. W. M. Smart, Dr. A. H. R. Goldie, Prof. C. M. Yonge, Prof. Norman Feather and Sir Godfrey Thomson; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Dr. T. R. Bolam and Dr. D. M. Steven; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Dr. D. P. Cuthbertson, Principal H. B. Nisbet, Prof. T. C. Phemister, Dr. J. B. Simpson, Prof. Meirion Thomas, Dr. J. M. Cowan, Dr. David Jack, Prof. J. M. Robertson, Prof. D. Whitteridge, Prof. E. M. Wright, Prof. E. L. Hirst and Dr. D. E. Rutherford.

The Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. A. Spence (plant pathologist, British Guiana), plant pathologist, Trinidad; A. C. Ellington (senior scientific officer, Government Chemists' Department, Jamaica), assistant government chemist, Government Chemist's Department, Jamaica; J. E. Ho-Yen (senior assistant government analyst, British Guiana), government analyst, British Guiana; R. M. Lawton (assistant conservator of forests, Gold Coast), assistant conservator of forests, Northern Rhodesia; Dr. G. M. Edington and Dr. M. H. Hughes (pathologists, Gold Coast), specialist pathologists, Gold Coast; P. H. Creutzberg and J. C. D. Watts (scientific officers, Sierra Leone), senior scientific officers, Sierra Leone; K. W. Aspinall (veterinary officer, Tanganyika), deputy director of veterinary services, Nyasaland; W. J. Gray (veterinary officer, Nyasaland), veterinary officer, Northern Rhodesia; J. McCulloch (principal veterinary officer, Eastern Region, Nigeria), deputy director of veterinary services, Northern Region, Nigeria; L. E. McLaren (veterinary officer, Jamaica), senior veterinary officer, Jamaica; G. C. Billington (assistant statistician, Gold Coast), senior statistician, Gold Coast; W. L. Booker and J. M. Simmonds (assistant statisticians, Gold Coast), statisticians, Gold Coast; St. G. C. Cooper (agricultural superintendent, Dominica), senior agricultural officer, Trinidad; J. W. Drummond and J. L. Maxwell, agricultural officers, Nyasaland; D. Jack, agricultural officer, Tanganyika; R. J. Jones, D. Juckes and J. Morrison, agricultural officers, Kenya; D. R. Mackay, agricultural officer, Northern Rhodesia; R. L. Morris, agricultural officer, Sierra Leone; J. A. Palmer, agricultural officer, Fiji; R. T. Cannon, R. A. Dujardin and D. G. Price, geologists, British Guiana; C. R. Jones, geologist, Federation of Malaya; D. M. Langbridge, scientific officer, Nigeria; R. H. Ansell, veterinary research officer, Kenya; H. J. Burgess, timber research officer, Federation of Malaya; L. G. Campbell, agricultural engineer, Trinidad; K. Klimacki, geologist, Water Development Department, Tanganyika; D. N. McNutt, entomologist, Kenya; J. R. Sterry, agricultural officer, Gold Coast; B. H. Wyatt, research assistant, Department of Tsetse Control, Gold Coast.

Announcements

WE regret to announce the following deaths:

Sir Wallace Akers, C.B.E., F.R.S., lately director of research, Imperial Chemical Industries, Ltd., on November 1, aged sixty-six.

Sir John Lennard-Jones, K.B.E., F.R.S., principal of the University College of North Staffordshire, on November 1, aged sixty.

AT the invitation of the Council of the Royal Society of Edinburgh, Prof. James Kendall, the immediate past president of the Society, will deliver the first Alembic Club Lecture of the Society, on January 10, 1955, his subject being "Michael Faraday".

PROF. K. MOTHES, of the University of Halle and of the Institute of Plant Culture Research, Gatersleben, of the German Academy of Sciences, has been elected president of the German Leopoldina Academy of Natural Sciences, Halle. Prof. Mothes is a member of the Botany Section of the Academy.

A Tin Research Institute Fellowship has been established at University College, London, and Mr. R. H. Prince has been appointed as the first holder. He will work under the supervision of Prof. E. D. Hughes on certain aspects of the chemistry of organotin compounds.

THE Technical Publishing Society, a professional group for the encouragement of the interchange of information among those preparing, editing or publishing technical and scientific documents, has been organized in Los Angeles, with A. E. Tyler, of the United States Naval Ordnance Test Station, Pasadena, as president. Membership includes editors, writers, illustrators, management and production personnel from industrial and government research and development laboratories. Further information can be obtained from the secretary-treasurer, William E. Welch, P.O. Box 607, Tarzana (Los Angeles County), Calif.

ADULT EDUCATION IN GREAT BRITAIN

REPORT OF THE ASHBY COMMITTEE

THE Committee appointed by the Minister of Education in June 1953, under the chairmanship of Dr. Eric Ashby, to consider the organization and finance of adult education in England and Wales, has now presented a unanimous report[*] which is of wide interest. It includes a concise, coherent account of previous inquiries into adult education and of the regulations which govern its administration. A summary is provided of the written and oral evidence submitted to the Committee, while there are appended, *inter alia*, copies of the resolution sent by the Trades Union Congress to the Prime Minister and Miss Horsbrugh in February 1953 and Sir Winston's reply, in which he stated his belief that "there is, perhaps, no branch of our vast educational system which should more attract within its particular sphere the aid and encouragement of the State than adult education".

It is clear from the report that the Ashby Committee was not asked to examine an organization which had broken down or lost its purpose. It heard no evidence which suggested that the present administrative arrangements are gravely unsatisfactory; indeed, the whole range of evidence, from Sir Winston's letter just quoted to the testimony of those engaged in teaching adult students, was unanimous in the assumption that liberal adult education is still essential. Such changes as the raising of the school-leaving age, the increased provision for secondary education, university expansion and increased assistance given to university students, the development of the cinema, broadcasting and television in a period of full employment have affected adult education, and its content and pattern must change with changing times. No one engaged in adult education, however, is so perturbed by these developments as to question the desirability of the work in which he is engaged, and at the most modest estimate adult education in its present framework serves a purpose which no other agency or activity fulfils.

There are indeed no signs that adult education as an organized activity has, or will become, either universal or lifelong. Out of 31 million adults in England and Wales, only some 150,000 attend adult education classes; but the Ashby Committee believes it to be broadly true that, in relation to the community at large, adult education students represent a social and intellectual asset the loss of which would be deplorable, and it records the hope that the genuine educational desire of such students will never go unfulfilled through lack of funds. This is not to say that the organization and provision of adult education could not be improved, or that its purposes and methods should not be readjusted to meet the needs of contemporary society. Nevertheless, it found no evidence that overlapping is a serious problem in the present system, which is essentially a partnership between the Ministry, universities, voluntary bodies and the local education authorities, with the drawbacks of administrative complexities as well as the mutual advantages which such a system involves. These advantages, however—not merely the enriching of adult education by the partnership of the universities, the voluntary bodies, the local education authorities, and the Ministry, but the enriching of the partners, too—are regarded as so important that, in this period of transition in British education, the Committee recommends they should be preserved. Disclaiming at this juncture any intention to set a course for adult education over the rest of this century, the Committee's advice is essentially to leave well alone.

Some changes indeed are suggested, but the arguments on which the Committee's recommendations are based are perhaps of wider interest than the detailed recommendations. The Committee pays tribute to the labours of the Workers' Educational Association and is unanimous that 'voluntary-ism' as exemplified by the Association is essential to the preservation of the spirit of adult education. Nevertheless, it believes that the future of the Workers' Educational Association will not be secure unless it can resolve its internal conflicts as to the direction and scope of its activity, and translate its decisions into executive action appropriate to its districts.

Of the universities and university colleges, on which has fallen the main burden for providing liberal adult education in England and Wales, the Committee remarks that the high regard which the public has for British universities is due partly to the fact that through their extra-mural departments they have kept close to the people of Britain. It is evident that many universities set a high value on extra-mural work for its own sake, both for this reason and as a duty which scholars owe to their fellow-citizens. There was great diversity of opinion in the evidence from extra-mural departments and the governing bodies of universities, but there was no dispute that universities should continue to take a large share in responsibility for liberal adult education and on no account surrender that responsibility to local education authorities; that full-time extra-mural tutors should be 'assimilated' in salary and status with the rest of the academic staffs; and that student fees should be determined locally and (in general) should not be increased.

While appreciating the traditional prestige and the real value of the longer course, and especially of the three-year tutorial class, the Committee thinks it undesirable from every point of view that university participation in adult education should be restricted to the provision of three-year tutorial and sessional classes. It did not, however, accept the argument that all adult teaching which is done by a university teacher is of 'university standard', and it considered that an extra-mural department which contemplates the provision of a particular course should satisfy itself that the course is one which can properly be given as part of the university contribution to adult education. In the current man-power situation, the caution against the regular employment of university teachers in providing elementary routine courses is timely, and it is coupled with an invitation to the extra-mural departments to consider whether their resources would not be most usefully employed if, in certain directions, they imposed something of a self-denying ordinance upon themselves.

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[*] Ministry of Education. The Organization and Finance of Adult Education in England and Wales. Report of the Committee appointed by the Minister of Education in June 1953. Pp. iv+67. (London: H.M. Stationery Office, 1954.) 2s. 6d. net.

On all grounds, and in agreement with the great majority of universities, the Committee thinks it would be undesirable for the Ministry to withdraw its direct grants to the universities for adult education, and for the whole financial responsibility to lie with the universities. It sees danger in maintaining extra-mural work indefinitely as a 'protected' activity in universities: adult education, it is observed, will never become an accepted part of university work in the sense that dentistry or psychology is accepted, unless it establishes its right to a share of the university's finances, but it does not consider that this is the occasion to precipitate the fight for recognition. The suggestion of the Association of Education Committees that the University Grants Committee should make itself responsible for financing all extramural work done by universities and that local education authorities should be responsible for financing the provision of all the rest is rejected, because of the weakening effect the proposal might have on voluntary effort and the risk of uneven interpretation. The Committee recommends that the Ministry should not only continue to give direct grants to the bodies responsible for adult education but also should be prepared to exercise on occasion a more active and flexible control of expenditure.

The Committee stresses the importance of this flexibility, which it would not merely preserve but even increase. The present diversity of pattern in the provision of adult education is regarded as an advantage: there is no evidence that it causes appreciable overlapping or extravagance in expenditure; and a uniform pattern, though it might appear efficient on paper, would suffer from all the inefficiencies of a system which takes no account of local differences. Accordingly, the Committee recommends that the present method of fixing grant ceilings on the basis of grant carried in the year when expansion was checked should be discarded. In its place a system should be adopted under which allocations representing the maximum amount of grant available to each responsible body for the coming year should be made after consideration of the quality and standards of work being done by that body, as well as its proposed programme, the needs of the region in which it operates, and the activities of other interested bodies in the region. The limits on the salaries of full-time tutors recognized for grant should be removed, although responsible bodies should still be required to obtain the Ministry's approval for new full-time appointments on which grant would be sought. It would also raise the level up to which fees of part-time tutors are recognized for grant, and in the calculation of grant the conception of sessional rates of payment for part-time tutors of tutorial classes should be replaced by rates of payment by the hour or by the meeting.

The Committee also recommends the amendment of Further Education Grant Regulations so as to give less prominence to the length of course as compared with other criteria. Classes for special groups of students should be acceptable for grant provided the enrolment of other students is not unreasonably prohibited and the Committee would not exclude courses of high quality from grant on the grounds of vocational interest. It recommends that responsible bodies should be given some assurance that the total allocation of grant for adult education should not be reduced at short notice. It would widen the interpretation of teaching costs to include, besides the primary responsibility of teaching costs, such work as responsibility for a library service or giving guidance to junior colleagues. Local conditions should be the primary consideration in fixing student fees. Such fees should be kept under review and raised if local conditions justified and necessitated this action; and both the Minister and local education authorities in determining their grants should take into account the total financial contribution being made by the students.

As regards the content of courses, the Ashby Committee thinks that money is well spent in satisfying a genuine demand from students who are prepared to throw themselves whole-heartedly into the work of the class; but that public money should not be spent on titillating the interest of students who are not prepared to make some sacrifice of their own time and effort to work at the subject of the class. As regards the content of the subject taught, the Committee would be sorry to see a list of approved subjects drawn up, because it would soon become obsolete and its very existence would discourage fresh ideas. This is a main reason for the suggestion that the Minister should establish a small committee to advise from time to time on the subjects and types of adult education courses which should receive priority in qualifying for grant.

The Ashby Committee's report, for all the merit of the minor improvements it recommends, is probably of most value as a stimulus to the constructive thinking which not only such a Committee but also the responsible bodies, local authorities and others should be giving to the scope, the functions and content of adult education in our changing social pattern.

THE PHYSICS OF THE IONOSPHERE

THE Physical Society held a Conference at the Cavendish Laboratory, Cambridge, during September 6–9, on "The Physics of the Ionosphere". It was attended by about 150 delegates, many of them from overseas. The subjects discussed were: the lowest ionosphere; irregularities and horizontal movements in the ionosphere; the *F*2-layer; the mathematics of wave-propagation through the ionosphere. Under each of these headings a paper was read which summarized the existing background of knowledge against which the discussion could take place. In the discussion itself short prepared contributions, which had previously been circulated in print, were first presented, and were followed by a general discussion on special problems. Most of the contributions to the prepared discussion will be published as full-length papers in a report on the Conference (available from the Secretary-Editor, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7). Some of the more interesting points emerging from the Conference are mentioned below.

D. F. Martyn presented the latest stage of his work on movements in the *F*-layer. He first pointed out that, when Hall effects are taken into account, in a modification of Schuster's theory of the atmospheric dynamo, the electrostatic polarization in the dynamo region is different from that deduced originally by Schuster. The fields produced, in the F-layer, by this polarization in the dynamo region would explain the major vertical and horizontal movements of that layer. Finer detail can be explained in terms of diffusion if the air density in the F-region is as small as seems to be indicated by recent rocket measurements. This latest stage of Martyn's work seems to bring us near the proper explanation of most problems of movement in the F-layer.

Delegates to the Conference were fortunate in hearing the first account of some of the scientific results which have resulted from a study of the forward scattering of 50 Mc./s. waves from the ionosphere. D. K. Bailey surveyed evidence which suggests that this scattering occurs at heights between 75 and 90 km. The height and the intensity of the scattering vary with season and with time of day. Preliminary results concerning the resultant distribution of signal amplitude over the ground were presented, both in terms of the speed of fading and of the auto-correlation function in distance. It is certain that these results, accumulated in the United States over a period of several years, will be of great importance for ionospheric theory; it is too early yet to try to assess their significance in detail.

The workers at the Naval Research Laboratory, Washington, led by E. O. Hulburt, one of the earliest ionospheric physicists, presented some most interesting and stimulating suggestions about the formation of the ionized layers. Measurements made recently with rockets were quoted to support the suggestion that both the E- and the F-layers are produced by X-rays and that, although the D-region is mainly ionized by ultra-violet light (Lyman α), the extra ionization at times of sudden ionospheric disturbances is produced by X-rays.

The absorption of waves of frequency between 2 and 4 Mc./s. was discussed, and the widespread belief that it could mostly be accounted for by D-region absorption, obeying the frequency law appropriate to a non-deviating region, was questioned. The majority of the workers on this subject were represented at the Conference and they had some fruitful discussion, without reaching any agreement. It was, at any rate, realized that the matter is still open to question.

Observations of echoes returned at vertical incidence from heights between 80 and 100 km. on frequencies near 1 Mc./s. were described. There was disagreement about whether the echoes represent total reflexion from an over-dense layer, partial reflexion from a sharp gradient of electron density, or scattering from irregularities.

Several new results were reported concerning irregularities and horizontal movements in the ionosphere. S. A. Bowhill suggested that in the lowest part of the ionosphere the irregularities of electron density have two sizes, a larger one low down and a smaller one higher up, and that the way in which the fading speed varies when the radio-frequency is changed from 16 to 2,400 kc./s. can be explained in terms of them. He also suggested that the mean drift-velocity of the larger irregularities is smaller than their random velocities, whereas the opposite is true for the smaller irregularities.

A consideration of the amplitude of successive echoes reflected from the E-layer on a frequency of 150 kc./s. led R. L. Schrag to suggest that, at night, the layer sometimes acts like a concave mirror and produces a focusing of the waves returned to the earth. This appears to be the first time that focusing has been noticed from the E-layer, although it is a well-known phenomenon with F-layer echoes.

J. L. Pawsey mentioned that workers at the Radio Physics Laboratory in Sydney had noticed ionospheric focusing of the radiation from radio stars received at shallow angles. It was not certain whether the focusing was produced in the E- or the F-layer. Evidence was presented to show that, on the average, the shape of the ionospheric 'lenses' is not circular.

It was emphasized that all radio methods measure the movements of irregularities of electron density, and that these are not necessarily the same as the movements of the air or even of the surrounding electrons. It is therefore important that the subject should not be confused by describing these movements as 'winds'; they could more precisely be called 'drifts'. In this connexion, P. C. Clemmow, K. Weekes and M. A. Johnson presented a paper which showed that a cylinder of enhanced ionization, immersed in a background of ionization, in the presence of a magnetic field would move in a direction which depended on the collision frequency of the electrons and might be different from the direction of motion of the surrounding ions.

Several speakers dealt with the question of the distortion of the F-layer at times of ionosphere disturbance. Sir Edward Appleton and W. R. Piggott suggested that the effects of disturbances depend on the epoch in the sunspot cycle, and that there is a difference between the rising and the falling parts of the cycle. S. Matsushita, and R. W. Wright and N. J. Skinner discussed the effects of disturbances in the equatorial zone.

It was frequently mentioned that, although a very great effort is put into obtaining ionospheric $h'(f)$ records from all over the world, the amount of information available from them, for purposes of ionospheric physics, is not as great as it might be. Several speakers discussed how the height distribution of electrons could be deduced from the records. The main emphasis was on the shortening of the computations and the inclusion of the effect of the earth's magnetic field. It appeared that the required computations could be carried out, with comparatively little labour, so as to indicate the state of the ionosphere at one place on an average magnetically quiet day in any month, and the hope was expressed that an organization might be set up to perform computations of this kind for the observations from a few selected sites during the forthcoming Geophysical Year.

In the part of the Conference dealing with mathematics, the discussion centred, as was intended, on mathematical methods rather than on the results obtained. A series of papers dealt with the problem of tracing rays through the ionosphere in the presence of the earth's magnetic field. This problem was solved, in principle, several years ago. The new work is concerned with methods which are sufficiently rapid for practical application, and some of them seem to be promising in this respect. If these can be brought into routine use, there will be considerable improvement in the calculations of maximum usable frequencies.

Other mathematical papers dealt with the coupling of the characteristic waves in the ionosphere, and with the detailed statistics of the collisions of electrons with heavy particles and its bearing on magneto-ionic theory.

The Physical Society is to be congratulated on arranging such a successful conference at a time when a large proportion of those actually engaged in ionospheric research could be present. The publication of the report, which is promised soon, will add considerably to the value of the Conference.

CARBON-14 DATING

SYMPOSIUM IN COPENHAGEN, SEPTEMBER 1–4

It is now generally recognized that the method of dating organic material by assay of radiocarbon content is of outstanding promise for many sciences, particularly archæology and the aggregate of archæology, geology and biological sciences which can be called 'Quaternary research'. The demonstration of its feasibility by W. F. Libby was followed by the initiation of many projects for radiocarbon dating, centred in North America and in Europe. Those most concerned in North America have already had more than one joint meeting, but European workers have remained relatively isolated from one another until this year, when they attended an informal symposium in Copenhagen.

The meeting was sponsored by the Danish Rask–Ørsted Foundation, and was actively supported by the organizing committee of the Copenhagen carbon-14 project which has been operating since 1951 under the chairmanship of Dr. Therkel Mathiassen. The secretary of the meeting was Dr. Hilde Levi, head of the Copenhagen carbon-14 dating laboratory, and, through her, invitations were sent to the several European centres known to have carbon-dating plant working or under construction: two or three members attended from each centre.

The first day's discussion opened with consideration of technical matters associated with solid-carbon counting by methods essentially those of W. F. Libby, as now being used in Copenhagen and in Rome, and in preparation at Trondheim and Stockholm. This was followed by accounts of the processes being worked out for the use of gas-counters with the carbon in the form of carbon dioxide (Groningen and Heidelberg), acetylene (Royal Institution, British Museum and Harwell jointly, and Cambridge), and methane (Goteborg). Many interesting aspects of the production of the counting gases were considered, more particularly the hydrocarbons.

It became perfectly clear that gas-counting both by carbon dioxide and by acetylene is more expeditious and somewhat more sensitive than screen-wall counting of elemental carbon, and may be expected to displace the older method, which nevertheless is now producing a large part of the published datings. Only brief reference was made to scintillation counting.

Discussion on the third day concerned sources of error inherent in the samples and the techniques, and precautions which they involve, and some brief consideration of datings secured by European projects. It was apparent that, while cross-checking of samples could usefully be considered in this way, the implications of several unpublished datings were far too wide for the limited personnel and time of the meeting.

Some consideration was given to the standardization of form of publishing results, and to dating projects requiring international organization. It was agreed that a second symposium ought to be held, at least to deal with technical advances, within the next year or so and that *rapprochement* should be sought with American colleagues.

This first meeting proved extraordinarily profitable to all participants, not least because of the close personal discussions made possible by its small size and informal nature. The hospitality of our many Danish hosts and the skill and tact of Dr. Levi in organizing the meeting were beyond praise.

H. Godwin

HYDERABAD CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1952

The annual report for 1952 of the Central Laboratories for Scientific and Industrial Research, Hyderabad*, which has only recently been published, refers to the slow progress of the new building, towards the completion of which the Government of India sanctioned a non-recurring grant of 5 lakhs of rupees. Research in the Oils and Entomology Sections during the year included the preparation of insecticidal material from sitaphal seed and soap-making trials of sitaphal oil, the dehydration of castor oil, continuous preparation of triricinolein, indigenous cotton-seeds and their oils, separation of fatty mixtures and the antioxidant properties of aca-catechin. The Fibre and Paper Section examined the possibilities of manufacturing filter and board paper from tailor wastes and of using casuarina wood pulp as a diluent for cotton-seed linters. The Fuel Section made a rapid survey of the distribution, classification and available reserves of Hyderabad coals and continued its systematic physical and chemical survey. A pilot-plant investigation of the briquetting of non-caking coals has been undertaken and, in connexion with the installation of the Lurgi low-temperature carbonization plant, the weathering properties of Hyderabad coal and its oxidation in a fluidized bed, the recovery of tar acids and hydrocarbons from low-temperature tar and of benzole from carbonization gas are being studied.

The Heavy Chemicals and Fertilizers Section has been concerned with the utilization of felspar and iron pyrites, and of sulphates for the manufacture of sulphuric acid as well as the preparation of activated charcoal from groundnut hulls. A systematic study of Hyderabad clays was made in the Ceramic Section as well as a study of their utilization as fireclay refractories. The work of the Organic Chemistry, Pharmaceutical and Drugs Section included studies of potential synthetic analgesics, including quinazoline derivatives and a new synthesis of pethidine, studies on Indian turpentine and alkaloids and attempts to synthesize compounds with sex hormone activity. In the Biochemistry Section, fermentation studies included the production of citric acid from sugar-cane molasses and of itaconic acid from glucose, using *Aspergillus terreus*; non-fermentation studies included the production of lævulinic acid from sugar-cane bagasse.

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* Central Laboratories for Scientific and Industrial Research, Hyderabad. Annual Report, 1952. Pp. xi+57. (Hyderabad-Deccan: Osmania University Press, 1954.)

X-ray studies were made on Hyderabad clays and on stilbene derivatives, and the conductivity of lithium nitrate in mixtures of methyl and ethyl alcohol and the isomerization of chromic chloride hexahydrate were studied in the Physical Chemistry Section. The Analytical Section is working out a method for the determination of tartaric acid with potassium dichromate, and a systematic study of the fusel oil from the Nizam sugar factory, Bodham, Hyderabad State, indicated that it contains 50 per cent of amyl alcohol with fair proportions of propyl and *iso*propyl alcohol. Besides erecting the low-temperature carbonization plant, the Chemical Engineering Section determined the solubilities of groundnut oil in 98 per cent ethyl alcohol at 40–60° C., while the Operational Research Unit was concerned with the manufacture of fructose on a semi-commercial scale, of triricinolein and of sesamin.

OXFORD SYSTEM OF DECIMAL CLASSIFICATION FOR FORESTRY

FOREST bibliography has for long been a difficult subject to deal with, more especially since forestry research institutes and new forest departments and their resulting publications began to make their appearance. Certainly nowadays it would be almost impossible to keep *au fait* with the great output of forestry literature without some form of international classification.

The International Association of Forest Research Institutes—since 1929 called the International Union of Forest Research Organizations—had put the question of forest bibliography on its programme as early as 1903 with the object of creating a minimal system of classification and an international forest bibliography, the work being then entrusted to a Bibliographical Committee. The subject was discussed at the three international forestry congresses held in Rome (1926), Budapest and Helsinki. From the outset, the Swiss forester, Dr. Philipp Flury, was one of the most ardent workers in this new cause in preparation, and it was not until 1933 that the Committee presented to the International Union a complete system of classification of forest literature which was adopted in congress. It bore the title "Forest Bibliography", but became widely known as the "Flury System". It was assigned the decimal signature 634·9 F, to distinguish it from the heading 634·9 forestry in the Universal Decimal Classification, which differs in the details of its sub-division. One of the Flury System's main uses was to classify the title references comprising the International Forest Bibliography—a scheme organized by the International Union for the regular exchange between member countries of references to literature considered to be of international importance.

The first post-war meeting of the Bibliographical Committee was held in Zurich in 1948 under the chairmanship of Prof. H. Burger. At this meeting Mr. F. C. Ford Robertson, director of the Commonwealth Forestry Bureau at Oxford, presented a completely revised system of classification for forest literature which had been prepared by his Bureau in consultation with the chief research station (Alice Holt) of the British Forestry Commission and the Forest Products Research Laboratory at Princes Risborough. This revision was based upon ten years of experience gained by the Bureau in the course of its day-to-day work in abstracting and classifying the world flow of forestry literature.

When a working agreement had been reached between the International Union of Forest Research Organizations and the United Nations Food and Agriculture Organization, the International Council of the former proposed to the latter the appointment of a joint Bibliographical Committee to study the new classification and to make appropriate recommendations to both. This was to supersede the previous Committee, and on it was appointed A. Oudin, director of the Nancy Forestry School, F. C. Ford Robertson and E. Saari, professor of economics in the University of Helsinki. J. D. B. Harrison and R. G. Fontaine were appointed by the Food and Agriculture Organization. Meetings of the Committee were held at Helsinki, Oxford, The Hague, Wageningen, Oxford and Rome. During this period the new classification system submitted by the Commonwealth Forestry Bureau at Oxford was carefully examined, and at various stages of revision was widely circulated to members of the International Union and research stations throughout the forestry world. Throughout the four years of revision, the Commonwealth Forestry Bureau acted as the natural clearing house for the work of correspondence and collation involved, in which Mr. P. G. Beak, assistant director of the Bureau, proved an invaluable helper.

The definitive English text of the new system of classification (which runs to 115 pages) is called the "Oxford System of Decimal Classification for Forestry"[*] and was finally presented to the International Congress in Rome in September 1953, when it was unanimously adopted with the recommendation that translations of the English text should be published in French, German and Spanish. The Food and Agriculture Organization, at its seventh session in Rome, approved of the system with a few resolutions on the subject of periodical revisions and so forth.

E. P. STEBBING

[*] The Oxford System of Decimal Classification for Forestry. (Being the Definitive English Version as authorized by the Rome Congress of the International Union of Forest Research Organizations, September 1953, and published on their Behalf by the Commonwealth Agricultural Bureaux.) Pp. 115. (Farnham Royal: Commonwealth Agricultural Bureaux, 1954.) 10*s*.

SUBMARINE ILLUMINATION AND THE TWILIGHT MOVEMENTS OF A SONIC SCATTERING LAYER

By ELIZABETH M. KAMPA and BRIAN P. BODEN

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IT has long been recognized that many zooplankton organisms exist in distinct strata during the day and that they may undergo extensive diurnal vertical migrations. The similarity of their behaviour to that of certain sonic-scattering layers in the sea, observable with echo-sounding equipment, led Johnson[1] to suggest that the origin of these layers is biological. Collections by various methods have shown that concentrations of both zooplankton and fishes are associated with these layers. Although much thought has been devoted to the composition of the layers and to the acoustic properties of the animals probably comprising them, attention to the causes of

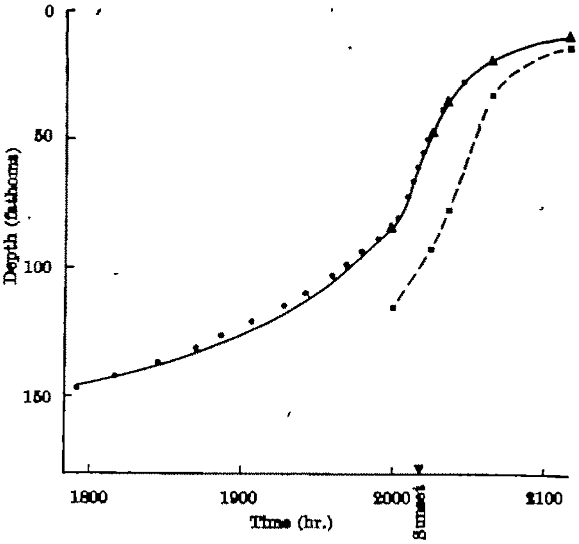

Fig. 1. Evening ascent of a scattering layer and of the 6·6 × 10^{-4} foot-candle isolume. Solid line represents top of layer as seen on *NMC*-1 fathometer record, round dots represent measured positions of the isolume, triangles represent scattering at 9·6–20 kc./s.; solid squares (– – – –) represent scattering at 2·4–3·4 kc./s.

their vertical migrations has been restricted to speculation and to laboratory experiments with individuals.

As a first step in determining these causes, the change of depth of a certain level of submarine illumination during twilight is compared here with the depths of a certain scattering layer during its vertical migration.

Intensity of illumination at depth was measured with a submarine photometer designed expressly for this purpose by James M. Snodgrass, of the Special Developments Division at the Scripps Institution of Oceanography. This instrument, described previously by Kampa and Boden[3], employs an *RCA 931A* photomultiplier tube which is sensitive to wavelengths between 300 and 700 mμ. The sensitivity has a sharp peak at 400 mμ and drops to 50 per cent at 320 mμ and 518 mμ. The tube is protected against pressure at depth by an oil-filled glass riding-light cover which makes water-tight contact with the brass cylinder containing the submerged portion of the photometer circuit.

The photometer was calibrated with a Weston illumination meter using a 100-watt *G.E.* projection bulb at 115 volts.

During the observations reported here, the submerged unit was rigged in such a way that the sensitive surface of the photomultiplier tube was vertical, favouring measurement of horizontal illumination.

When a curve of equal illumination was to be determined for comparison with scattering layer position during vertical migration, the submerged unit was lowered to the depth of the top of the layer, and the light intensity and time were recorded. This time was noted on the fathogram as well. The photometer was then either raised (sunset) or lowered (sunrise) 10 m. and held at the new position until meter readings showed that the illumination intensity was the same as that previously observed. The time was again recorded. This process was repeated until the fathogram showed that the scattering layer position had become relatively constant, either at the surface or at depth.

Scattering layers were observed with an *NMC*-1 fathometer operating at 17·5 kc./s. A more detailed analysis of the scattering properties of these layers was effected by a multiple-frequency technique similar to that employed by Hersey, Johnson and Davis[3]. The wide-band sound source in this analysis was a half-pound block of TNT detonated at the surface about 30 m. from the receiver. The receiver was a directional Rochelle salt hydrophone directed vertically downward just below the surface at the side of the ship. Sounds received by hydrophone were recorded with a 'Magnecord' 63*AH* tape-winder with *PT7-P* 'Magnecord' amplifier adapted to operate at 30 in. per sec. The record of echoes from each explosion was filtered through an H. H. Scott Type 420-*A* sound analyser, and an oscillographic record was made of the reverberation at various frequencies using a triggered single-sweep oscillograph fitted with a 'Polaroid' Land camera.

Biological collections were made from each layer under observation with a 1-m. plankton net of 8 xxx bolting silk. This net could be opened and closed at depth by means of the Leavitt[4] opening and closing device. A time–depth recorder was incorporated in the collecting gear to give a record of the fishing depth of the net. After superficial examination these collections were dark-adapted in running sea water and then deep-frozen. A report of the light-sensitive substances obtained from these animals will be presented shortly.

Fig. 1 shows the twilight ascent of a scattering layer in the San Diego Trough on June 30, as well as the ascent of the level of illumination (6·6 × 10^{-4} foot-candles) with which this scattering layer had been associated during the afternoon. It can be seen that the ascending scattering lags behind the ascending light intensity between 1830 and 1950 hours (P.D.T.).

This layer was observed to split into two components during its migration. A similar splitting of the single layer during ascent was observed on the following evening when the multiple-frequency technique was employed (risk of damage to the light meter precluded its use while TNT was being detonated). Fig. 1 also shows the ascent of this split layer on July 1. The upper component of the split layer scattered relatively high frequencies (9·6–20 kc./s.), whereas the lower component scattered only lower frequencies (2·4–3·4 kc./s.). Fig. 2 shows oscillo-

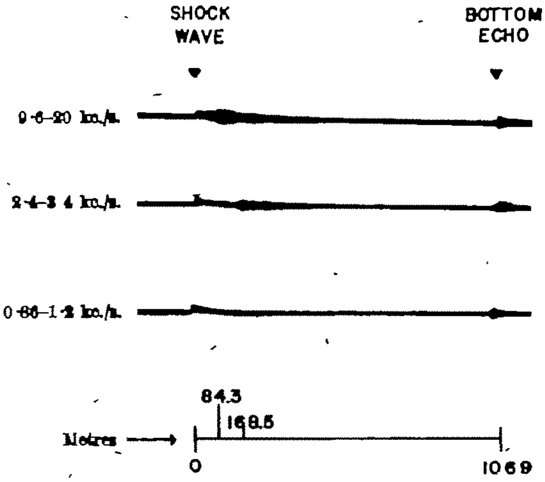

Fig. 2. Oscillogram showing back reverberation at selected frequency pass-bands. Peaks of scattering can be seen at 84·3 and 168·5 m

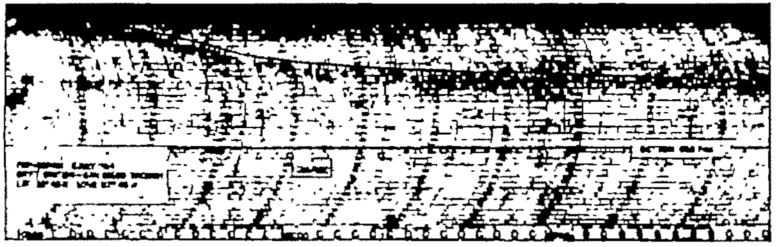

Fig. 3. Fathogram of layer descending in the morning. The $5 \cdot 9 \times 10^{-5}$ foot-candle isolume is superimposed

grams of reverberations from the second TNT explosion in the July 1 (Fig. 1) series. The upper component, scattering at higher frequencies, is apparent at 84·3 m. (46·1 fathoms), while the lower component is at 168·5 m. (92·4 fathoms).

Fig. 3 is a fathogram made in the San Diego Trough on July 2 during morning twilight to sunrise. As soon as a scattering layer could be observed breaking away from surface scattering, the photometer was lowered to the top of the layer. The intensity of illumination here was $5 \cdot 9 \times 10^{-5}$ foot-candles. The descent of the $5 \cdot 9 \times 10^{-5}$ foot-candle isolume is superimposed on the fathogram. It can be seen that the descending layer and the isolume enter and continue through a layer which had persisted through the night at about 135 fathoms.

The extremely close correlation between the vertical movements of a scattering layer and those of a constant level of illumination (Figs. 1 and 3) argues strongly that the migrations of these layers are simple responses to variations in environmental light intensity. The slight lag in the ascent of the layer behind that of the isolume (Fig. 1) during the early part of the migration suggests that, although 0·00066 foot-candles may constitute an optimum illumination for the scatterers, the threshold intensity for migration is slightly lower. This threshold was reached apparently at about 1900 hours, and the scatterers increased their rate of ascent. Shortly before sunset the layer overtook the isolume, and, at sunset when the ascent is most rapid (about 2·75 fathoms per minute), the rates of ascent of illumination-level and scattering layer are identical.

It is interesting to note that the illumination intensity ($5 \cdot 9 \times 10^{-5}$ foot-candles) with which the descending layer (Fig. 3) was associated on July 2 is less than one-tenth of that determined for the ascending layer on June 30 ($6 \cdot 6 \times 10^{-4}$ foot-candles). Assuming that these layers were similar in biological composition—an assumption which was borne out by collections taken from them—it seems that during the moonless night the animals became dark-adapted and consequently more sensitive to lower light intensities. The extent to which various degrees of dark- and light-adaptation influence the position of the scatterers relative to illumination-level demands further investigation.

Frequency analysis, at the time the fathometer has revealed the splitting of a layer during ascent, shows that the upper component, which seems to be responding to a photic stimulus, scatters sound at 9·6–20 kc./s., whereas the scattering peak of the lower component is at 2·4–3·4 kc./s. This is evidence that the upper part of the layer may be comprised of smaller organisms (invertebrates ?) and the lower part of larger ones (fish ?).

Thus we have the picture of a heterogeneous layer existing during the day at an illumination intensity which is optimum for one or more animals associated with the layer. During the evening twilight this organism ascends with its optimum intensity and is followed by predators which have been in the layer during the day. This contention is supported by the results of Tucker[5], whose analysis of net hauls taken in the layer led him to conclude that invertebrates (euphausiid crustaceans) were the dominant organisms in the upper part of the layer, while fish were dominant in the lower part of the same layer. Rigidly controlled biological collections from different components of the layer during vertical migration promise to do much in elucidating which organisms are responding to light and which are merely following a migrating food source.

This work is being conducted under contract between the Geophysics Branch of the Office of Naval Research and the Scripps Institution of Oceanography, University of California. [Aug. 7.

[1] Anonymous. Stratification of Sound Scatterers in the Ocean University of California, Division of War Research. Report No. M397 (1946).

[2] Kampa, E. M., and Boden, B. P., Bermuda Biological Station. Rep. 1 (1954)

[3] Hersey, J. B., Johnson, H. R., and Davis, L. C., *J. Mar. Res.*, 11, (1), 1 (1952).

[4] Leavitt, B. B., *Biol. Bull.*, 69 (1), 111 (1939).

[5] Tucker, G. H., *J. Mar. Res.*, 10 (2), 215 (1951).

THE INTERTIDAL FLORA AND FAUNA OF THE CHATHAM ISLANDS

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IN January–February 1954 an oceanographic expedition from Canterbury University College and Canterbury Museum, sponsored by the New Zealand Oceanographic Committee, visited the Chatham Islands in the M.V. *Alert*. This group of islands and rocks lies 560 miles due east of Banks Peninsula on the South Island, New Zealand, the largest member of the group, Chatham Island, being about thirty miles long. During the time spent round the Islands opportunity was taken to make observations on, and fairly complete collections of, intertidal plants and animals, at several localities on the main island and on many of the outlying islands.

The Chatham Islands lie in a zone of mixed cool sub-antarctic and warm sub-tropical water. Cool sub-antarctic water passes up the east coast of the South Island and is deflected east towards the Chatham Islands when it impinges on a tongue of warm sub-tropical water from the north, described by Fleming[1] as the East Cape Current. The area of intermingling, known as the Sub-tropical Convergence[2], is clearly defined at times, ill-defined at others, and varies considerably in position seasonally and from year to year[3]. The Chatham Islands, then, are subject to both sub-tropical and sub-antarctic influences in varying degrees, and this has an important bearing on the flora and fauna of the intertidal region.

A striking feature of the intertidal ecology of the Chatham Islands to one familiar with the New Zealand shores is the odd mixture of species characteristic of the northern and southern parts of New Zealand; for example, algae such as *Apophloea lyalii* Hook. f. et Harv. and *Pachymenia lusoria* (Hook. f. et Harv.) J. Ag., found only in the southern part of the South Island and Stewart Island, grow alongside other species, such as *Carpophyllum plumosum* (A. Rich.) J. Ag., which are limited to the northern part of the North Island. Moore[4] states that, of the 190 species of algae recorded from the Chatham Islands, ten are not otherwise recorded from New Zealand and the rest are a mixture of northern and southern species. Powell[5] has recorded 256 species of intertidal and shallow water molluscs from the Chatham Islands. Of these, forty-seven are endemic species or subspecies, and he states that there is an approximate equality in numbers of species that definitely show either northern or southern origin.

Many characteristics of the intertidal zonation, such as the absence of serpulid and *Mytilus planulatus* zones and the presence of a well-marked *Apophloea lyalii* zone, are those found only in the extreme south of the South Island and Stewart Island. Others, such as the development of *Chamaesipho brunnea* and Vermetid zones, are characteristic of the zonation of northern New Zealand shores. The basic pattern of zonation, with a well-developed *Durvillea* zone, is that of the southern, cold-temperate, New Zealand shores with some northern, warm-temperate, New Zealand features superimposed, as well as a number of endemic features.

Another striking feature is the complete absence of many of the commoner species of the New Zealand shores. Notable examples are the barnacles, *Chamaesipho columna* Spengler, *Elminius modestus* Darwin and *Pollicipes spinuosus* Quoy and Gaimard, the common intertidal serpulid, *Pomatoceros coeruleus* (Schmarda), and the molluscs, *Amaurochiton glaucus* (Gray), *Mytilus canaliculus* Martyn, *Modiolus neozelanicus* (Iredale), *Nerita melanotragus* (Smith), *Lunella smargada* (Martyn), *Scutus breviculus* (Blainville) and *Benhamina obliquata* (Sowerby). Other species, such as *Mytilus planulatus* Lamarck, were present only in very limited numbers and were not band-forming species as on the New Zealand coasts. Only one species of limpet, the endemic *Cellana chathamensis* (Pilsbry), occurs intertidally, whereas at least two or three species of *Cellana*, as well as several patelloid limpets, are to be found in most parts of New Zealand. Graspoid crabs were absent, as well as the anomuran, *Petrolithes elongatus* Milne-Edwards. On the New Zealand shores the latter species is one of the commonest and most ubiquitous animals. The complete absence of crabs above mean low-water neaps is an unusual feature not found on other southern temperate shores. Absences were not so marked among the algae, the majority of the dominant intertidal species of the New Zealand coasts being present. One example is *Durvillea willana* Lindauer, although *Durvillea antarctica* (Champ.) Hariot is abundant and another species *Durvillea caespestipes* (Mont.) Skotts[6] occupies a similar place on some Chatham shores to that of *D. willana* on the New Zealand shores.

The absence of certain species has led to some interesting changes in the vertical zonation of others when compared with their zonation on the New Zealand shores, and serves to illustrate the effect of competition in determining the limits of intertidal plants and animals. Extremely interesting and difficult to account for is the absence of the commonest New Zealand intertidal barnacle, *Chamaesipho columna*, as this species occurs throughout New Zealand, the Kermadec Islands and temperate Australia. On the New Zealand shores *Chamaesipho brunnea* occupies a comparatively narrow zone from about mean high-water neaps to mean high-water springs, above the optimum development of *C. columna* which extends down to about mean low-water neaps. On the Chathams, with the absence of *C. columna*, *C. brunnea* extends throughout the midlittoral zone down to the upper limit of the brown algal zone at mean low-water neaps. Apart from competition between adult barnacles, the difference in the breeding season of the two species of *Chamaesipho* is probably an important factor in determining their relative ranges in New Zealand. *C. columna* breeds throughout the year, whereas *C. brunnea* has a more restricted breeding season from September to February[7].

A consideration of the above evidence leads to the conclusion that the Chatham Islands intertidal region has been populated from New Zealand. This conclusion is supported by geological evidence. Finlay[8] states that the whole of the recent molluscan fauna of the Chathams seems to be independent of the Tertiary faunas, the most characteristic shells inhabiting the shores not being represented in Pliocene beds[9]. He concluded that "the Recent Molluscan fauna of the Chatham Islands is not a remnant or an evolution of the Tertiary fauna found there, but a repopulation from the mainland, in Post-Pliocene times, but yet long enough ago for characteristic regional species and sub-species to have evolved". Few endemic intertidal species have been recorded in the other animal groups and in the algae. More may, however, be recorded when the results of the present expedition have been worked out; but, apart from molluscs, nearly all the dominant intertidal plants and animals are also found on the New Zealand shores.

The absences pose some interesting problems concerning the means of dispersal of the species involved. Establishment of an intertidal population across a sea barrier can take place by the transport of sufficient numbers of larval stages by current systems, or adults by floating objects or by shipping. Drifting kelp was observed throughout the voyage to and from the islands, and it probably formed an important method of dispersal in the past. Some mainland animal species which are closely associated with brown algae, such as the anemone *Oricophorus nutrix* (Stuckey) which is practically confined to species of *Cystophora*, are also found at the Chathams; others are absent. Although *Durvillea antarctica* is abundant at the Chatham Islands, the chiton *Frembleya egregaria* H. Adams, one of the dominant species confined to *Durvillea* holdfasts on the New Zealand shores, has not been recorded. Another dominant species, *Siphonaria australis*, is rare, and was first recorded by the expedition. A second chiton, *Ornithochiton neglectus* Rocheburne, occurs abundantly in holdfasts both in New Zealand and the Chathams. Shipping may have formed a transporting agent in recent times, but it is interesting that no specimens of the barnacle, *Elminius modestus*, were found, although it has recently been introduced to Europe[10].

Crisp and Southward[11] have recently discussed the influence of sea barriers on the distribution and evolution of predominantly intertidal plants and animals and conclude that "a critical distance must exist, related to the current system and the duration of the free swimming stages, beyond which the rate of settlement of the larvæ is normally insufficient to reach the minimal population density within the lifetime of an individual". As yet there is very little information available regarding the life-histories of New Zealand intertidal animals. Information is, however, available concerning the current velocities between New Zealand and the Chathams. Young[12] reports that light wreckage from Cook Strait has been picked up three weeks later on the north side of Chatham Island. Drift bottles liberated off the Otago Heads have been picked up on various parts of the island from 3 to 15 months later[13]. The velocities of these currents would be sufficient to transport the free-swimming larvæ of many species.

Detailed results of this investigation of the intertidal ecology of the Chatham Islands will be published elsewhere. The expedition which enabled the above observations to be made was financed by a grant from the New Zealand Council of Scientific and Industrial Research, with contributions from Canterbury University College, Canterbury Museum, the Dominion Museum and the Canterbury Branch of the Royal Society of New Zealand. This assistance is gratefully acknowledged. I also wish to thank Dr. M. Naylor and Mr. R. K. Dell for helpful discussion.

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EXPERIMENTAL CHEMICAL CARCINOGENESIS AND THE INFLUENCE OF SOLVENTS

RESEARCH IN FINLAND

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STUDYING the mechanism of experimental tumorigenesis there are—besides the cancer-provoking agent itself—several factors influencing essentially the development of tumours. The majority of these factors are, however, still totally unknown. Even the few which can be regarded as known need further explanation. It may therefore be of value to summarize some of our present knowledge and try to illustrate the significance of some of the observations already obtained.

Cancer-provoking agents as used in experimental research are, in general, the fat-soluble aromatic polycyclic hydrocarbon carcinogens. When they are employed for an investigation on living biological material, it is necessary to bring these fat-soluble substances into close contact with the aqueous environment of the organism. In applying fats and/or fat-solvents as vehicles for the carcinogen, a number of factors, not easily controllable, are introduced which modify the results. A considerable number of investigations dealing with factors which alter the action of tumorigenic agents confirm the existence of some kind of 'solvent effect'. The nature of this is unknown. That is why the effect of the vehicle used and that of the actual carcinogenic agent cannot be clearly distinguished from each other. It seems possible, however, that a satisfactory explanation of this particular circumstance would throw additional light to the question how the carcinogenic hydrocarbons actually function.

Selecting suitable mediators for the carcinogen, it is logical to examine the physiology and pathology of living matter for suggestions as to their required nature[1–3]. One should take into account the large body of data which has been accumulated, for example, upon the chemistry and fine structure of protoplasm and its derivatives, intercellular substances and the permeability phenomena. (On these matters I consulted (at the beginning of 1946) Prof. R. Collander (Institute for Botany, University of Helsinki), a leading investigator on the permeability of cells, who agreed with this view, and made some illuminating comments.) The vehicles in the present experimental series ought to satisfy, so far as possible, the following demands: (1) in principle they should be as 'physiological' as possible; (2) they must be well known and chemically well defined; (3) they must have the property of solubilizing both water- and fat-soluble substances; and (4) it must be possible to vary the chemical and the physical nature of the resulting solutions within wide limits when needed. It seems, therefore, natural that the vehicles should be nonpolar–polar compounds having their principal counterparts in living Nature[1–10]. For experimental studies, compounds of varying nonpolar–polar behaviour can be selected, either from the biologically active, natural nonpolar–polar substances or from the technical products known as detergents (cf. refs. 4, 5, 8 and 10). (From the beginning of 1947 until 1951, Prof. P. Ekwall (Institute for Physical Chemistry, Åbo Akademi, Turku, Finland) acted as chemical adviser in our studies in the field of aqueous solutions of association colloids[7].) Since 1946 I have systematically employed certain synthetic high polymers—for example, solutions of various polyethylene glycols (carbowaxes). It appeared that both these compounds and the so-called 'association colloids' which were brought into use later during our studies[7] have some common properties from the physico-chemical point of view[5,6,7].

Before investigations concerning the actual mechanism of experimental carcinogenesis could be started, some orientating tests were made (regarding the maintenance of the carcinogenic activity, differences in carcinogenic response of tissues when various types of nonpolar–polar vehicles are employed, the significance of the carcinogen and the colloid concentration, penetration and absorption of the carcinogen into various tissues, the possible transport mechanism, etc.). Some of the aspects are dealt with in the following. (Investigations have been carried out since 1945.)

Tumorigenic power. The first task was to test if the carcinogenic hydrocarbons solubilized by these nonpolar–polar mediators retain their tumorigenic activity. The tumorigenic power was tested using various strains of mice. In systematic studies, however, mice of our anonymous known strain employed in all our experiments were used. Up to the present, about 15,000 animals have been expended. For the orientating experiments, only relatively small series (ten to twenty mice in each subgroup) were at our disposal. The reasons for this were two-fold: the wide scope of the programme, and post-war difficulties in Finland. In the actual experiments, larger series (fifty to two hundred mice in each subgroup) were employed (see refs. 9, 13).

A priori, it was far from certain that these nonpolar–polar mediators would retain their activity (cf. ref. 11, pp. 56–59). So far, a great number of different representatives of nonpolar–polar mediators (both ionic and non-ionic ones) has been studied. It has now been established with certainty that carcinogens retain their carcinogenity and induce cutaneous[1–3,5,8,12], fore-stomach[3,6,13] and subcutaneous[3,9] tumours. In addition, there are significant differences in the average response when different vehicles are employed. Further, tumours can be induced by applying only a fraction of the quantities of the carcinogen reported in the literature.

Cutaneous tumours developed with a concentration, for example, of 0·0045 per cent of 9,10-dimethyl-1,2-benzanthracene in aqueous solutions of sodium lauryl sulphate[3,6,9]. The average time of response decreased with increasing concentration of the nonpolar–polar compound, and the fact that this time decreased at first faster with higher dilutions, and then more slowly, seems to indicate that the physico-chemical nature of the vehicle is important. The concentration of the nonpolar–polar substance is significant when the carcinogen concentration is low. At higher carcinogen concentrations, already at 0·009 per cent dimethyl-benzanthracene, the colloid concentration seems to be of secondary importance. These observations may perhaps be interpreted as indicating that the concentration, for example, of 0·03 per cent dimethyl-benzanthracene (a usual concentration in experimental work) is, in general, high enough to avert variations depending on differences in the physico-chemical nature of nonpolar–polar vehicles. Furthermore, these observations indicate that one has to use relatively low carcinogen concentrations when the significance of well-defined vehicles is studied[8].

Fore-stomach tumours developed in feeding experiments with a total dose of 0·6–4·0 mgm. dimethylbenzanthracene per mouse when various types of aqueous solutions of detergents acted as mediator, and on an average of 1·6 mgm. when polyethylene glycols were used[3,6,13].

Penetration and absorption of the carcinogen. As to the skin, fluorescence studies indicated, first, that 3,4-benzpyrene, as well as other carcinogens, solubilized by aqueous solutions of various nonpolar–polar compounds, easily penetrate into the cutaneous elements[1–3,6,8,12], and secondly, that the localization and distribution of benzpyrene or its blue fluorescent metabolites, shortly after painting on the skin, depend on what types of nonpolar–polar substances are used[8]. The characteristics of the mediator substance seem to affect the rate at which the carcinogen is absorbed by the skin and the pathways for the passage of the carcinogen through the skin[5,8,9]. In addition, it appeared that benzpyrene can penetrate directly into the living epidermis and dermis in newborn mice when the carcinogen is applied before the tenth hour of life, that is, before the development of the pilo-sebaceous apparatus[3,14].

As to the gastrointestinal tract, gastric absorption of 3,4-benzpyrene was studied following gastric instillation of a single dose of the hydrocarbon. No signs of absorption or penetration by benzpyrene of the gastric glandular mucosa were observed after administration of the hydrocarbon in fat and oils. This is understandable, because little or no fat is absorbed by the glandular stomach wall under normal conditions. On the contrary, for penetration into this region the physico-chemical nature of the mediator substance is decisive. With substances possessing nonpolar–polar properties a weak penetration is observed if the lipophilic characteristics predominate, and a strong penetration if the hydrophilic characteristics are predominant. This was first observed using water-soluble polyethylene glycols[15]. Later it appeared that both these compounds and aqueous solutions of the actual association colloids (namely, soaps and soap-like substances) cause penetration into the gastric glandular mucosa[3,6,13,16]. Aqueous solutions of certain natural biological nonpolar–polar substances, such, for example, as those of bile acid salts and of higher fatty-acid salts, also cause penetration of benzpyrene into the glandular mucosa of the stomach[3,6,16].

Observations on the transport mechanism of the carcinogen. The mechanism determining the distribution in the body of carcinogenic hydrocarbons is a complicated phenomenon. However, certain facts suggest it being likely that the absorption (cf. also the preceding) and the transport mechanism of these substances are in some way linked to those of lipids. However, comparatively little is known about the physical state in which the carcinogen—shortly after its administration to the experimental animal—travels in the aqueous fluids of the body. After having examined the influence of some agencies (histamine administration, X-ray radiation of certain regions of the body) upon the behaviour of the so-called chylomicrons, that is, mobile visible lipids of the blood (cf. ref. 17), it was observed, first, that large amounts of benzpyrene or its blue-fluorescent metabolites exist in the content of the mesenteric lymphatics and in that of the thoracic duct after gastric instillation of the carcinogen[3,6], and secondly, that benzpyrene moves in the blood stream, at least to some extent, in association with chylomicrons[18]. It was also possible indirectly to confirm this by preparing 'artificial chylomicrons' containing various nonpolar–polar substances, globulins and 3,4-benzpyrene. If the resulting solutions contain certain biological nonpolar–polar compounds in varying suitable proportions, the size and the behaviour of these particles can be changed within wide limits when needed[9]. Further, parenterally administered fat, if emulsified with nonpolar–polar substances, enters the blood stream in the form of small visible particles, so-called lipomicrons, the physical state of which most probably is similar to that of the alimentary chylomicrons[19]. This happens also when large amounts of these nonpolar–polar compounds are painted to the skin of mice[9]. It is possible that the observations presented here may throw additional light on the problem how experimental remote tumours 'sediment' themselves.

Morphological changes induced by nonpolar–polar compounds. Ever since the recognition of skin carcinogenesis, attention has been paid to various changes in cutaneous elements as well as to the interaction between such changes caused by carcinogenic tars and hydrocarbons (see review in ref. 11, pp. 159–163). Already during the orientating experiments of the present series with water-soluble polyethylene glycols[1,2,4], and later also in connexion with aqueous solutions of other detergents[5,6,9], it appeared that some of the mediators induced different types of epilation phenomena from those usually observed in skin carcinogenesis. In the present phase of the studies, it is certain that some of the nonpolar–polar compounds, without any known carcinogen, can cause morphological alterations in various cutaneous structures. For example, painting of the skin with the non-ionic polyoxyethylene sorbitan mono-oleate ('Tween 80') with a high hydrophile–lipophile balance value (cf. ref. 8) caused distinct alterations, especially in the subcutaneous adipose tissue[20]. On the other hand, another non-ionic detergent, sorbitan monolaurate ('Span 20'), with much lower hydrophile–lipophile balance value induced alterations both in the epidermis and dermis: enlargement of the individual cells, increased mitotic ratio, distinct thickening of the epidermis, destruction of the pilo-sebaceous apparatus, changes both in the intercellular matrix and in the connective tissue proper, dilatation of capillaries, degenerative changes in the vascular walls, etc.[9,12].

Using systematically selected nonpolar–polar compounds (for example, synthetic detergents) and high polymers (for example, polyethylene glycols), without any known carcinogen, it is possible to induce (within wide limits) various types of morphological changes in epidermis, dermis, or in both (as well as in some remote organs), in experimental animals, some of which are seen in connexion with carcinogenesis. Taking into account, first, the principles according to which certain of these compounds have been selected (for example, what is known about interactions between synthetic detergents as well as high polymers and various proteins[10]), and, secondly, what is known about connective tissue physiology and pathology, it is possible to throw additional light to the mechanism and pathogenesis of some of these alterations. Here we have at hand a better method for distinguishing the influence of a well-defined carcinogen from that of a well-defined vehicle.

Mechanism of experimental skin carcinogenesis. After these orientating studies, some observations upon the pathogenesis of experimental skin carcinogenesis may be considered. It has been reported that new-born mice (2–10 hr. after birth) are refractory to a single application of the carcinogen. The absence of pilo-sebaceous apparatus and also the thicker epidermis of new-born mice would explain the ineffectiveness of the carcinogen for penetration and tumour formation. In our studies the co-carcinogenic action of croton oil (cf. ref. 11, pp. 151–164) on the skin of new-born mice painted once with 9,10-dimethyl-1,2-benzanthracene during the first 10 hr. of their life was tested[9]. As a result cutaneous tumours do not develop, though the carcinogen easily penetrates into the cutaneous elements (*loc. cit.*). The reason for this seemingly negative result must thus be found elsewhere[9]. Following this work, series of adult mice received a single painting of 9,10-dimethyl-1,2-benzanthracene solubilized by various nonpolar–polar compounds. After this, croton oil treatment was carried out in the usual manner. The co-carcinogenic effect of this mixture became apparent as expected beforehand[9]. Taking into account the nature and morphology of the alterations in the skin induced by certain nonpolar–polar compounds, in another series of adult mice some of these compounds (for example, 'Span 20') were employed as co-carcinogens. As a result, cutaneous tumours developed at the site of painting[9,13]. These compounds are favourable for this kind of experiment because they do not induce cutaneous tumours when used without any known carcinogen. In other words, a considerable number of well-defined and biologically active colloid-forming compounds (both ionic and non-ionic) can serve as co-carcinogens as effectively as croton oil. (It is of interest that croton oil also contains several nonpolar–polar compounds which are able to react, for example, with proteins.) A large series of other well-defined co-carcinogenic agents is already under test. The results available so far point in the same positive direction[9]. To sum up, a new group of chemically and physico-chemically well-defined co-carcinogenic compounds has been discovered.

Accordingly, it would seem that the existence of a 'solvent effect' has become apparent in several different ways. We are continuing investigations on the following lines: (1) to search for powerful co-carcinogens from the large series of well-defined and well-known natural and synthetic nonpolar–polar compounds, high polymers, etc., having certain effects upon different biological systems; (2) to study the specific mode of action upon living matter of each of the principal different types of these agents. Employing series of systematically selected well-defined co-carcinogenic compounds with known influences upon various tissue elements, something of the tumorigenic property of the 'actual' carcinogen can gradually be transferred to these co-carcinogens. In this way it may be possible to investigate, among other matters, what is meant by the present concepts 'carcinogenic' and 'co-carcinogenic', what types of morphological and chemical (analysed, for example, with X-ray diffraction and biochemical methods) alterations in the elements of origin for tumour formation are essential, as well as interactions between parenchymal and stromal reactions during tumorigenesis—that is, the power to induce tumours under controlled conditions—and thus to throw more light on the biological processes, as a result of which experimental tumours develop.

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LETTERS TO THE EDITORS

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Effects of Ribonuclease on the Metabolism of Living Root-Tip Cells

USING ribonuclease as an analytical tool, Gale and Folkes[1] have recently brought forward new evidence for the hypothesis that ribonucleic acid plays an important part in protein synthesis[2,3]. A recent report, by Kaufmann and Das[4], that ribonuclease induces mitotic abnormalities in root-tip cells, shows that the enzyme actually can penetrate into living root-tips. These findings led to the present study on the effects of ribonuclease on the metabolism of nucleic acids, protein and respiration in onion root-tips. The experiments have been performed with the technical help of J. Brygier, E. Baltus and F. Vanderhaeghe.

When intact onion root-tips are treated with crystalline ribonuclease (1 mgm./ml.) for a few hours prior to immersion in water containing a labelled amino-acid (radioactive glycine or phenylalanine), there is considerable inhibition of the incorporation of amino-acid into the proteins: a 50 per cent inhibition is observed after pre-treatment for 1 hr. with ribonuclease, and it reaches almost 90 per cent after treatment for 3 hr. with the enzyme. These biochemical results have been confirmed by using an autoradiographic method: as seen in Figs. 1 and 2, treatment for 3 hr. with ribonuclease considerably reduces the uptake of labelled phenylalanine into the cells. Inactivated crystalline ribonuclease showed no effect on the incorporation of the labelled amino-acids into the proteins of the root-tips.

Very different results are obtained when the incorporation of labelled adenine in the nucleic acids is studied: treatment with ribonuclease first increases the incorporation of adenine into ribonucleic acid, the increase reaching 60 per cent for a 3-hr. period. Incorporation then steadily decreases, so that in root-tips treated for 20 hr. with ribonuclease, 80 per cent inhibition is found. As regards deoxyribonucleic acid, the incorporation of labelled adenine is immediately reduced: the inhibition reaches 30 per cent during a period of 1–3 hr. and it becomes practically complete after 20 hr. These observations suggest that ribonuclease immediately slows down deoxyribonucleic acid synthesis, leading to the cytological abnormalities described by Kaufmann and Das[4], while it first stimulates, then inhibits ribonucleic acid metabolism.

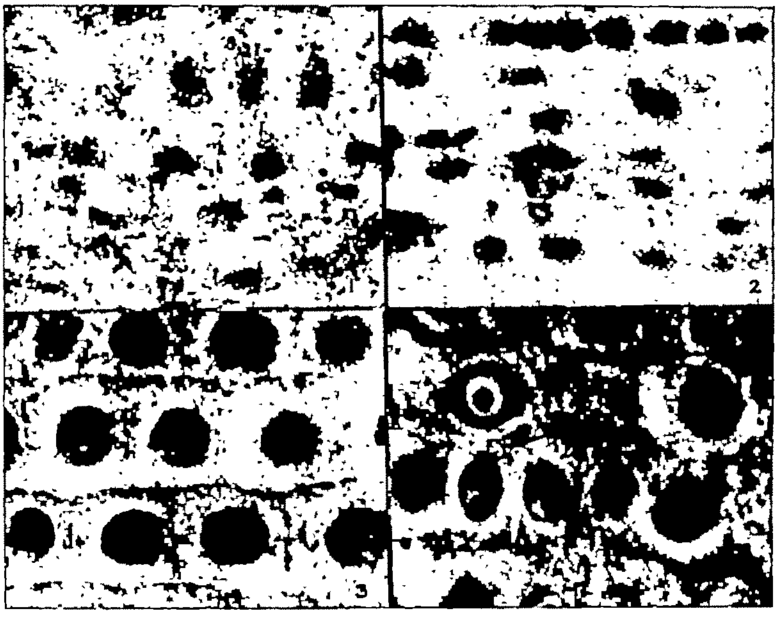
In contrast to these striking changes in protein and nucleic acid metabolisms, the oxygen consumption of the root-tip meristematic tissue remains unaffected by ribonuclease, even after treatment for 15 hr.

While the oxidative activities of the mitochondria thus apparently remain normal, phosphorylations are effected by the ribonuclease treatment: the inorganic phosphate content drops by 20 per cent during the first 3-hr. period, without any further changes. At the same time, acid-labile organic phosphate (presumably adenosine triphosphate) shows a 30 per cent increase during the first 3 hr. of the ribonuclease treatment and remains constant afterwards. These results probably mean that adenosine triphosphate is not utilized and thus accumulates, when protein and deoxyribonucleic acid metabolisms are inhibited by ribonuclease.

Ribonucleic acid, when estimated spectrophotometrically according to the method of Ogur and Rosen[5], shows a 20 per cent drop after the root-tips have been treated for 3 hr. with ribonuclease; there is no further decrease afterwards, even after 18 hr. Soluble nucleotides seem to drop slightly at the beginning (1–3 hr.), then steadily increase, finally reaching a value 40–50 per cent above controls after 18 hr. It should be pointed out, however, that classical methods of estimation of ribonucleic acid might be misleading if the nucleic acid of the cells is partly degraded by ribonuclease. It seems, nevertheless, that the strong inhibition of protein metabolism is not linked to any extensive degradation of ribonucleic acid.

This conclusion is confirmed by cytochemical observations on cells treated with ribonuclease: after Unna staining, the cells of the outer layers are more basophilic than normally after 3 hr. in ribonuclease. The increased basophilia is due to ribonucleic acid, as shown by the ribonuclease test[3]; it is thus likely that the enzyme first induces a synthesis of ribonucleic acid in the external cells. Later on, after 6 hr., for example, this outer layer of cells loses its basophilia almost completely.

An interesting point is that when sections of roots previously treated *in vivo* for 3 hr. with ribonuclease are stained with Mazia's[6] method for proteins, an empty space becomes visible around most of the nucleoli (Figs. 3 and 4). This finding might



Track-radioautograph of onion root-tip cells incubated in radioactive phenylalanine. Control (1) and after treatment by ribonuclease (2)
Sections of onion root-tip cells stained by Mazia's method. Control (3) and after treatment by ribonuclease (4)

mean that, as proposed by Caspersson[2], the nucleolus plays a very important part in protein synthesis, in agreement with the experimental data obtained in this laboratory by A. Ficq[7].

These results, in showing that ribonuclease produces a very strong inhibition of amino-acid incorporation into the proteins of living cells, bring fresh evidence for the view that ribonucleic acid is intimately concerned with protein synthesis. The accumulation of adenosine triphosphate in the treated cells as well as the fact that ribonucleic acid only partly disappears after treatment by ribonuclease agree well with Dounce's hypothesis[8] that a phosphorylated form of ribonucleic acid is involved in a template mechanism of protein synthesis. It should finally be pointed out that ribonuclease, when acting on living cells, exerts effects comparable to those of the removal of the nucleus in unicellular organisms[9]; for in such cases, ribonucleic acid decreases together with protein anabolism, while adenosine triphosphate increases and oxygen consumption remains unaffected.

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Inactivation of the Chromatophore-expanding Activity of Pituitary Extracts by Ascorbic Acid

IN experiments dealing with the connexion between the adrenocorticotrophic hormone (ACTH) and intermedin, we have tried to protect the hormone from inactivating oxidation by the addition of substances with a low redox potential. Among others, ascorbic acid (Merck) has been used, as it is well known that it protects for several hours from oxidation, for example, highly diluted solutions of sympathins. But contrary to expectation, it was found that after the incubation of an adrenocorticotrophic hormone preparation of Schering in a Ringer solution containing 10 mgm./100 gm. ascorbic acid at + 4° C. overnight, its original chromatophore-expanding activity was found to be reduced to 2 per cent.

We have therefore tried in a number of experiments to get some information upon the mechanism of the reaction between ascorbic acid and the active polypeptide. Experiments were carried out on Voegtlin–Standard powder, on ACTH–Schering, and on corticotrophin-*B* 52*R*6239 (kindly supplied by N. Brink, Merck). The chromatophore-expanding activity of the extracts was estimated from the permeability to light of isolated frog skin in a Pulfrich photometer. By this method a straight dose – response curve can be obtained by plotting the logarithm of the dose against the ratio (Δ extinction of each dose)/(Δ extinction of a standard dose). The slope of this curve is about 1, λ about 0·1. Using an ACTH preparation of Messrs. Schering (1 mgm. = 3 I.U. ACTH) the threshold was 0·001 μgm. of the dry extract per ml. Ringer solution, for corticotrophin *B* (1 mgm. = 150 I.U. ACTH) between 0·0002 and 0·0005 μgm. per ml. Ringer. To compare the activities of preparations treated in different ways, the six-point assay technique has been used. The following results have been obtained.

(1) A depletion of the chromatophore-expanding activity of Voegtlin powder by 90 per cent after 0·5 μgm. (= 10 melanophore-expanding units, M.E.U.) has been incubated at room temperature in 10 ml. Ringer solution containing 10 mgm./100 gm. ascorbic acid (*p*H 6·6) for 1 hr.; under similar conditions a depletion of the chromatophore-expanding activity of ACTH–Schering (3·95 μgm. (= 900 M.E.U.) per ml. ascorbic acid Ringer) by 70 per cent after 2 hr., by 85 per cent after 4 hr., by 96 per cent after 20 hr. incubation.

The chromatophore-expanding activity of corticotrophin-*B* (5 μgm. (= 1,880 M.E.U.) per ml. ascorbic acid Ringer) shows in several experiments a mean depletion by 22 per cent after 4 hr., 52 per cent after 12 hr. and 88 per cent after 28 hr. when compared with the spontaneously declining activity of the control solutions containing no ascorbic acid. Lower concentrations of ascorbic acid, for example, 0·1 mgm./100 gm., also produced inactivation. Inactivation occurred whether atmospheric oxygen was present or not.

(2) If ACTH–Schering was incubated in a solution containing dehydroascorbic acid and *l*-gulonic acid, the depletion after 20 hr. was only 58 per cent against 99·16 per cent with ascorbic acid.

(3) If the pituitary extracts were incubated for 2 hr. in solutions containing ascorbic acid plus cystein, or thiourea, or 8-hydroxyquinoline, their activity on frog skin was reduced by approximately 40 per cent of that of the control. But this depletion did not increase, although the incubation was prolonged for another 18 hr. Cystein, thiourea and 8-hydroxyquinoline themselves did not significantly influence the chromatophore-expanding action of the pituitary extracts tested.

Details of this work will be published elsewhere.

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Interrelationships between a Yeast and a Bacterium when growing together in Defined Medium

SINCE the introduction of solid medium, the isolation of micro-organisms in pure culture, formerly a matter of considerable difficulty, has become a relatively easy process. The numerous studies of micro-organisms in pure culture which resulted have enabled the science of microbiology to develop rapidly. In Nature, however, micro-organisms are rarely found in pure culture, and there is a need for investigation of the growth and metabolism of organisms growing in association with each other. Woods[1] has recently stressed the need for such research. The present study of a yeast (*Saccharomyces cerevisiae*) and of a bacterium (a *Lactobacillus* species) growing separately, and also when growing in association with each other in defined media, was commenced approximately two and a half years ago and is concerned mainly with the nutritional requirements of the micro-organisms. A number of interesting relationships between the organisms when in mixed culture have been observed.

The medium employed in these studies was nutritionally adequate for each of the two micro-organisms and contained: glucose (6 per cent), casein hydrolysate (1 per cent) and the following growth factors: inositol 10 μgm./ml., D-biotin 2·2 mμgm./ml., calcium-D-pantothenate 2 μgm./ml., thiamine 2 μgm./ml., pyridoxin hydrochloride 2 μgm./ml., nicotinic acid 2 μgm./ml. and pteroylglutamic acid 100 mμgm./ml. In pure culture, the yeast requires an exogenous source of inositol, biotin and pantothenic acid: thiamine, nicotinic acid and pyridoxin are stimulatory. The *Lactobacillus* requires biotin, pantothenic acid, nicotinic acid, thiamine and folic acid (pteroylglutamic acid).

The *Lactobacillus* failed to grow in the defined medium when either nicotinic acid or thiamine was absent. In mixed culture with the yeast, however, the lactobacilli grew moderately well in the absence of either of these growth factors, but only when the concentration of the other growth factors in the medium was considerably reduced, that is, as compared with the concentration normally present. Thus, in the absence of nicotinic acid, the growth of the lactobacilli in mixed culture was greatest when the other growth factors were present at approximately one-twentieth of the concentration normally employed. In such cultures growth of the yeast is restricted, and it would appear that the organism is synthesizing nicotinic acid, or some substance which can replace the nicotinic acid requirement of the *Lactobacillus*, and secreting it into the medium where it becomes available to the *Lactobacillus*, which is thus able to grow. It was shown that the yeast when growing alone in such media did in fact secrete such a substance in the medium; further examination of the yeast culture filtrate showed that the active substance was nicotinic acid itself or its amide. Addition of this yeast culture filtrate to medium not containing nicotinic acid and inoculated with the lactobacilli enabled the bacteria to grow, whereas no growth occurred in this medium when yeast culture filtrate was not added.

Similar interrelationships were observed in connexion with the purine requirements of the *Lactobacillus*. The yeast does not require either purines or pyrimidines for growth, whereas the *Lactobacillus* needs an exogenous supply of adenine, guanine and uracil—or hypoxanthine together with uracil. The *Lactobacillus* failed to grow in media lacking adenine or guanine or both, but did so when in mixed culture with the yeast: such growth, however, occurred only in media in which the vitamins were present at sub-optimal concentrations, that is, media in which yeast growth was restricted.

Eight interrelationships were observed in connexion with the amino-acid requirements of the *Lactobacillus*. Its requirements were determined in a glucose medium in which amino-acids were the sole source of nitrogen, and the organism was found to be exacting to ten of the acids: two other amino-acids were stimulatory. In media lacking any one of eight of these twelve amino-acids the *Lactobacillus* grew to a very limited extent or not at all, whereas in mixed culture with the yeast the bacterium was able to grow to an appreciable extent; such interactions were most marked in media lacking aspartic acid, tryptophan, glycine, alanine or lysine, and only occurred when the vitamin concentration was sub-optimal (approximately one-tenth of the concentration normally employed), that is, in media in which yeast growth was restricted. The filtrates of pure yeast cultures grown in such media were shown by chromatographic or other methods to contain the missing amino-acid or some substance which could replace it.

In all, some thirteen inter-relationships between the yeast and the *Lactobacillus* have so far been observed, and in each of them the yeast appears to be the active organism, that is, to have synthesized the missing substance essential for the growth of the *Lactobacillus*. The substances concerned are widely different in nature and include vitamins, purines and amino-acids. It is suggested that other methods of restricting growth of micro-organisms may well repay investigation, for example, alteration of *p*H or of degree of aerobiosis or of incubation temperature.

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Effect of Streptomycin on the Host – Pathogen Relationship of a Fungal Phytopathogen

IN these laboratories we have found tomato and potato suitable subjects for the study of the effect of streptomycin on host – pathogen relationships and have observed an interesting effect of this anti-bacterial substance on the course of development of infections due to *Phytophthora infestans*. Bonde[1] has reported a similar effect from the absorption of terramycin hydrochloride through the cut stems of Katahdin potato plants, but failed to obtain an effect with streptomycin even at concentrations of 100 μgm./ml.

We applied the antibiotic via the root system by exposing 35-day old plants to nutrient solutions containing different concentrations of streptomycin calcium chloride for one week. The effect on the reaction of the host to infection was examined by inoculation of detached leaves with a zoospore suspension applied in filter-paper disks and incubated at 20° C. in a moist chamber. In one experiment whole plants were sprayed with a zoospore suspension.

The concentration of streptomycin in leaf tissue was determined by bio-assay, and the toxicity of the antibiotic to the pathogen was tested *in vitro*.

The main results were as follows. In both potato and tomato a marked protective effect was observed at concentrations which had no effect on the vegetative development of the plants. In the case of tomato, even 4 μgm. of streptomycin per ml. of nutrient solution completely checked the disease. However, infection itself is not prevented by the presence of streptomycin in the tissue, but spread of the parasite is restricted after contact with the host plasm in contrast to the diffuse spreading noted in the untreated plants. The parasitized host cell dies and, very often, the surrounding tissue becomes chlorotic.

The concentrations supplied and those in extracts of treated plants have been shown to have no significant effect on zoospore development or germination of the parasite. *Phytophthora* mycelium tolerated streptomycin at concentrations even of

200 μgm./ml. However, slight depression of growth was observed at 8 μgm./ml.

The suppressive effect on the growth of the pathogen in living tissue was tested further by inoculation of cut tuber surfaces treated with streptomycin solutions and rinsed to remove free antibiotic. It was found that higher concentrations were required to obtain a checking effect in this work. A slight depression of sporulation occurred at 60 μgm./ml., and complete inhibition was observed at 200 μgm./ml.

It appears that when absorbed by the host cell streptomycin is firmly held, since there is little movement to tissue developed after the plant is removed from treated to normal nutrient solutions. Thus in one series of plants, *Phytophthora* developed rapidly on axillary shoots, but there was a slight reduction of sporulation on the basal leaves indicating that some translocation may have occurred.

There is a difference in response between organs of treated plants, the effect being more marked in leaves of both potato and tomato than in tubers or fruits. There are indications that young leaves respond more definitely than older ones.

Streptomycin does not exert a general protective effect against fungal pathogens. Even when treated with a concentration of 100 μgm./ml., many potato plants were severely attacked by powdery mildew (*Erysiphe solani Vanha.*).

If one assumes that streptomycin is evenly distributed within the cell and total extraction of streptomycin is obtained, the concentrations demonstrated by bio-assay of tissue extracts cannot be responsible for the effects observed. It would appear, then, that the antibiotic is either: (*a*) unevenly distributed in such a way that the parasite contacts lethal concentrations at the surface of the cell where parasite and host plasm first establish contact; or (*b*) it induces some change which alters the host–pathogen relationship in such a way as to confer some degree of resistance to the host.

Further experimental work will be required for the elucidation of the mechanisms involved in these changes of the host–pathogen relationship.

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Reaction between Phthalein Dyes and Heated Foodstuffs

A TENTATIVE method for the estimation of the quality of soybean oil meal, based on varying ability of different meals to absorb or react with phenolphthalein, has been briefly described[1]. Properly heated meals absorbed or reacted with significantly more phenolphthalein than under-heated samples, and over-heated samples somewhat more than the properly heated ones.

Since then, a variety of other dyes has been tried, but it was found that only phthaleins like phenolphthalein, phenol red, bromothymol blue, and cresol red reacted in this characteristic way. Other dyestuffs tried—methyl red, methylene blue, fuchsin—were absorbed to about the same extent regardless of the heat treatment of the meals. Further, it was found that the absorption of the phthalein dyes was rather independent of the fineness of the sample. From these facts it is concluded that there is not only an absorption but also a staining reaction between the phthalein dyes and substances in the soybean oil meal, especially those formed by heating (the Browning reaction).

From the experiments with the different phthalein dyes it has been found that phenolphthalein under given conditions best distinguishes between under-heated, properly heated and over-heated meals. It has, however, the disadvantage of not being stable when made alkaline in presence of substances present in soybean oil meal. The solution must be made alkaline immediately before the reading in the photometer. It is supposed that the substances in the alkaline medium form products which react with phenolphthalein. Cresol red is much more stable, and when using this dye the method has been simplified as follows: 400 mgm. samples are weighed in centrifuge tubes and 10 ml. freshly mixed reagent solution (one part of an alcoholic solution of cresol red, 2 mgm./ml., and nine parts of 0·1 *N* hydrochloric acid) are added. The tubes are shaken for one hour and then centrifuged. One ml. of the supernatant is added to 10 ml. 0·02 *N* sodium hydroxide. The colour is read in a spectrophotometer at 5,700 A.

Some results from the experiments with this method are given in Table 1. From this it is seen that there is a marked tendency of heated meals to absorb (react with) more cresol red as compared with under-heated samples.

Table 1. ABSORPTION OF CRESOL RED BY DIFFERENT SOYBEAN OIL MEALS

Character of the soybean oil meal*	Number of meals tested	Photometer readings (% transmission)	Mgm. cresol red absorbed per gm. meal
Much under-heated	6	9–15	2·5–3·0
Under-heated	4	21–28	3·3–3·8
Properly heated	8	30–52	4·0–4·3
Over-heated	2	54–55	4·4–4·5

* As indicated from laboratory determinations and chick growth experiments.

This cresol red test has also been performed with some samples of rape seed meal, linseed meal and dried milk. Even with these, correlation between heat treatments and cresol red absorption was found. Details of these experiments will be published elsewhere.

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Induction of Tumours with 1-(2-Tolylazo)-2-naphthol (Oil Orange *TX*)

PEACOCK[1] induced hepatomas in seven of seventeen mice surviving subcutaneous injection of oil orange *E* (1-benzeneazo-2-naphthol) for more than fourteen months. This substance was then in use as a food dye. Clayson[2] has since suggested that it might be active by virtue of its *in vivo* reduction to 1-amino-2-naphthol. If this be so, it was thought that other compounds capable of being reduced to this aminonaphthol might be carcinogenic.

1-(2-Tolylazo)-2-naphthol was purified by chromatography on alumina. 3 mgm. of this compound as a 3 per cent solution in arachis oil were injected subcutaneously into albino mice twice a week for fifty weeks. Of thirteen mice which survived for more than forty-six weeks, three developed spindle-cell sarcomas at the site of injection at 46, 53 and 61 weeks respectively (Table 1). In another three mice, tumours of the intestine were found. The first of these was detected by palpation before the mouse was killed, 62 weeks after the commencement of treatment. It was an adenocarcinoma arising in the region of the ileo-cæcal junction, probably in the cæcum, invading through the muscular coat and spreading extensively in the omental lymphatic vessels. There was a secondary deposit in a para-ileal regional lymph node. On microscopical examination in another mouse killed after 69 weeks, an adenocarcinomatous polyp was seen in the cæcum close to the junction with the ileum. At the base of this tumour there was invasion of the muscular coat, and a nodule of adenocarcinoma, probably situated in a lymphatic vessel, was found in the omentum. The third tumour, which arose in a mouse treated for 65 weeks, was detected macroscopically as a thickening of the small intestine. It proved to be an adenomatous polyp of such irregular structure that early malignant change was suspected, but neither invasion of muscle nor metastasis was found.

Table 1

Experimental mice				Control mice	
Weeks of survival after beginning treatment	Local sarcoma	Intestinal tumour	Other findings	Weeks of survival after beginning treatment	Findings
46	+			46	
				46	
53	+		Lung adenoma		
54				59	
61	+		Lymphoma		
62				64	Lymphoma
62		+		64	Lymphoma
65		+	Lymphoma	64	Lymphoma, lung adenoma and luteoma
67				64	
69		+		70	
69			Lung adenoma	70	Lung adenoma
72			Lung adenoma		
84			Lung adenoma and mammary cancer	77	
84			Lymphoma and lung adenoma	80	

Lymphomas, lung adenomas and mammary cancer occurred in mice treated with the dye and in others injected with arachis oil alone (Table 1); but in the latter no local sarcomas and no intestinal tumours were found.

The livers of mice treated with 1-(2-tolylazo)-2-naphthol showed no proliferative changes. This is in contrast with Peacock's experiment where hepatomas, but no other type of tumour, were induced with the closely related chemical 1-benzeneazo-2-naphthol. In the present experiment the dye was given by subcutaneous injection of an oily solution. It seems unlikely that its carcinogenic activity would be suppressed if it were given by mouth, a point which is already under test. Therefore the use of the dye (oil orange *TX*) as a food colorant should be discontinued.

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A Brain Extract as a Substitute for Platelet Suspensions in the Thromboplastin Generation Test

THE test described in 1953 by Biggs and Douglas[1] has proved a valuable technique for the study of the generation of plasma thromboplastin, and in the diagnosis of the various hæmorrhagic states due to defects at this level. Of the three ingredients for the 'incubation mixture', as originally described, only the preparation of a consistently satisfactory platelet suspension is troublesome and time-consuming enough to cause difficulties for those not constantly using the test. We have devised a modification, which we feel allows a higher degree of accuracy, as well as solving this problem and eliminating the need for siliconized glassware.

A standard human brain thromboplastin, prepared by acetone drying, is further washed with acetone until free of cholesterol, as judged by a negative Liebermann–Burchardt reaction. When 1 gm. of the dried powder is extracted at room temperature with approximately 50 ml. of chloroform, more than 300 mgm. of active material is obtained by evaporation of the filtrate. This gummy residue is finely homogenized in 50 ml. of 0·85 per cent sodium chloride. An approximately 1 : 100 saline dilution of this concentrate, substituted for the platelet suspension, gave 'peak' times of 10 ± 1 sec. in thromboplastin generation tests of plasmas and sera from twenty normal individuals; as with platelets,

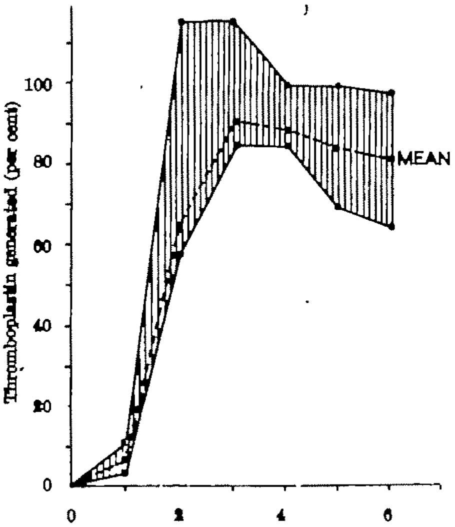

Fig. 1. Shaded area indicates range obtained with plasma and serum of each of twenty normals and same batch of extract 1 : 100

this 'peak' is reached in 3–5 min., and the optimal 'alumina' plasma and serum dilutions are 1 : 5 and 1 : 10 respectively, as recommended by Biggs and Douglas.

When frozen, the concentrated saline suspension remains stable for at least twelve months; it may be thawed and re-frozen repeatedly without loss of activity. The exact dilution for use should be determined for each batch of extract.

This modification was evolved in the process of work[2] on an extract for therapeutic use in thrombocytopenic states. It has proved entirely satisfactory in the diagnosis of hæmophilia and Christmas disease.

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Influence of Ethylenediamine-tetra-acetic Acid on the Excretion of Zinc by the Rat

The administration of ethylenediamine-tetra-acetic acid (versene, sequestrene) causes increased urinary excretion of calcium, iron, lead and other metallic ions[1]. We became interested in this chelating agent as a possible means for reducing zinc stores and thus hastening the onset of deficiency in rats maintained on a diet low in zinc. Information on the effect of ethylenediamine-tetra-acetic acid on zinc metabolism was also required in planning an investigation of the excretion of recently absorbed zinc-65. Stability constants indicate[2] that zinc forms one of the most stable complexes with ethylenediamine-tetra-acetic acid, but we are not aware of any previous experiments to test its action on body stores of zinc, apart from a brief reference to unpublished work by Mager[3].

The present report concerns a preliminary investigation of the effect of ethylenediamine-tetra-acetic acid on the urinary excretion of zinc in rats. The calcium disodium salt of ethylenediamine-tetra-acetic acid was injected intraperitoneally into young adult male rats in doses of 100 mgm. per kgm. daily for three days. In experiment 1, four rats were kept in a stainless steel metabolism cage and the pooled urine collected each day for 18 hr. after the injection, and once for the following 6 hr. A control sample was collected on the day before injections began. During the control period and the first test period, the rats received distilled water but no food. Thereafter, a synthetic diet (modified from Day and McCollum[4]) containing less than 0·5 μgm. zinc per gm. was supplied continuously. In experiment 2, the animals received Purina Fox Chow (75 μgm. zinc per gm.) during the daily 6-hr. feeding period and were kept in the metabolism cages, with water but no food, for the 18-hr. collection period. Two groups of four rats each were used. Control samples were collected for three days previous to the injection of ethylenediamine-tetra-acetic acid. Results of urine zinc analyses by the method of Vallee and Gibson[5] are given in Table 1.

Table 1. Influence of Ethylenediamine-tetra-acetic Acid on Urinary Excretion of Zinc

Sample	Collection time (hr.)	Mean urine zinc (μgm. per rat) Exp. 1	Exp. 2
Control	18	2·2	3·8
EDTA, 1st day	18	68·5	37·1
EDTA, 2nd day	18	69·5	61·0
Remainder of 2nd day	6	1·8	—
EDTA, 3rd day	18	156·2	75 7

Controls: Exp. 1: Urine from four rats collected for one 18-hr. period. Exp. 2: Urine from eight rats collected for three 18-hr. periods.

Tests. Exp. 1: 100 mgm per kgm CaNa$_2$EDTA per day—1st day in 5 per cent, 2nd and 3rd days in 2·5 per cent solution; Exp. 2: 100 mgm. per kgm. CaNa$_2$EDTA per day in 0·83 per cent solution.

Intraperitoneal injection of the calcium disodium salt greatly increased urinary excretion of zinc. Very little zinc is normally excreted in the urine, and the range of values observed in experiment 2 was 1·6–5·9 μgm. zinc per 18 hr. Zinc mobilization occurred immediately after injection of ethylenediamine-tetra-acetic acid, and from the one determination for the final 6-hr. period in experiment 1, it seems that little excess zinc was excreted after the 18 hr. following injection.

After the last collection period, the following tissues from experiment 1 were analysed for zinc: stomach, ileum, pancreas, kidney, testis, epididymis, dorsolateral prostate, bone (tibia) and blood. All tissues except ileum and pancreas gave results within the normal range for rats fed on Purina Fox Chow—the diet of these rats before the experiment began. Ileum zinc approached that found in rats maintained for 5–8 weeks on the zinc-deficient diet (Table 2), while pancreas zinc in three out of four cases was equal to that found in such zinc-deficient rats. The reduced zinc concentration in pancreas and ileum was not unexpected, since zinc excretion normally occurs via the pancreas[6] and alimentary canal. The reduced intake and increased urinary excretion would decrease the need for this excretion route and thus lower the concentration of transient zinc.

Table 2. Effect of Ethylenediamine-tetra-acetic Acid on Zinc Content of Ileum and Pancreas

Treatment and diet since weaning	Ileum No. of rats	Ileum Mean Zn (μgm. per gm.)	Ileum S.E. of mean	Pancreas No. of rats	Pancreas Mean Zn (μgm. per gm.)	Pancreas S.E. of mean
Controls						
Zinc-deficient	10	19 7	±1 8	6	18 5	±1·2
Deficient + 100 μgm. zinc per day	14	37·2	±2 6	12	25·7	±1·4
Fox chow	13	28·7	±1·7	10	23·9	±0·7
EDTA injection						
Fox chow; zinc-deficient for 3 days	4	20 7	±2 9	4	18 1	±3·1

Controls are mean values from unpublished experiments.

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Histochemical Adaptation of Aryl Iodosoacetates

It has been possible to obtain cleavage of the 1,2 glycol linkage in tissue sections with a solution of phenyl iodosoacetate in glacial acetic acid[1], thus duplicating histochemically the chemical studies of Criegee and Beucker[2]. However, to establish definitely the reliability of aryl iodosoacetates as histochemical reagents, it was felt that several other compounds of this type should be examined in a similar manner.

Four aryl iodosoacetates were prepared by Willgerodt's general methods[3], namely, *p*-nitrophenyl iodosoacetate, *p*-tolyl iodosoacetate, *m*-tolyl iodosoacetate, 2,4 xylyl iodosoacetate. These compounds were then tested histochemically for 1,2 glycol cleavage using formalin-fixed sections (paraffin technique) of rat and rabbit intestine and kidney. Concentrations of these compounds in glacial acetic acid were used ranging from 0·001 *M* to saturation, with oxidation periods of 15 min.–3 hr. All reactions were performed at room temperature (27° C.), and the aldehyde radicals resulting from the cleavage were stained with leucofuchsin. The 0·02 *M* solutions suggested by Pausacker[4] for chemical cleavage of *iso*hydrobenzoin and used in the phenyl iodosoacetate experiments appeared to be the concentration of choice, while the period of optimal oxidation was between 1 and 2 hr. The histological picture was similar to the one obtained with phenyl iodosoacetate and resembled that of lead tetraacetate[5] although weaker and less precise.

These experiments would appear to indicate that aryl iodosoacetates as a group are adaptable to histochemical procedures, and although their use is still academic, they may be of value to histochemistry in due course.

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Chromatography of Tissue Histamine

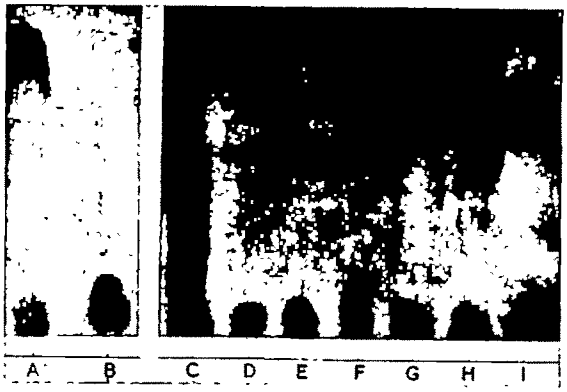

Fig. 1. Chromatograms developed with Pauly diazo-reagent for histamine. (*A*) Extract of dog mastocytoma in 10 per cent trichloracetic acid; (*B*) solution of histamine (100 μgm.) in water; (*C*) solution of histamine (100 μgm.) in 10 per cent trichloracetic acid; (*D*) solution of histamine (100 μgm.) in *N*/3 hydrochloric acid; (*E*) solution *C* after ether extraction; (*F*) solution of histamine (30 μgm.) in 10 per cent trichloracetic acid; (*G*) solution *F* with 300 μgm. arginine added; (*H*) solution *G* after ether extraction; (*I*) solution *F* with 100 μgm. each of arginine, lysine and ornithine added

Extracts of tissues exceptionally rich in histamine, such as ox pleura, ox liver capsule, and mast cell tumours from dogs[1], were prepared for ascending chromatographic estimation of histamine by simple extraction or by grinding the tissues with 10 per cent aqueous trichloracetic acid and centrifuging. Using as solvent mixture *n*-butanol : acetic acid : water (4 : 1 : 5), we observed that after spraying with the Pauly or the paranitraniline diazo-reagent two sharply defined spots appeared on the chromatogram of $R_F = 0 \cdot 11$ and $0 \cdot 65$ (Fig. 1,*A*). Both spots contained material which when eluted with water or 0·01 *N* hydrochloric acid showed histamine activity on the isolated guinea pig ileum and on the blood pressure of the atropinized cat. Prior removal of the excess trichloracetic acid from the solution by ether extraction merely reduced the intensity of the fast-running spot. When an eluate of this fast-running spot ($R_F = 0 \cdot 65$) was re-run in the same solvent as before, the histamine now remained entirely in its lower location ($R_F = 0 \cdot 11$).

At least three factors appear to be involved in the migration of histamine to the fast-running spot, namely: (1) the concentration of trichloracetic acid; (2) the concentration of histamine; (3) the presence of a basic amino-acid. First, pure histamine acid phosphate in water forms a compact spot at $R_F = 0 \cdot 11$ (Fig. 1,*B*), but with increasing concentration of trichloracetic acid a 'trail' of histamine moves up the paper as far as the $R_F = 0 \cdot 65$ area (Fig. 1,*C*). This is not a mere *p*H effect, for histamine in 0·33 *N* hydrochloric acid (Fig. 1,*D*) or in 10 per cent aqueous acetic acid does not migrate in this way. Trifluoracetic acid resembles trichloracetic acid in its mobilizing effect on histamine, recalling the similar effect of these acids on the chromatographic behaviour of adrenaline[2]. Removal of the excess acid from these solutions by ether extraction concentrates the histamine into a single compact spot at $R_F = 0 \cdot 11$ (Fig. 1,*E*). Secondly, when the strength of the trichloracetic acid is kept constant, any increase in concentration of histamine in the mixture is followed by increased upward trailing from the slow-running spot (Fig. 1, cf. *C* and *F*). Thirdly, for complete separation of the two spots, the presence of at least one basic amino-acid is necessary. When an artificial mixture is made up containing pure histamine, trichloracetic acid and arginine, lysine or ornithine, the chromatographic pattern now exactly resembles that seen with tissue extracts, the histamine being divided between the two spots, $R_F = 0 \cdot 11$ and $R_F = 0 \cdot 65$ (Fig. 1,*G*); ether extraction of this mixture simply reduces the intensity of the fast-running spot (Fig. 1,*H*). When all three amino-acids are present in the mixture, the chromatogram shows inversion (Fig. 1,*I*).

It is thus possible that the remarkable ability of trichloracetic acid to extract histamine from tissues is related not only to its coagulative effect on protein but also to its participation in a loose complex containing histamine (probably as the trichloracetate) and basic amino-acids. Detailed analysis of the original tissue chromatogram shows that arginine and lysine are in fact present and trail behind the fast-running spot of histamine.

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Fluorescent Substances in Chromatograms of a Mutant Stock of *Drosophila*

In chromatograms prepared from various *Drosophila* organs and from whole flies, seven different ultra-violet fluorescent substances have been described[1,2]. The concentrations of these substances were shown to vary in different mutant stocks of the fly. Flies carrying recessive mutants in the heterozygous state could be distinguished from wild-type homozygotes on the basis of their fluorescence patterns[3,4].

It seemed of interest to determine whether the characteristic features in the chromatogram of a mutant stock depend on the major mutant gene it carries, or whether other genetical factors may be involved in their determination. This investigation was based on an *ey*^{2} stock of *D. melanogaster*.

Chromatograms were prepared on Whatman No. 1 paper, by squashing the severed heads of female flies (age at least four days), which had been briefly immersed in 96 per cent alcohol and afterwards boiled for 2½ min. in distilled water. For preliminary examinations, one-dimensional ascending chromatograms of various lengths were developed in propanol – ammonium hydroxide. For quantitative determinations, two-dimensional ascending chromatograms of 29 cm.^{2} were developed in a dark room in butanol – acetic acid – water in the first dimension and in water-saturated collidine in the second dimension. Twelve heads of the wild-type laboratory stocks or fourteen heads of the *ey*^{2} stock were used for one two-dimensional chromatogram. All *ey*^{2}-flies utilized possessed eyes of reduced size. Animals entirely devoid of eyes frequently appear in the stock, but these were not analysed. The ultra-violet fluorescent spots were identified in the chromatograms by the light of a lamp with maximum radiation at 365 mμ. These spots and blanks of corresponding sizes, having received identical solvent treatment, were eluted in the dark room in 3 c.c. of distilled water each. The fluorescence of the solutions obtained was measured with a Farrand fluorometer using filters of maximum transmittance at 366 mμ and 440 mμ as primary and secondary, respectively.

The *ey*^{2} stock differed from two laboratory strains (Berlin and Canton *S*) in three fluorescent spots, which are here designated by the symbols of Hadorn and Mitchell[1]. *Fl* 4 ('blue') was stronger, *Fl* 5 ('yellow') was weaker and *Fl* 7 ('yellow') appeared much fainter than in the wild-type flies.

Males of *ey*^{2} stock were crossed to virgin females of each wild strain. The *ey*^{2} males obtained in the F_2 generation were again mated to virgins of the appropriate wild stock. This procedure was repeated to the seventh backcross generation. The *ey*^{2} gene, the expression of which remained unimpaired, was thus gradually transferred to a background of genes and cytoplasm from the laboratory stocks. All cultures were kept at 26·5° ± 1° C. After the seventh backcross to the Berlin strain, allelism of the *ey*^{2} gene carried in the original stock with that of the modified line was confirmed by a test cross.

Starting with the F_2 of the fifth backcross generation, *ey*^{2} females with a Berlin background were utilized for chromatograms. Their one-dimensional fluorescent pattern was by then indistinguishable from that of the Berlin strain, whereas the original *ey*^{2} stock, under identical culture conditions, had preserved its distinctive features. Similarly, *ey*^{2} flies tested after the seventh backcross to Canton *S* had assimilated themselves to the Canton *S* pattern.

Fluorometric measurements were confined to *Fl* 4 and *Fl* 5. As in the experiments of Hadorn and Mitchell[1], these substances overlapped strongly in the first dimension. Their separation into distinct spots was achieved in the second dimension. In order to eliminate such differences in absolute quantities as might arise from the reduced size of the *ey*^{2} heads and eyes and from the variability in the eye size of the mutant, the ratio of the fluorometric values of *Fl* 5 to *Fl* 4 was determined for each chromatogram. Table 1 shows that the original *ey*^{2} stock differs significantly from the Berlin strain and from the *ey*^{2} with Berlin background. There is a small residual difference between the latter and the Berlin stock. Two sets of measurements carried out with the Canton *S* backcross series yielded comparable results.

Table 1. Ratios of Fluorometric Values *Fl* 5/*Fl* 4 in Chromatograms of Female Heads

	Berlin	*ey*^{2}	*ey* from sixth and seventh backcross to Berlin	Canton *S*	*ey* from seventh backcross to Canton *S*
Number of chromatograms	16	9	9	2	2
Ratio *Fl* 5/*Fl* 4 means	1·74	0 64	1·38	1·83	1 98
Standard error (σm)	±0 09	±0 03	±0 06	—	—

Significance of differences between:

	Berlin and *ey*^{2}	Berlin and *ey* on Berlin background	*ey*^{2} and *ey* on Berlin background
t	9·57	2 805	8·88
p	< 0·001	0·01	< 0 001

A reciprocal backcross stock is in preparation, utilizing *ey*^{2} females and Berlin males. It is hoped that this stock may furnish information on the importance of cytoplasmic or chromosomal factors in the determination of the fluorescent pattern.

In conclusion, it should be mentioned that the fluorescent characteristics of *ey*^{2} and of Berlin flies were differentiated autonomously in eye disks transplanted reciprocally between the two strains at the third instar, and in host eyes. This autonomy was demonstrated qualitatively in a series of chromatograms prepared from transplants (9–37) and from a corresponding number of excised host eyes (unboiled).

This investigation was started in the laboratory of Prof. Ernst Hadorn (Zurich), to whom I am indebted for advice and instruction. The fluorometric measurements were carried out by Dr. M. Finkelstein (Jerusalem), whose help is also acknowledged.

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Instability of Milk due to a High Content of Calcium Ions

IN the nineteen thirties, great difficulty arose in the Netherlands from the frequent occurrence of flocculation of fresh milk on boiling and even during transportation or storing for a short time. This condition was called 'the Utrecht abnormality of milk', for it appeared first in the province of Utrecht. Afterwards this abnormality was found in other parts of the country as well[1]. The abnormality disappeared gradually; at present it is quite rare.

Milk exhibiting the Utrecht abnormality does not show any unusual value for the common numerical data (for example, *p*H, titration acidity, protein content, total calcium content). The bacterial count is normal. There was evidence, however, that the instability is caused by an abnormally high content of calcium ions[2]. But the evidence was only indirect, for at that time it was not possible to determine the calcium ion content. In recent years a reliable method for the determination of calcium ion content in milk ultrafiltrate has been developed[3,4].

In recent months we have had the good luck to obtain a few samples of milk showing the Utrecht abnormality.

The method of determination consists in using murexide (the ammonium salt of purpuric acid) as a calcium indicator and measuring with a Unicam *S.P.*500 spectrophotometer the change of colour due to the amount of calcium ion present. For full details of the method and its theoretical background refs. 3 and 4 should be consulted.

The results for four samples are listed in Table 1.

Table 1. ANALYSIS OF FOUR SAMPLES OF MILK SHOWING THE UTRECHT ABNORMALITY

	1	2	3	4	Normal range
*p*H	6·7	6·6	6·6	6·4	6·4–6·6
Titration acidity*	7·8	14·5	16·0	19	14–20
Heating test	+	++	+++	++	—
Alcohol test	+	++	+++	++	—
Total Ca (mgm. per cent)	176	144	216	184	120–200
Ultrafiltrable Ca (mgm. per cent)	44	34	45	54	20–46
Ca ions (mgm. per cent)†	14·8	15·2	20	27	8·0–14·4
Citric acid (mgm. per cent)†	161	74	122	208	96–288

* ml. of 0·1 *N* sodium hydroxide/100 ml. of milk.
† In the ultrafiltrate.

In complete accordance with Seekles's expectations[1], we have found the content of calcium ions to be significantly higher than normal.

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A Toxic Effect of Fluoride

BECAUSE fluoride has been shown to depress bacterial activity, and because the bacteria of the intestinal tract synthesize several vitamins which are utilized by the host, it was considered that the ingestion of large amounts of fluoride might influence the onset of specific vitamin deficiencies in a manner comparable with the effect produced by the insoluble sulpha drugs or the antibiotics.

In one set of experiments large amounts of fluorine ingested orally were found to favour the initiation of a nutritional deficiency (probably a biotin deficiency) in rats under certain conditions. In this experiment 80 parts per million of fluoride, in the form of sodium fluoride, was added to the drinking water of the experimental group. The control group received no fluoride supplements. For three weeks the following semi-synthetic diet was fed: 75 per cent sucrose, 18 per cent vitamin-free casein, 4 per cent lard, 3 per cent salts. To each 100 gm. of ration the following vitamins were added: 1 mgm. thiamine, 1·5 mgm. riboflavin, 0·5 mgm. calcium pantothenate, 0·5 mgm. pyridoxine, 10 mgm. inositol, 10 mgm. *p*-aminobenzoic acid, 10 mgm. niacin, 10 mgm. 2-methyl naphthoquinone, 40 international units vitamin A, 200 mgm. choline chloride. No change in the weights or the appearance of the animals was observed.

The diet was then changed to include 16 per cent raw egg-white, 10 per cent casein, 67 per cent sucrose, 4 per cent lard and 3 per cent salts. The vitamin supplements were the same as listed above. The egg-white was added to aid the onset of a biotin deficiency. At the beginning of the period during which this diet was used, the average weights of the three rats of the control and experimental groups were 204 and 178 gm. respectively. After sixteen days the average weights were 196 and 125 gm. One of the rats of the experimental group died at this stage.

The fur of the experimental animals was bristled and rough, and there was alopecia of the snout, head and legs, mild diffuse dermatitis, and mild 'spectacle eye'. The control animals showed none of these symptoms.

This experiment was repeated and a similar result was obtained.

The diet used had a low vitamin A and pantothenic acid content. Increasing the vitamin A content to 200 international units slightly delayed the onset of the symptoms. Increasing the calcium pantothenate content to 2 mgm. per 100 gm. of ration did not affect the result.

The toxicity of the fluoride alone was not the cause of these symptoms, because other experiments revealed that: (*a*) 120 p.p.m. of fluorine in the drinking water did not affect the growth of rats during a seven-week period, when a natural stock diet was fed; (*b*) if the egg-white was excluded from the diet shortly after the loss of weight began, there was no further loss of weight even though the fluoride supplements were continued.

The deleterious effects described above must have been due to either a nutritional disturbance, possibly a biotin deficiency complicated by other factors, or an unknown form of toxicity resulting from the use of egg-white and fluoride during the same period. Space will not permit a discussion of the evidence for and against each hypothesis. However, in support of the former is the fact that the deleterious effect of the egg-white – fluoride combination did not occur when the egg-white was added to a natural stock diet.

In a second set of experiments large amounts of fluoride ingested orally were found not to affect the severity of riboflavin deficiency. In this work 200 p.p.m. of fluoride as calcium fluoride and 120 p.p.m. as sodium silicofluoride were included in the semi-synthetic diets of two groups of young rats. The diet was deficient in its riboflavin content. After five weeks the average weights of the animals of the control group, which had received no supplementary fluoride, and the experimental groups were approximately the same.

A similar result was obtained when fluoride was added to a diet which was deficient in pantothenic acid.

The results of further experiments which have recently been begun should help clarify the problem presented in the first experiment.

This work will be published in detail at a later date.

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Toxicity and Narcotic Activity of Fluorocarbons

Published information on the results of investigation of the toxic and narcotic activity of fluorocarbons is very scanty, and such as is available is probably invalidated because of the lack of purity of the samples used in the tests. Struck and Plattner[1], who examined C_4F_{10}, C_5F_{10} and C_6F_{12}, concluded that the materials were toxic, whereas Spiegl[2] used concentrations of C_7F_{16} and C_8F_{18} which were too low to acquit them of toxic properties. He found C_7F_{14}, of unspecified purity, to be toxic.

We have examined the physiological activity of a sample of C_7F_{14}; this had been subjected to exhaustive washing with methyl alcohol, which is known to be an excellent selective solvent for hydrofluorocarbons[3]. When tested against grain weevils by the method described by Bradbury and Armstrong[4], the compound was non-toxic and virtually devoid of narcotic activity (8 per cent knockdown after 4 hr. exposure to a thermodynamic concentration of 0·8). In a 24-hr. test, there was very slight narcosis (39 per cent at 0·9) and only 10 per cent mortality. Tests with mice at thermodynamic concentrations of 1·0 showed no narcosis and no signs of toxicity in a 1-hr. test. There were no delayed deaths.

Mullins[5] has recently referred to experiments with C_8F_{16} on mice, which failed to show either toxic or narcotic action at a thermodynamic concentration of 1·0 for 1-hr. exposures.

We believe that the results of Mullins and ourselves represent the first unequivocal evidence that fluorocarbon vapours are non-toxic when the impurities have been removed to sufficiently low limits. The unsuitability of fractionation for this purpose when applied to fluorocarbons has been emphasized by Grafstein[6] and is consistent with our experience.

The almost complete absence of narcotic activity is also noteworthy. The results obtained with C_7F_{14} may be compared with those for C_7H_{14}, which gave a 50 per cent knockdown at a thermodynamic concentration of 0·1 in a 2-hr. test with grain weevils. Ferguson[7] has similarly shown that heptane, C_7H_{16}, exhibited threshold narcosis at a concentration of 0·15 and complete narcosis at a concentration of 0·25.

It is hoped to publish a full account of this work elsewhere. We wish to thank Dr. J. Raventos, of I.C.I. (Pharmaceuticals), Ltd., for carrying out the tests on mice.

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Differential Thermogravimetry

The methods of differential thermal analysis and thermogravimetry have been used in parallel for thermal investigations of analytical precipitates[1]. This double method possesses obviously the advantage that the same thermal change can be observed and characterized by the loss of weight and the change of temperature simultaneously, the two sets of measurements checking each other, or indicating by differences of results some changes which could not otherwise have been observed. In addition, the differential thermal analysis method completes the thermogravimetry measurements in the case when no loss of weight occurs. On the basis of thermogravimetry results, accurate quantitative conclusions may be drawn, which can scarcely be made with thermograms obtained by differential thermal analysis. During our investigations materials have also been studied which, for some reason (for example, melting), could not be subjected to differential thermal analysis. This gave rise to the idea of a differential thermogravimetric method and we succeeded in developing and applying this procedure.

Our thermobalance has been constructed of an air-damped automatic analytical balance. To the beam of this a permanent magnet has been attached, which moves inside a symmetrically placed coil with a very large number of turns. On decomposition of the specimen the beam of the balance moves and causes the displacement of the permanent magnet. The

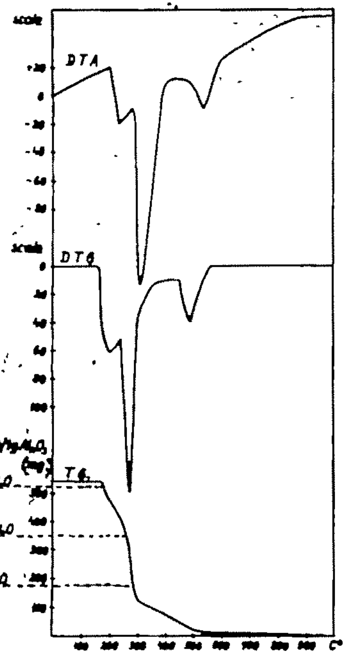

Fig. 1. Gibbsite (hydrargillite)

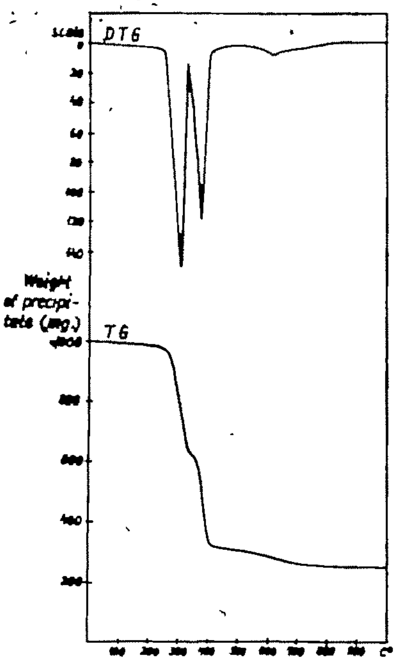

Fig. 2. Zinc anthranilate

rate of motion of the magnet corresponds to that of decomposition, and consequently a current proportional to the change of weight is induced (dm/dt). This latter is measured by means of a sensitive mirror galvanometer. Registering the values of deviations observed on the galvanometer as a function of oven-temperatures, the thermograms shown in Figs. 1 and 2 have been obtained. Fig. 1 shows differential thermal analysis (*D.T.A.*), differential thermogravimetric analysis (*D.T.G.*) and thermogravimetric analysis (*T.G.*) curves for gibbsite (hydrargillite), while Fig. 2 shows differential thermogravimetric analysis (*D.T.G.*) and thermogravimetric analysis (*T.G.*) curves for zinc anthranilate.

The many advantages of the differential thermogravimetric method may be summarized as follows.

(1) It can be carried out together with thermogravimetric measurements.

(2) The curves for differential thermal analysis and differential thermogravimetric analysis are comparable, but the results by the former method indicate even those changes of state which are not accompanied by loss of weight. The curves obtained by the latter method reflect only changes in weight, but are more reproducible.

(3) While the curves for differential thermal analysis extend over a wider temperature interval, due to the subsequent warming of the material after reaction, the differential thermogravimetric measurements indicate exactly the temperatures of starting, the maximum rate and the end of the change, and give a most attractive picture of the whole process.

(4) On the thermogravimetric curves, changes following each other immediately cannot be distinguished, as the corresponding stages coincide (Fig. 2). The differential thermogravimetric curves of the same change indicate by sharp maxima that the thermogravimetric stages can be divided in two parts.

(5) The differential thermogravimetric curves are exactly proportional to the derivatives of thermogravimetric diagrams; therefore the area under the curve gives the change of weight precisely, in contrast to the differential thermal analysis curves, where the corresponding area depends also on other factors (for example, heat conductivity, heat of translation, solidity). Accordingly, differential thermogravimetric curves enable one to make exact quantitative analyses.

(6) The method can be used for the investigation of materials which for some reason or other cannot be analysed by the differential thermal analysis method. For example, some organic compounds melt during heating, but even so, differential thermogravimetric methods yield fairly good results.

Very recently, a similar method was described by W. L. De Keyser[2] for determination of the rate of decomposition of some materials. While his method is interesting, objections can be made to its theoretical basis, for the method gives only the ratio of the finite increments of a thermogravimetric curve, whereas by our method—in the case of uniform heating—the derivative dm/dt can be obtained.

The results of our investigations will be published in detail in the *Acta Chimica* of the Hungarian Academy of Science.

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A Mechanism for the Displacement of Ions in an Ionic Lattice

The most direct way by which an ion can be displaced in an ionic lattice when the lattice is subjected to ionizing radiation is through simple collision displacements. Thus high-energy electrons can be expected to produce displacements by simple 'billiard-ball' collision; γ-rays can possibly produce displacements by Compton scattering, either by direct recoil of the ions or by producing high-energy electrons which afterwards collide with and displace ions.

Some displacement experiments I have carried out are difficult to interpret solely on a 'billiard-ball' collision mechanism. In these experiments alkali halide crystals have been bombarded with high-energy electrons giving coloration of the crystal. Some of the colour centres induced are stable against subsequent irradiation with white light, the remainder are unstable. After optical bleaching, it is observed that the crystal is 'permanently' coloured to some depth below the crystal face on which the bombarding electrons were incident. The depth of coloration increases with increasing energy of the incident electrons, but the intensity of the coloured region is very much greater than would be the case if each bombarding electron produced one colour centre.

Moreover, for Rutherford scattering, the collision cross-section for producing displacements (high-angle scattering) approaches zero as electrons lose energy in passing through the crystal, for the smaller the incident electron energy the more nearly must the collision be 'head-on' to produce a displacement. The intensity of the coloured region might thus be expected to fall off steadily to zero with increasing distance from the incident crystal surface. In actual fact, observation shows that the intensity is of the same order throughout the depth of the coloured region and that the colour ceases quite abruptly.

To account for these features the following simple mechanism for producing displacements by any form of ionizing radiation is postulated. The incident radiation, high-energy electrons or high-energy photons (X-ray, γ-ray and possibly even ultra-violet light), ionizes the negative ions in the ionic lattice, stripping these ions of several and at least more than two electrons. The stripped electrons move through the crystal, possibly themselves producing further ionization of negative ions, and eventually become trapped either at negative-ion vacancies in the crystal or by halogen ions which are short of electrons as a result of their ionization. These stripped negative ions, which are now positively charged, are sitting uncomfortably surrounded by positively charged nearest neighbours and will be displaced into interstitial sites by the induced high Coulomb repulsive force. Such displacement may be expected to occur in a time which is of the order of a few atomic vibrations, provided that the recombination time for the recovery of the electrons by the stripped negative ions is sufficiently long ($\sim 10^{-11}$ sec.).

The Coulomb repulsion between these stripped negative ions and their environment will be less unfavourable in these interstitial sites. Here the ions will recover all but one of the electrons which were originally lost, so becoming electrically neutral. Provided that thermal activation does not restore the displaced ions from trapped sites to normal lattice sites, the remaining electron will be trapped in a negative ion vacancy. This gives rise to a colour centre which cannot be optically bleached at low temperatures (room temperature for sodium or potassium chloride, etc.).

It will be observed that such a mechanism is of mportance only if: (1) the lattice bonding is eteropolar; (2) the recombination time for the ipped electrons is long compared with the time of attice vibration; (3) the cross-section for multiple ization is large enough to produce an appreciable ct.

Condition (3) is justified for electron bombardment, smuch as cross-sections for multiple ionization crease approximately by an order of 10 for each unit rease in the degree of ionization. Thus single nization by electrons has a cross-section of the order f 10^{-14} cm.^{2}, double ionization 10^{-17} cm.^{2} and so on[1].

The number, n, of interstitial atoms per c.c. produced as a result of this ionization displacement mechanism is given by:

$$n = N_0 F t \sigma,$$

where σ is the ionization cross-section for multiple ionization, N_0 is the number of ions per c.c., F is the flux number of incident particles per cm.^{2} per sec., and t is the time of exposure in seconds.

Taking $\sigma \sim 10^{-19}$ cm.^{2} (fourfold ionization), it will be seen that the number of displacements per unit volume per unit integrated flux (Ft) is $\sim 1{,}000$. Thus for every incident electron per square centimetre, $\sim 1{,}000$ displacements per c.c. are produced, and this will produce a colour far more intense and uniform throughout the electron range than would be formed by a simple collision process. Any form of ionizing radiation should be capable of producing displacements by this mechanism, the magnitude of the effect depending upon the cross-section for multiple ionization and the intensity of the ionization. For example, this simple mechanism may explain the mechanical hardening of alkali halide crystals by X-rays[2].

Finally, it will be realized that if such a mechanism for producing displacements is accepted, the magnitude of the effects of radiation damage will depend markedly upon the type of radiation used and also upon the characteristics of the atomic binding forces within the crystal. For example, electron bombardment may produce considerably more damage than neutron bombardment per incident particle; again, under electron bombardment, more damage may be expected in the case of an intermediate phase in a metal alloy system in which the bonding is largely ionic and the recombination time long, than in the case of a simple solid solution or a pure metal.

I wish to acknowledge helpful discussions with Dr. W. M. Lomer and Mr. R. A. Dugdale.

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Electronegativity and the Stability of Metal Complexes

Various workers[1] have remarked on the order of stability for metals with the same complexing agent. Thus, with salicylaldehyde in 50 per cent dioxan, the order is Pd > Cu > Ni > Pb > Co and Zn > Cd > Mg, and is the same for glycine and 8-hydroxy quinoline. A further list is Cu > Ni > Zn > Pb > Co > Mn > Mg > Ca > Sr > Ba based on considerations of glycine, alanine, glycyl-glycine and several carboxylic acids[2].

However, in a critical review of the available data, Irving and Williams[3] conclude that there is only one order of stabilities, which holds almost without exception for all complexes: Mn < Fe < Co < Ni < Cu > Zn. Earlier[4], they had pointed out that this particular order of stabilities could be intelligibly correlated with the second ionization potential. Ackermann[5] had also suggested correlation with the sum of the first two ionization potentials and that the electron structure of the metal in the chelate somehow resembled that of the metal in the elementary state.

Mellor and Maley[1] briefly considered the significance of ionic radius and electronegativity in discussing the

Table 1

Metal	Electronegativity (Haissinsky)	Metal	Electronegativity (Haissinsky)
Ba	0·85	Co	1·7
Ca	1·0	Ni	1·7
Sr	1·0	Cu	2·0
Mg	1·2	Zn	1·5
Mn	1·4	Cd	1·5
Fe	1·65	Pd	2·0

empirical order of stability which included elements such as cadmium, palladium, lead, magnesium, etc., but did not observe any clear correlation between complex stability and ionic radius or any other parameter which might be related empirically.

An empirical relation has now, however, been found to exist between electronegativity values as calculated by Haissinsky[6] and the stability of metal complexes. These electronegativity values calculated in an analogous manner to that of Pauling[7] from thermochemical data are shown in Table 1.

It will be observed that the order of stability given by Irving and Williams[3], namely, Mn < Fe < Co < Ni < Cu > Zn, is practically identical with the electronegativity order for the same metals, namely, Mn < Fe < Co = Ni < Cu > Zn. The 'significant' rise of ionization potential ($I_1 + I_2$) to a maximum at copper and fall at zinc, observed by Irving and Williams, is also observed with these electronegativity values. Further, a plot of log stability constants of a typical complexing agent, glycine[8], against the appropriate electronegativity values of the metals gives rise to a smooth curve (Fig. 1). Similar curves have been obtained for malonic acid, oxalic acid, ethylene diamine and alanine. This shows that complex stability is a continuous function of the electronegativity difference between metal and ligand. It appears also that metals other than those in the Irving–Williams's invariable-order list, for example, calcium and barium, fit the correlation. The slopes of the curves vary with the ligand, ethylene diamine being greater than glycine which is greater than oxalic acid. This fact is also in agreement with the general correlation of greater stability of complex with decrease in difference of electronegativity of metal and ligand.

That there should be a relationship between complex stability and electronegativity is reasonable, since the strength of any molecular bond is almost certainly a function of the electron-attracting power of the atoms in the bond, and it is probably significant that the values of the Walsh force-constant electronegativities[9] for the transition metals show the same rise in value to a maximum at copper and fall at zinc as do the Haissinsky values. In addition to this, electronegativity difference is related to the amount of covalent character of the metal–ligand bond[10] and thus complex stability is also related to covalent character.

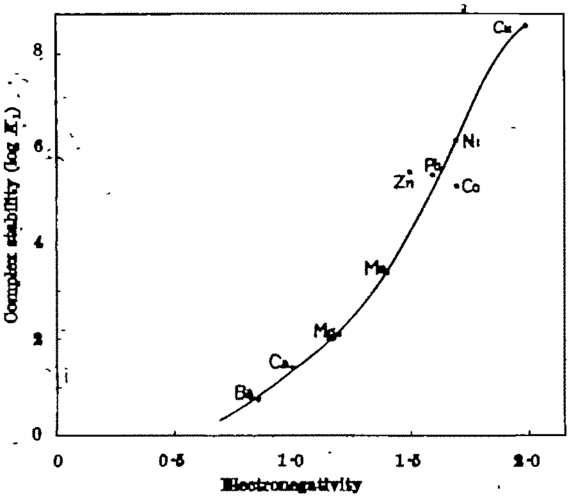

Fig. 1

From this new correlation with stability, it would seem possible to state that the stability of a metal complex in solution, and for a given ligand, is determined by two main influences: (*a*) the tendency towards or ease of formation of the complex, as governed by, for example, the second ionization potential; and (*b*) the strength of the metal–ligand bonds after complex formation, as governed by the electronegativity difference of metal and ligand. Other influences such as steric effects may also play their part, while hybridization, inductive effects, etc., in certain cases will influence the effective electronegativity difference, and hence influence the stability of the complexes.

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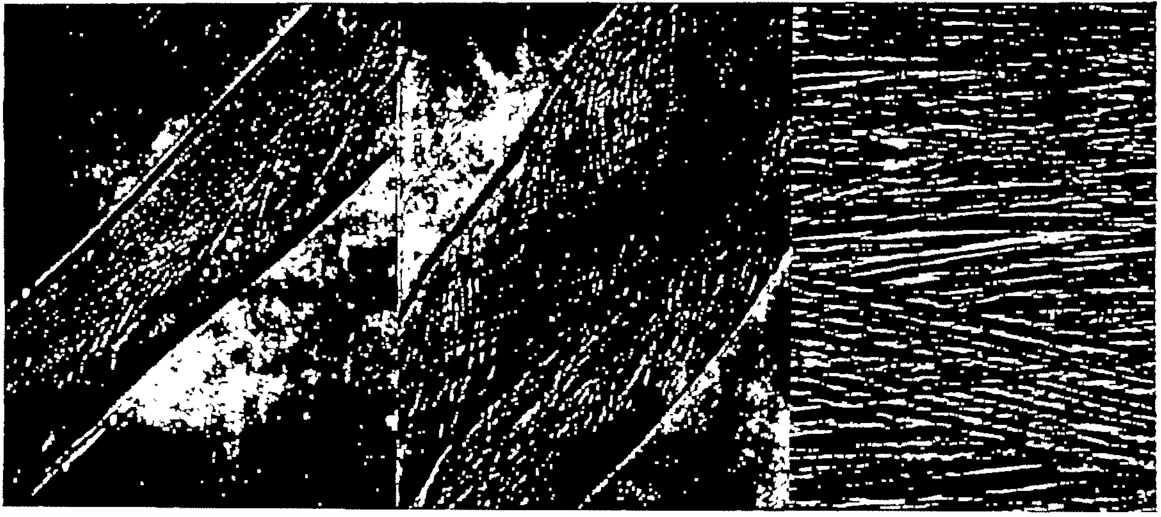
Effects of Pressure upon Collagen

During recent investigations into the microstructure of collagen fibres, we have utilized the 'crushing technique' of Boddy[1], and combined this with the interferometric method due to Merton[2]. By these means, changes in structure due to physical or chemical effects may be readily observed, and we have found that liquid globules are exuded from air-dried collagen fibre bundles under pressures in the region of 2,500 kgm./cm.^{2}. Fig. 1 shows the appearance of a fibre bundle originally 35 μ in diameter after the application of a load of approximatel 2,000 kgm./cm.^{2}. The globules are seen on the surfa and at the edges of the bundle. These appear discrete globules after the release of the pressu if it has been sufficient to force the film of displa liquid to an excessive distance. The effect of increas the pressure to approximately 2,500 kgm./cm.^{2} shown in Fig. 2, where the displaced liquid continu to 'wet' the fibres at the perimeter of the ma pressure area. The portions of fibres from whi liquid has been displaced appear dark as they a virtually dry-mounted. Further work is in progress upon the nature of this liquid.

It is possible that the loss of moisture on drying which contracts the fibres and allows them to coalesce into a more or less homogeneous bundle is never com-



Collagen fibre bundle (1) after pressure has been applied, showing globules of liquid; (2) after great pressure has been applied; (3) dried before applying pressure

plete. Thus, even in the so-called dry state, the fibres possess surface films which prevent structural dissociation of the constituent fibrils and ensure the preservation of fibre identity. Continued increases of pressure expand the bundle by increasing its width and may involve rupture of fibres with splitting of the bundle if dry fibre bundles are used. It has been noted that there is a significant elastic contraction after removing the pressure, and further plastic flow of material on re-applying the loads. A point can be reached at which the elastic contraction ceases.

Fig. 3 illustrates the effects of crushing a fibre bundle containing sufficient moisture to allow the fibrils to separate; a 35-μ diameter bundle can be reduced to a unit layer of constituent fibres about 1·5 μ thick (that is, the diameter of the fibre).

Similar exudation effects have been obtained with other fibres and with tanned collagen from leather. In this case, the exudate contains oils or fats as well as moisture. Full reports on this work will appear elsewhere, but it is thought the release of what may be more or less chemically bound water by mechanical pressure may be of interest in the study of surface films and conditions on fibres.

We shall be interested to know if this has been observed under other conditions.

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Radiation Dosimetry of Iodine-132

FISSION product tellurium-132 (half-life 77 hr.) is w obtainable from the Atomic Energy Research tablishment, Harwell. The daughter isotope odine-132 is potentially valuable in a variety of tracer applications, such as double tracer experiments in conjunction with 8·0-day iodine-131 or in short-term physiological studies where minimal radiation dosage is desired[1]. The measurements reported here provide the necessary physical data for the calculation of the radiation dosage resulting from the use of iodine-132 in biological tracer investigations[2].

Tellurium-132 is obtained from the Atomic Energy Research Establishment as a dilute sulphuric acid solution containing potassium permanganate. The iodine-132 is conveniently separated as 'carrier-free' iodine by distillation following the addition of sufficient $N/10$ hydroxylamine hydrochloride to render the solution colourless. 4π β-counter measurements[3,4] indicate that longer-lived radioactivity, assumed to be due to iodine-131, accounts for less than 1 per cent of the initial radioactivity of the separated material.

The γ-ray dose-rate and total β-energy emission from iodine-132 have been measured by the ionization methods described by Gray[5]. The dose-rate at 1 cm. from 1 mc. of iodine-132 (measured by 4π β-Geiger–Muller counter) was found to be 12·1 r./hr. and the mean β-ray energy emitted per disintegration was 0·45 MeV. Collectively, these results imply a difference of approximately 3·3 MeV. between the ground-states of iodine-132 and its daughter nucleus, and this value should be correct within about 10 per cent irrespective of the precise details of the decay scheme.

The results were obtained by comparison with the γ-ray output of a radium needle, which had been carefully compared with a source held at the National Physical Laboratory, and this in turn had been calibrated there against the British Radium Standard. It was assumed that the γ-ray dose-rate from 1 mgm. of radium screened by 0·5 mm. of platinum is 8·3 r./hr. at 1 cm., and in deducing the β-ray energy emission it was further assumed that the mean energy required for the formation of 1 ion pair in air is 32·5 eV.

The β-ray energy measurement depends on the observation of the ionization in a cavity lined by a solution of the radioactive material in agar or gelatin. Corrections are applied for the effects of attenuation of the β-rays by the air in the cavity, for the limited thickness of the active lining, and for the ionization caused by the γ-rays from the lining. The chamber used had a lining 4 mm. thick, and the first two corrections were calculated on the assumption that iodine-132 has two β-rays of maximum energy[6] 2·2 and 0·9 MeV. It then follows from the experimental result that each of these contributes approximately 50 per cent to the total emission of β-ray energy. The combined correction for these effects was 4·3 per cent. The γ-ray correction, based on the measured value of 12·1 r./hr./mc. at 1 cm., amounted to 8·8 per cent.

A measurement of the half-life was made on a β-ray ionization chamber, and a regression line through seven points, spread over 8 hr., gave a half-life of 2·259 ± 0·003 hr. (after correcting for 0·7 per cent iodine-131 initially present as contaminant). This figure is subject to a systematic error not greater than about 0·005 hr. due to possible error in the chamber background.

We are grateful to Dr. G. B. Cook and Mr. J. D. Eakins, of the Isotopes Division, Atomic Energy Research Establishment, Harwell, for their co-operation and their advice on the separation of iodine-132, and to the Medical Research Council for the loan of the equipment used in the ionization measurements.

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Successful Inter-breed Transfer of Ova in Sheep

Successful transfer of ova by surgical techniques in sheep has been reported by Warwick and Berry[1] and Lopyrin, Loginova and Karpov[2]. In our experiments, transfers of ova have been carried out between the Border Leicester (mature weight 140–180 lb.) and Welsh Mountain (mature weight 80–100 lb.) breeds in order to evaluate the maternal influence on the size of lambs at birth and at subsequent ages.

Thirty Welsh Mountain and twenty-five Border Leicester ewes were run with a raddled, vasectomized ram. Synchronization of the onset of œstrus in the majority of the ewes was attempted by means of progesterone treatment[3]. Four days before the expected onset of œstrus, the donors were treated with raw pregnant mare serum (stored at – 10° C.) and then run with a fertile ram of the same breed. The recipients remained with the vasectomized ram.

Laparotomy in the donors was performed 68–90 hr. after the onset of œstrus. *In vivo* recovery of the ova from the Fallopian tubes was carried out as described by Chang[4]. Either homologous blood serum or Ringer's solution was used as the flushing medium. The ova were transferred in a glass pipette which was inserted into the lumen of the uterine horn near the utero-tubal junction. Single ova were transferred to seventeen recipients and one ewe received two ova. After recuperation, the recipients were run with a fertile ram of the opposite breed.

One male and two female Border Leicester lambs were born to Welsh ewes, all requiring assistance at parturition, and five Welsh ewe lambs were born to Border Leicester ewes. The mean birth-weight of the Border Leicester lambs from the Welsh ewes was 11·1 ± 0·38 lb. after a mean gestation period of 146·0 ± 0·58 days, and that of the Welsh lambs from Border Leicester ewes was 9·5 ± 0·18 lb. after a mean gestation period of 149·6 ± 0·51 days. Birth-weights and mean gestation periods of Border Leicesters are normally 13·5–14 lb. and 145 days respectively, whereas the corresponding figures for the Welsh breed are 8–8·5 lb. and 147 days respectively.

Transfers were successful when œstrus in the recipients commenced from 16 hr. before to 20 hr. after that in the donors. Thirty-seven ova, representing 58 per cent of the ovulations, were recovered from thirteen ewes; the standard error of the recovery-rate was 20·2 per cent. Of the eight successful transfers, two were 4-cell, five 8-cell and one a 16-cell ovum. Four out of seven and four out of eleven transfers, using blood serum and Ringer's solution respectively, were successful. Prior to transfer to the recipients, seven of the ova which developed to term were exposed for 30–45 min. at room temperature, and one developed after exposure for 70 min.

Our results to date indicate that the influence of the size of the breed of the mother on birth-weight is marked, and that ovum transfer in the sheep can be as successful as in the rabbit[5].

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L. E. Rowson

Agricultural Research Council
Unit of Animal Reproduction,
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Sept. 15.

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Mechanical Separation of Plant Tissues

An investigation was recently carried out in this Laboratory into the best way of separating the fibre strands of various 'bast' and 'leaf' fibres into their component elementary cells. The fibres were first treated by the chlorite method[1] and then divided into two parts. One part was subjected to shaking with glass beads in a glass bottle, whereas the other part was shaken in a polythene bottle with short (about 2 cm.) lengths of glass rod covered with rubber 'policemen'. Microscopical examination showed that excellent separation was effected by the secon method without damage to the fibres, althoug damage was pronounced with the glass beads. It i possible that this method, which appears to be n generally known, may be capable of wider applicati for separating plant tissues.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 8

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Mr. T. M. Herbert: "The Application of Science in Railways" (Joule Memorial Lecture).

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Methods of Teaching Technical Writing".

Pharmaceutical Society of Great Britain (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Prof. G. Valette (Paris): "The Role of the Pharmacist in Phytopharmacy in the Present and the Future".

Tuesday, November 9

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. G. A. Wells: "The Stand Against Scientific History—Schopenhauer to Collingwood".*

British Ornithologists' Union (joint meeting with the Zoological Society of London, at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Dr. H. L. Løvenskiold (Norway): "The Birds of Spitsbergen".

Society for Cultural Relations with the U.S.S.R., Southampton Group (in the Senior Common Room, The University, Southampton), at 5 p.m.—Academician M. M. Dubinin: "Scientific Research in the U.S.S.R.".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. A. Skinner and Mr. F. B. Martin: "Some Considerations of Airfield Pavement Design".

Royal Institute of Chemistry in collaboration with the Imperial College Chemical Society (in the Large Lecture Theatre, Chemistry Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Dr. Robert Neville Haszeldine: "Fluorocarbon Derivatives" (Meldola Medal Lecture).

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. C. S. de Whalley: "The Decoloration of Sugar Liquor by Solid Absorbents".

Institute of Physics, London and Home Counties Branch (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. H. M. Finniston: "The Materials of Atomic Energy".

Wednesday, November 10

University of London (at the Postgraduate Medical School, Ducane Road, London, W.12), at 2 p.m.—Dr. Barbara Clayton: "Laboratory Investigation in Endocrinology".*

Institute of Petroleum (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. B. W. Bradford, Mr. D. Harvey and Mr. D. E. Chalkley: "The Chromatographic Analysis of Hydrocarbon Mixtures".*

Institution of Electrical Engineers, Radio and Measurements Sections (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. L. Essen: "Standard Frequency Transmissions": Mr. J. McA. Steele: "The Standard Frequency Monitor at the National Physical Laboratory": Mr. H. B. Law: "Standard Frequency Transmission Equipment at Rugby Radio Station".

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. V. A. Ambartsumyan (U.S.S.R.): "Stellar Systems of Positive Total Energy".* (Further Lecture on November 11.)

Institute of Physics, Education Group (at 47 Belgrave Square, London, S.W.1), at 6 p.m.—Dr. F. Sherwood Taylor: "Galileo".*

British Psychological Society, Social Psychology Section (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 8.15 p.m.—Dr. C. M. Fleming: "Education and Psychology".

Thursday, November 11

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. Charlesby and Mr. J. J. Polling: "The Optical Properties of Thin Oxide Films on Tantalum"; Mr. M. A. H. Lanyon and Mr. B. M. W. Trapnell: "The Interaction of Oxygen with Clean Metal Surfaces".

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Sir Alfred Egerton, F.R.S.: "Reflections on the Management of Heat". (Eighth Hinchley Memorial Lecture.)

Institution of the Rubber Industry (in the Lecture Theatre, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Dr. E. J. Buckler: "Nitrile Rubbers".

Royal Aeronautical Society (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. G. V. Lachmann: "Boundary Layer Control".

Society of Chemical Industry, Microbiology Group (joint meeting with the Agriculture Group, at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—"The Present State of our Knowledge of Ruminant Digestion". Dr. A. E. Oxford: "Its Bacteriology and Protozoology"; Dr. A. T. Phillipson: "Its Physiology".

Friday, November 12

Biochemical Society (in the Department of Biochemistry, St. Bartholomew's Medical College, Charterhouse Square, London, E.C.1), at 2 p.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

North East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. B. J. Terrell: "Instrumentation in Engineering Research with Particular Reference to Marine Turbine Machinery".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Kenneth M. Smith, F.R.S.: "What is a Virus?"

Saturday, November 13

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. F. E. Zeuner: "The Camel and the Elephant".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (with the National Diploma in Agricultural Engineering or equivalent qualifications, and with a special knowledge of agricultural engineering together with sound practical experience) in Farm Mechanization—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex (November 10).

Assistant Lecturer or Lecturer in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (November 13).

Assistant Lecturers (with special qualifications in physical chemistry) in Chemistry—The Registrar, The University, Manchester 13 (November 13).

Assistant (with a recognized qualification in mathematics or statistics) in the Statistics Section—The Secretary, Long Ashton Research Station, Long Ashton, Bristol (November 13).

Lecturer (with a first- or second-class honours degree in metallurgy or equivalent qualifications, and preferably with practical experience) in the Department of Chemistry and Metallurgy—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (November 13).

Lecturer (Grade II) in Agricultural Botany, and an Assistant Lecturer in Animal Husbandry, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (November 15).

Senior Lecturer in Civil Engineering, Senior Lecturer in Electrical Engineering, and a Lecturer (Grade A) in Electrical Engineering (Radio and Telecommunications), at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 15)

Lecturer (with an honours degree in zoology or agricultural zoology, and with postgraduate experience in one of the following fields: (*a*) mammalian physiology, (*b*) entomology or (*c*) parasites of plants and animals) in Agricultural Zoology; and a Lecturer (with an honours degree in chemistry, agricultural chemistry or zoology, and with postgraduate experience in some aspect of soil research, preferably in soil classification or soil physics) in Pedology—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne (November 20).

Scientific Officers (with a first- or second-class honours degree in engineering, physics or mathematics or equivalent qualification) in the Mechanical Engineering Research Laboratory, Department of Scientific and Industrial Research, East Kilbride, near Glasgow, for research into the following branches of mechanical engineering: properties of materials in the elastic and plastic ranges; fluid mechanics; heat transfer; lubrication; improvement of mechanisms—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.551/54A (November 20).

Lecturer in the Fluid Motion Laboratory, to work on problems of electronics and instrumentation for the measurement and observation of fluid flow, including turbulence, the propagation of shock waves and aerodynamic noise—The Registrar, The University, Manchester 13 (November 27).

Assistant Lecturer or Lecturer in Clinical Psychology—The Registrar, The University, Leeds 2 (November 29).

Professor of Physics at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

Soils Chemist (with a first- or second-class honours degree and at least three years postgraduate experience, and preferably with some experience of tropical soils), at the Rubber Research Institute of Malaya, Kuala Lumpur, to undertake work on soil fertility problems with particular reference to rubber cultivation—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (December 1)

Chief of the Division of Fisheries, Commonwealth Scientific and Industrial Research Organization, to be responsible for the research activities of the C.S.I.R.O. in the fields of oceanography and marine biology, and on scientific problems relating directly to various branches of the fishing industry in Australia—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 320/81 (December 15).

Lecturer (preferably with an interest and experience in vacuum techniques) in the Department of Electronics—The Secretary and Registrar, The University, Southampton (January 1).

Bacteriologist, for sterility testing and supervision of sterile work—The Secretary, Blood Products Laboratory, Lister Institute of Preventive Medicine, Elstree, Herts.

BRITISH RAYON RESEARCH ASSOCIATION RESEARCH SCHOLAR (with a first- or top second-class honours degree in physics or physical chemistry), to work in the Department of Textile Chemistry on rheological problems connected with the interaction of water with assemblages of hygroscopic fibres—The Registrar, College of Technology, Manchester 1.

GRADUATE (preferably with some knowledge of electrical engineering) for work concerned with experimentation and re-design of control points in steelworks to fit the human operator—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Control".

LIBRARIAN (with a science degree and a working knowledge of French and German)—The Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans.

MASTER to teach physics to scholarship level—The Headmaster, Malvern College, Malvern, Worcs.

ORGANIC CHEMISTS (Ph.D. or equivalent experience) to continue research on the degradation of carbohydrates—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

PHYSICIST OF ELECTRICAL ENGINEER (with a first- or second-class honours degree or equivalent in physics or electrical engineering and with research experience in physical optics, photoelectricity, photographic processes or electronics) at the Ministry of Supply, London Headquarters, for duties which include the preparation of contract proposals for research and development projects, scrutiny of specifications, supervision of the work and assessment of results—The Ministry of Labour and National Service, Scientific and Technical Register (K), 26 King Street, London, S.W.1, quoting A.291/54A.

PHYSICISTS (with a first- or second-class honours degree) for fundamental research on (*a*) friction, adhesion and abrasion, and (*b*) ionic diffusion in proteins using radar tracer methods—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

RESEARCH ASSISTANT (preferably with previous experience of either X-ray crystallography or large-scale computing) IN THE DEPARTMENT OF ORGANIC AND STRUCTURAL CHEMISTRY, to be a member of a small group engaged in preparing programmes for, and carrying out, extensive crystallographic calculations on the Manchester University electronic digital computer—Prof. E. G. Cox, Department of Inorganic and Structural Chemistry, The University, Leeds 2.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemical engineering or in chemistry with a diploma in chemical engineering, or A.M.I.Chem.E. and preferably with two to four years experience in plant development work), for work covering a wide range of chemical plant development and design problems in the radioactive and inorganic fields—The Senior Recruitment Officer, United Kingdom Atomic Energy Authority, Aldermaston, Berkshire, quoting 248/WGB/2.

TECHNICIAN IN THE DEPARTMENT OF PHYSICS—The Secretary, Birkbeck College (University of London), Malet Street, London, W.C.1.

TECHNICIAN (with previous experience in a biological or chemical laboratory) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*

Great Britain and Ireland

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SCIENTIFIC MANAGEMENT AND SOCIAL FACTORS

IN October 1952, the Anglo-American Council on Productivity appointed a specialist team to investigate the American approach to the improvement of methods of manufacture and the continuous reduction of operating costs. The team, which visited the United States early in 1953, was concerned with the effect of planning, control, budgeting and costing on the improvement of manufacturing methods; with the relation between design and methods of manufacture; with the means used on the factory floor to improve methods; with the effect of administrative arrangements on methods; and with the educational arrangements for training industrial engineers and for giving tuition in industrial engineering to managements and young workers. The report, entitled "Industrial Engineering", which the team has now produced* sets forth a number of recommendations intended to indicate the steps which British industry should take in the interest of productivity, and it also includes a supplementary report on 'industrial engineering' education in the United States.

Although some of the recommendations involve action by government as well as by industry, both the reports are of general interest to the scientist and to the technologist, as will appear from the definition of industrial engineering adopted by the team for the purposes of these reports. Industrial engineering is regarded as the application of basic scientific and engineering knowledge and certain analytical techniques to the methods of operating an organization in industry and other appropriate fields. It requires investigation into the economic advantages of one policy as against another and implementation of the most suitable procedure for raising productive efficiency. To this end performance and costs need to be checked constantly. Industrial engineering, the report continues, is a staff activity of management, and is concerned with decisions on what to produce, the design of the product, standardization, the influence of cost analysis on methods of production, the investigation of these methods, planning and control of production, calculation of what is the most efficient machinery for the job, layout of plant and handling of materials, design of tools, maintenance of plant, time study, motion study, incentives, method of calculation of wages, suggestion schemes and industrial relations. It requires consideration to be given to the communication of new ideas among senior and junior managers, among supervisors, and to and from workers on the shop floor. It also requires careful regard to the well-being, attitudes and opinions of workers.

The definition is given at length, not so much because the team seriously recommends that the British Standards Institution should set up a committee to deal with the terminology of the whole field of industrial engineering, as because it illustrates the way in which the team has adopted the term to cover activities which are inherent in industrial administration or scientific management, as conceived by such writers as Taylor, Fayol, Urwick, Mayo and Whitehead. It is at least arguable whether it is wise on the grounds of its mechanical connotations alone to use such a term as 'engineering' to cover activities which depend particularly on human co-operation. That alone could be a hindrance to much that is already being done in the field of human relations in industry by the Science and Industry Committee reconstituted early this year. Samuel Butler's "Erewhon" could still be a salutary warning to those who use the words 'machine' or 'machinery' for organization without due forethought.

---

* British Productivity Council. Industrial Engineering—Report of a visit to the U.S.A. in 1953 of a British Specialist Team on Industrial Engineering. Pp. xii+116. (London: British Productivity Council, 1954.) 5s.

At the outset, the report emphasizes the bearing of the social and industrial background on the approach to problems of productivity, and its opening chapter sketches with considerable skill the features of the American background which are significant in this connexion, and more especially those which are also to be found in Britain. Nevertheless, this recognition of the importance of the climate of opinion does not lead the team to examine the means by which that climate of opinion may be made more favourable to the improvement of productivity. Accordingly, recommendations which may be unexceptionable in themselves are made with little appreciation of the magnitude of the repercussions involved. The correct objective may indeed be indicated, but the means recommended sometimes suggest a degree of naïvety or even arrogance that, to say the least, is disturbing.

For example, in stressing the importance of shift work in order that expensive machinery may be used economically, the team rightly recognizes that it is desirable that retail shops and restaurants should be open for the workers coming off duty. When it goes on to suggest legal sanction for such arrangements, it shows little conception of what is thereby involved. Alternative means depending on individual enterprise and initiative are more likely to provide what is required. For the rest, patient but determined education of public opinion and, at the most, no more legal action than is required to prevent restraints contrary to the public interest are the more hopeful lines of advance. It may be surmized that the presence of any investigator from the National Institute of Industrial Psychology among the members of the team would have prevented any such mistake.

So, too, the team's study of industrial engineering education in the United States does not prevent it from making a similarly naïve recommendation that "industrial engineering studies in universities and technical colleges, whether as single subjects or as courses, should be expanded". It is assumed without question that industrial engineering studies are appropriate, both for universities and for technical colleges, and although the report notes that more than half those who enter the courses in American universities fail to complete them, the wastage is accepted without criticism. Whether these four-year courses of industrial engineering with their high concentration on subjects concerned with the application of knowledge rather than basic science are appropriate in a university is not discussed, nor is there any comment on the proposals to replace such four-year courses by less crowded five-year courses.

The team recognizes indeed, so far as Great Britain is concerned, the danger of over-hasty development of 'industrial engineering' studies in the universities, and it makes clear that it is not asking for any change of standards. In fact, although in the United States, out of 127,550 engineering students in 1951–52 there were estimated to be 5,067 industrial engineering students attending sixty schools, while there were thirty-one accredited courses as well as thirteen in mechanical engineering carrying accredited industrial engineering options, the team seems to look to development in the technical colleges rather than in the universities in Britain. It recommends that technical colleges should offer more single specialist courses in such subjects where industry is willing to support them, and that technical colleges should develop further short courses to serve the needs of small businesses. It also looks to the development of the sandwich diploma courses which are being tried in some technical colleges, and to the co-operation of industry in such courses and in the release of employees for part-time day attendance.

The team recognizes the value of participation by the technical colleges in research in the fields covered by its definition of industrial engineering, but the suggestion for courses in industrial engineering is of dubious value. The promotion of contacts between teachers and industry, the encouragement of research and interchange of staff both between Britain and the United States and between Britain and the Continent of Europe are much more likely to be fruitful and assist the expansion which the team recommends.

As has been indicated, a main weakness of the discussion of the educational aspect of the subject in this report is the absence of any clear conception of the functions of a university and of the relative position of university and technical college in regard to technical and vocational training. With that goes a complete indifference to the importance of educating public opinion on the need for new attitudes to shift-work, to motion study and time study, incentives, redundancy and the like. Even in regard to safety, there is nothing more specific than the recommendation that much more education is required on this subject in factories.

By and large, the recommendations of this report endorse many of the projects which have already been taken up by the Science and Industry Committee, and the findings of a number of investigations already completed, such as those of J. F. Scott and B. P. Lynton for the British Institute of Management and of Dr. W. H. Scott of the Department of Social Science in the University of Liverpool. As regards fiscal matters, however, on which the Advisory Council for Scientific Policy hesitated in its report last year, the team is entirely uninhibited. It recommends that the annual depreciation allowance should be revised to facilitate the more rapid writing-down of machinery and equipment. It condemns the effects of present taxation on business and suggests that a more liberal import licensing policy should be adopted to encourage firms to obtain new equipment essential for increasing productivity but not available in Great Britain. It also recommends that the facilities available to small firms for obtaining finance for capital investment should be more widely publicized and used, and that trade and trade associations, including the trade unions, should be legally required, where they do not already do so, to publish any rules or agreements which bind their members.

Such recommendations obviously bear on the utilization of the results of research and the encouragement of research itself, and though one would not have expected to find reference to that aspect of increased productivity in a report under this title, there are in fact references to the need for further effort to encourage the rapid application of the results of research and to the assistance which more efficient services for the dissemination of technical information could give. An appendix on research in the United States quotes an estimate of 2,000 million dollars expended on research by Federal government agencies in 1952–53, of which 94 per cent was spent on applied research. Two-thirds of the United States expenditure on research and development was for work undertaken by private industry, and such industrial research is dominated by not more than twenty firms, each with research staffs of a thousand or more. Some 3,391 engineers and scientists are employed on research by professional industrial consultants, and more than sixty-five per cent of the 44 million dollars expended on such research comes from the Federal government.

The team noted that the American manufacturer employs consultants more freely than the British manufacturer to advise on the development of new products, changes in range of manufacture and the substitution of new raw materials for old. Specifically it recommends that British firms should make greater use of such consultants and also of the practice termed management audit, entailing a check on the effectiveness of senior management by means of an investigation into the operational efficiency of an organization. Such practices, however, presuppose that the main difficulty in the utilization of existing scientific and technical knowledge, emphasized both in the survey "Industry and Research" made by the Manchester Joint Research Council and by Vera Connell more recently in "The Application of the Results of Research", is the lack of at least one person in the confidence of the management who is competent to appreciate the significance for the firm of new knowledge. If in fact there were the receptivity to new ideas and the readiness to exchange ideas which the team notes as characteristic of American business, that part of the problem of increasing productivity would largely be solved.

We thus come back to the fundamental question of the climate of opinion and of how best we are to promote at all levels—not merely at the top—the outlook and readiness of mind favourable to increased productivity and the modification of processes, practices, ideas and attitudes involved thereby. The team obviously appreciates that close contact between industry and the technical Press is important, but in commending the activities and influence of such journals in the United States in this connexion, it seems scarcely aware of the possibilities in Britain. In this respect the report shows the same lack of imagination as characterizes its treatment of education for management, at the university or at the technical college.

It is refreshing to contrast with this report Prof. A. N. Whitehead's characterization many years ago of the needs of a business organization in discussing technical education in his lectures on "The Aims of Education". Prof. Whitehead pointed out even then that those directing a business organization require an imaginative grasp of the psychologies of populations living under a wide range of conditions, of the complexities of interlocking interests involved in its activities, an imaginative understanding of the social effects of conditions in factories, of the laws of political economy and habits of government, some vision of the binding forces of human organization and some knowledge of the laws of health and fatigue; and, above all, the discipline of character which enables management to take and stand by decisions. Prof. Whitehead rejected then, as forthrightly as Dr. R. M. Hutchins and Sir Hector Hetherington have done in our day, the idea that the university is primarily concerned with the technical or professional knowledge which its students may require for an industrial or other career. A university, he insisted, is an institution uniting young and old in the imaginative consideration of learning: it functions in the preparation for an intellectual career by promoting the imaginative consideration of the general principles underlying that career.

In its report for the quinquennium 1929–34, the University Grants Committee unequivocably affirmed that conception of the functions of the university. Had it been remembered by the productivity team on industrial engineering, some of the recommendations of its report might never have been formulated. We might not indeed have received an adequate discussion of the respective functions of the university and of the technical colleges in training for management and specific recommendations; but the human issues involved would at least have been treated more imaginatively and with less risk of the psychological difficulties into which any discussion of human beings and organization in mechanical terms is liable to run. The over-riding emphasis would have been put in the right place. It is not a new name for management and its myriad activities that is required. The first need is to secure by all possible means the change in opinion in industry at all levels, in parliament, and in the country generally which is necessary for management to get on, without obstruction, with its task of raising the general level of productivity in small firms, as in large. This requires the more rapid and continuous utilization of existing technical knowledge and of new knowledge as it comes along, with all that is implied thereby, and the discarding of obsolete and restrictive practices and their imaginative replacement by methods which increase output, lower costs and diminish the hazards, monotony and physical strain which the older methods involved. Along with the task of improving the training for management goes the greater task, in which every bit of assistance that the Press, broadcasting, television, adult education and other means can give will be needed, of securing the climate of opinion in industry and in society which will give wise and progressive management a chance to function.

MEN OF CAMBRIDGE

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900. Volume 6: Square–Zupitza. Pp. iv+627. (Cambridge: At the University Press, 1954.) £10 10s. net. Complete set of 10 volumes, 85 guineas net.

THE president of Queens' College, Cambridge, Dr. J. A. Venn, is to be congratulated most heartily on the completion of his stupendous task in preparing for publication and seeing through the press the biographies of some 140,000 members of the University of Cambridge. It has occupied a great part of his time during the past forty-six years, during which he has served in a world war, carried out the duties of a university lecturer, president of a college and vice-chancellor of the University. He has been helped, naturally, by a small staff (for many years one assistant only), by volunteers from individual colleges and last but not least by the financial support and careful, accurate and pleasing workmanship of the University Press. More than six million words were typed and printed in the course of the work—and read over at least twice by the compiler.

It was to Dr. Venn that the idea of this publication was due in the first place. The sources that were used, the names of those who helped and the history of the whole work are given in the prefaces to volumes 1 of the two parts (to 1751 and 1752–1900) of the whole work. We should have liked to see an epilogue at the end of the last volume, in which Dr. Venn could have given an account of his work, looking back over the whole period from 1908 to the present. He gave a taste of the story that he had to tell in his reply to the congratulations of the University conveyed by the Vice-Chancellor at a reception to Dr. and Mrs. Venn organized by the Syndics of the Cambridge University Press on the day of publication of the tenth and last volume.

An analysis of the Fellows of the Royal Society noted in the present volume, more than a hundred in number, shows six presidents (Wollaston, the Duke of Sussex, Stokes, Kelvin, Rayleigh and J. J. Thomson), a predominance of mathematicians, followed by physicists, clerics, public servants, physicians and geologists in that order; among others, a dilettante, a poet (Tennyson) and a banker. Dr. Venn's father, Dr. John Venn, F.R.S., who kept the work going while Dr. Venn was absent on service during the First World War, and who is associated with Dr. Venn in some of the earlier volumes, is one of six generations of the Venn family to graduate in Cambridge. Thomas Young added to his work as a physicist and physician philological skill which enabled him to find the key to the hieroglyphics on the Rosetta Stone. Two hardened Tories were C. P. Yorke, First Lord of the Admiralty, who strongly opposed the abolition of mutilation after execution for treason, and George Whitmore, tutor of St. John's, who addressed his pupils on "a laudable exhibition of justifiable zeal" in breaking the windows of many Dissenters. T. P. Thompson, who at the same time was a midshipman on H.M.S. *Isis* and a Fellow of Queens', had an unusual career: he described his fellowship as "a sort of promotion, which has not often gone along with the rank and dignity of a midshipman". In view of his start, it is not surprising to learn that he was later governor of Sierra Leone, a general in the Army and a Fellow of the Royal Society. Another Fellow, Richard Watson, was simultaneously professor of chemistry and regius professor of divinity, and later held his professorship of divinity along with the bishopric of Llandaff. He was elected to the chair of chemistry, "having never read a syllable on the subject nor seen a single experiment". That may explain why his workshop was afterwards shattered by an explosion; all the same, he is said to have saved the Government £100,000 by advice on the manufacture of gunpowder.

Such notes as the above in the biographies of eminent men may account for Miss Rose Macaulay's description of the "Alumni Cantabrigienses" as a bedside book. The size, weight and small print of the volumes are against such a description, but the biographies do yield many fascinating notes on men in all classes of society. Thus, Thomas Turner, a distinguished physician, was garrotted by ruffians at the age of ninety and was thereby cured of his goitre. John Steggall, who had run away from school and lived with gypsies, came up to Corpus Christi after having been to sea on a whaler and serving in the army in India. He later took Holy Orders and also practised as a surgeon. Edward Tatham preached a famous sermon, 2½ hours long, and left the subject of his discourse to be settled by the learned bench of bishops "who have little to do and do not always do that little"; H. H. Vivian, while an undergraduate, brought to England the first camera to pass the London custom house, and afterwards took a daguerreotype, still extant, of a "Breakfast Party" of undergraduates. William Henry Waddington was later naturalized as a French citizen and became in due course Prime Minister of France. William Yardley made the first century in the University match. Edward Wilson of the Antarctic, who reached the South Pole with Captain Scott in 1912, and A. F. R. Wollaston, surgeon and naturalist to the first Mount Everest expedition in 1921, deserve mention among many distinguished Cambridge explorers.

But these volumes can serve many purposes more valuable than that of interesting the casual reader. Sir A. F. Rook has used them to disprove the common view that early subjection to severe athletic strain shortens men's lives, and Mr. Caradog Jones to pursue various sociological studies. The list of biographies provides a mine of information into which inquirers will delve for generations. It is good to know that the University has set up an organization to preserve its archives and to facilitate the work of Dr. Venn's successor, when the burden which he has now set down is taken up again some fifty years hence.

F. J. M. STRATTON

LIFE AND SENSES OF THE HONEY BEE

The Dancing Bees

An Account of the Life and Senses of the Honey Bee. By Karl von Frisch. (Translated by Dora Ilse.) Pp. xiv+184+30 plates. (London: Methuen and Co., Ltd., 1954.) 16s. net.

KARL VON FRISCH is one of the most distinguished of living experimental zoologists, and it is to him that we are indebted for the greater part of recent advance in knowledge of the behaviour and sense organs of the honey bee. It follows that the publication of a good English translation of the fifth revised edition of "Aus dem Leben der Bienen", a popular and completely up-to-date book by him, is something of an event.

The translation is strictly faithful to the original and has on the whole been admirably done by Dr. Dora Ilse; there are very few places where a slight awkwardness of phrase betrays that it has in fact been put into English by one who is not herself English.

The knowledge of German possessed by most biologists in Great Britain is not by any means so extensive and precise as it should be, and many of us who have perhaps battered an exhausting and uncertain course through the verbose entanglements within which the gems of discovery of the average German biologist are hidden will have come with relief and delight to the scientific papers of von Frisch. Here at last are experiments and results of an unrivalled perfection described with such simple lucidity and logic as to flatter us that our knowledge of the language is, after all, better than we thought. Quite apart from the language itself, what a delight it is to be able to see from the simple narrative style of von Frisch exactly how the investigation developed: to see the extraordinary flashes of insight, the weary plodding after statistical 'certainty'—and no less to be able to appreciate the long treks after false scents and up blind alleys. Nevertheless, if only because several of von Frisch's original papers are by no means easy of access, a great many biologists will welcome the concise simplified account of the beautiful investigations by himself and others, many of them his pupils, which Chapters 7–12 of this book provide. Even the most expert student of bees is likely to profit by reading it, for again and again a descriptive aside or apparently casual observation suggests some new approach to the problems of the evolution of bee organization, or reveals some hitherto unsuspected nicety of adjustment of behaviour to the needs of the colony.

About the rest of the book it is not easy to be quite so enthusiastic. The six introductory chapters are apparently written for readers who are presumed to know nothing at all about either biology in general or bees in particular. There are many gems of precise and vivid description here: thus the honey-stomach is aptly likened to a shopping bag, and a laden pollen collector is described as looking as if she were wearing 'plus fours'. But in spite of such happy phrases the general effect of the extreme simplicity of diction is to give a 'told to the children' air which is somewhat wearisome, and the question is whether a reader who needs this kind of thing will really be able to appreciate the more advanced sections. Although the book has had a great success in Austria and Germany, one wonders if it will meet quite the same need in English-speaking countries, where there are already so many good popular accounts of the natural history of bees and other social insects; and it is against this competition that the book must be judged.

In writing such a popular book it is scarcely possible for an author to avoid all the pitfalls of over-simplification, and the very brilliance of von Frisch's powers of exposition has perhaps led him astray at times. Thus not many zoologists will agree to the description of *Amoeba* as "a little lump of mucus come alive". Again, in describing the star-shaped 'Polaroid' filter as a demonstration of one of the possible ways in which the compound eye could mediate appreciation of the polarization characteristics of light reflected from the blue sky, the author seems in several places to imply that the individual ommatidia must actually be functioning in this way, and he nowhere alludes to the neurological problems which such a theory raises. For if each of the eight sensory cells which go to make up an ommatidium is in fact registering and passing separately to the brain the information it receives, a radical revision of some present concepts as to the mode of action of the sensory fibres will probably be necessary, and many of our present ideas about the compound eye may have to be revised. There are other similar points in the work which might be questioned. But in spite of such, the book is undoubtedly a masterpiece of condensation and simplification by a very great zoologist summarizing a life-time of research—research which has been largely instrumental in initiating a re-appraisal of some of the basic ideas about invertebrate sense organs and behaviour.

Von Frisch is very reticent about theory, and generally prefers that the facts should speak for themselves and that others should do the theorizing. Perhaps it is for this reason that the brief chapter on "Mental Capacity" is somewhat misleading. Here he states that no example of 'really intelligent action' by honey bees has ever been recorded; whereas what he means is that the ability to cope with new problems is strictly limited to certain situations only. Their ability to remember colour, odour and relative position of landmarks is extraordinary, and their powers of combining these memories and associating them with a given passage of time is even more remarkable. Every such combination learnt involves some perception of relations, and when a bee makes a detour around an obstacle and afterwards straightens its path as a result of experience it is showing, within strict limits, an insightful action. Moreover, the author supports his conclusions by citing lack of 'intelligence' in other insects; but to do this he merely quotes a story about a 'mason bee' and fails to cite much striking evidence to the contrary—not only with the mason bees *Eumenes* and *Rhynchium*, but also the far more conclusive and precise experimental studies of adaptive behaviour in the hunting wasps *Philanthus* and *Ammophila*. Indeed, his treatment of social and semi-social insects other than *Aphis mellifica* is too brief to be of much value, and is perhaps the least satisfactory chapter of the book.

But in spite of such shortcomings, it must be said that there are not many scientists of like eminence who could produce such a good popular book. Quite apart from its general educative and instructional value, it will, if it leads biologists as a whole to give more attention to simplicity and clarity in exposition, have a most valuable effect. W. H. THORPE

BLOOD GROUPS

Les groupes sanguins chez les animaux

Individualités sanguine et tissulaire. Par R. Dujarric de la Rivière et A. Eyquem. (Collection de l'Institut Pasteur.) Pp. 407 + 2 plates. (Paris: Éditions Médicales Flammarion, 1953.) 3,275 francs.

BLOOD-GROUP differences between individual goats were described by Ehrlich and Morgenroth in 1900 only a few months after Landsteiner's announcement of his discovery of the human blood groups. Ever since then, research on animal blood groups has continued and an enormous literature has been built up, scattered through very many journals and very varied in its methods and its aims, in contrast to the fairly well-integrated study of the human blood groups. Hitherto, almost the only comprehensive account of the subject has been a single excellent chapter in Wiener's "Blood Groups and Transfusion", so that a book bringing together the scattered threads has long been needed by workers in the field itself and in many related branches of science, especially, for purposes of comparison, by investigators of the human blood groups. That Dr. R. Dujarric de la Rivière and Dr. A. Eyquem have undertaken the task of reading and summarizing this vast literature entitles them to the gratitude of all such workers.

The title, "Les Groupes Sanguins chez les Animaux", as it appears on the outer cover, is supplemented on the title page by the words, "(Individualités sanguine et tissulaire)", and this extension of the subject to cover the whole of tissue immunity has involved the reading of another vast body of literature and has made the area covered so wide that no one or even two authors could possibly treat the whole of it critically.

Blood-group investigations require a knowledge both of serology and of genetics. The authors are primarily serologists, and the book is much sounder in its treatment of serology than of genetics. It is quite impossible for anyone to compress the whole of genetical theory, as the authors have attempted, into eighteen pages in a way that will be useful as an introduction to the genetics of the blood groups. To those without a knowledge of genetics such an account is inadequate; to those with the knowledge it is unnecessary.

Because the human blood groups have been more thoroughly investigated than those of any of the lower animals, an account of them is a necessary part of a book such as this; but it is the weakest part of the present book, containing numerous errors and statements of doubtful validity, especially on the genetical side. There is, for example, no evidence that (p. 64) the red cells of $Lu^a\ Lu^a$ individuals are more strongly agglutinated than those of heterozygotes; and the tabulation of the Lewis genotype $Le^b\ Le^b$ as corresponding to the phenotype $Le\ (a-b-)$ (p. 65) is contrary to the facts.

Most readers will, however, turn at once to chapter 5 on the blood groups of various animal species. It is disappointing to find that this central subject of the book is dealt with in only 90 out of a total of more than 400 pages. Nevertheless, nearly every investigation of any importance is adequately, if not critically, described. Of particular interest are the accounts of antigenic differences between different breeds of certain animals, especially sheep. On the other hand, the more difficult genetical topics are not so well treated, and the profoundly interesting subject of the linkage groups in cattle and some other animals, their similarities to and differences from the human *Rh* system, deserves more space than it is given. There is a very good and comprehensive chapter on hæmolytic disease of the newborn among animals which will greatly interest comparative pathologists.

More than a hundred pages are devoted to the subject of tissue antigens, cytotoxic antibodies, and tissue grafting. The treatment appears on the whole to be adequate, but the reviewer is only familiar with a small part of this extensive field. It is surprising that only about four pages are devoted to a subject of such great practical importance as skin grafting.

A very valuable feature of the book is an alphabetical bibliography of some eight hundred entries. A number of these have been checked—some minor spelling mistakes were found but no errors in dates, volume numbers or pages. The bibliography includes most of the papers of first importance, but a very considerable number of the works cited in the text are not included in the bibliography. Names, other than French, are very frequently misspelt in the text, but are mostly correct in the bibliography. There is a short but adequate general index.

Despite its faults, this book is an indispensable work of reference. It is most unlikely that in the near future anyone else will undertake the task of re-reading this immense literature. It is almost inevitable that in a few years a new edition will be needed. It is suggested that the authors should then omit the section (pp. 35–52) on general genetics, should call into collaboration a geneticist to ensure a more adequate treatment of the genetical and statistical aspects of the blood groups, should include in the bibliography references to all papers mentioned in the text, and should deal more fully with experimental skin grafting.

A. E. MOURANT

ELECTRON MICROSCOPY AS A TEXT-BOOK SUBJECT

Introduction to Electron Microscopy

By Prof. Cecil E. Hall. (International Series in Pure and Applied Physics.) Pp. ix + 451. (London: McGraw-Hill Publishing Company, 1953.) 64s. 6d.

THE final stage in the maturity of a branch of science or technology is the establishment of university lecture courses about it and the reduction of the sprawling, groping literature of its infancy to text-book form. By these standards electron microscopy has now come of age, as indeed the lapse of time since the invention of the first electron microscope would indicate. To gain entry to the McGraw-Hill International Series in Pure and Applied Physics adds the hallmark of respectability to a young and still somewhat revolutionary discipline.

The text now offered by Prof. C. E. Hall is based on his lectures to postgraduate students in biophysics at the Massachusetts Institute of Technology. It may be felt that it is much more detailed in its treatment of physical fundamentals than such a class would either understand readily or be likely to need in practising the subject. But the author has deliberately chosen such an approach, with an eye to probable future developments in the design of the instrument and in its operation. This is undoubtedly the wisest course to follow, although it will make the text long and in parts heavy going for "science and engineering students with a background in physics and engineering at about the sophomore level".

That said, nothing but praise is due to this volume, both for its choice of material and for its presentation. The first two chapters form a résumé of fundamental physical theory, including an outline of wave mechanics, and the motion of electrons in electrostatic fields. The next three chapters discuss the ideal lens and then the practical electrostatic and magnetic lenses, the aberrations of which are dealt with in Chapter 6. The essential features of the electron microscope and its commercial realization are the subjects of Chapters 7 and 8. Chapter 9, one of the most valuable in the book, treats scattering phenomena as a prelude to the discussion of image formation in Chapter 10. The remaining two chapters deal thoroughly with the most important methods of specimen preparation and with typical examples of the applications of the electron microscope.

The text is marked by that clarity which follows from complete familiarity with a subject, and it is illustrated by plenty of excellent diagrams and photographs, remarkable even for this series; at a quick estimate there are some 350 figures, or nearly one per page. Most chapters are followed by problems to test the understanding of the student, and at the end it is a pleasure to find such full author and subject indexes. Although there is room, as in any new subject, for differences of opinion on the presentation of some points, such as the alignment of lenses, the book can be unreservedly recommended to all workers in the field, whether they be students or older practitioners; in fact, it is much more of a handbook than an introduction.

V. E. Cosslett

MAMMALIAN GERM CELLS

Mammalian Germ Cells

Edited by G. E. W. Wolstenholme, assisted by Margaret P. Cameron and Jessie S. Freeman. (A Ciba Foundation Symposium.) Pp. xvi+302+15 plates. (London: J. and A. Churchill, Ltd., 1953.) 30s. net.

This symposium conducted at the Ciba Foundation "for the promotion of international co-operation in medical and chemical research" has assembled thirteen papers concerned with the physiology of spermatozoa and eleven papers concerned with ova. It represents an attempt to bring together in a series of relatively brief presentations recent progress in these rapidly advancing fields. In addition to the formal papers, there is included the discussion of each by the various members of the symposium.

There can be no doubt that the general objective is attained. The various discussions of spermatozoa include analyses of the biochemistry of semen. In a number of instances attempts are made to correlate certain biochemical properties with practical problems in reproduction. For example, there is a critical review of aerobic metabolism in semen and its relationship to fertility in a paper by Dr. C. Terner. Again, Mr. J. C. N. Kok discusses the factors influencing the longevity of bull semen as used for artificial insemination. Of more interest to the physiologist and biochemist are the papers on the biochemical aspects of semen (by Dr. T. Mann), on factors controlling metabolic rates of mammalian spermatozoa (by Dr. H. A. Lardy) and on proteolytic enzymes in human semen (by Dr. F. Lundquist). A fascinating discussion on the movements of spermatozoa by Lord Rothschild reveals hitherto unsuspected hydromechanical relationships. The recent work on the preservation of spermatozoa at extremely low temperatures is informatively presented by Mr. C. Polge. The implications of this low-temperature work for the general problems of mammalian fertility and the preservation of desirable genetic characteristics are most fascinating. The practical implications of spermatozoology in human health and disease are ably presented by Dr. J. MacLeod.

Investigations of mammalian ova described in this volume are concerned with: (*a*) ovulation, (*b*) ovum maturation, (*c*) ovum transplantation, (*d*) *in vitro* studies with mammalian eggs, (*e*) early developmental physiology, and (*f*) medical problems relating chiefly to the ovum and pregnancy. As in the case of the spermatozoa, the problem of the longevity of the mammalian egg is touched upon in practically every phase of these investigations. This is especially apparent in the paper by Dr. S. A. Asdell on the effect of controlled ovulation upon the fertility of the mammalian egg, the paper by Dr. M. C. Chang on the fertilizability of rabbit germ cells and a paper by Dr. L. E. Casida on factors affecting fertilization and embryonic death. One of the chief mysteries relating to the development of the mammalian ovum is the problem of fertilization *in vitro*. This is discussed particularly in the paper by Mr. O. Venge, but forms part of the discussion of a number of the papers. The great difficulty experienced by a number of investigators in consistently effecting fertilization *in vitro* is emphasized. The experiments of Audrey U. Smith on the effects of low temperature on rabbit eggs signalize another field of experimentation which parallels similar work with spermatozoa. The transplantation of ova subjected to various experimental conditions is ably reviewed by Mr. C. E. Adams as well as by Dr. Chang. The clinical aspects are presented in papers by Dr. P. N. F. Bishop and Dr. Ian Donald.

It is, of course, not possible to present criticism of the numerous experimental details contained in this assemblage of papers. I find the presentation of sperm biochemistry comprehensive and adequate. The biochemistry of the egg is much less well established. For example, the knowledge of enzymatic transformations and the carbohydrate metabolism of sperm has no counterpart in ovum investigations. This may be due in part to the need for the development of adequate micro methods for use with the limited number of ova available for study. There is only tangential discussion of the role of hormones as regulators of sperm and ovum physiology. Although it is clear that some of the effects of the gonadal hormones may be indirect, nevertheless it would have been useful to have set forth their function in creating specific environments for spermatogenesis, ovulation, fertilization and early development.

There can be no question of the great usefulness of this volume to active investigators in the field of mammalian germ cells. It should be of fundamental interest also to persons interested in the problems basic to modern animal husbandry. Although in no sense a book for the medical practitioner, the thoughtful physician interested in problems of fertility and sterility should find this symposium informative and stimulating.

Gregory Pincus

Geometrical Mechanics and de Broglie Waves

By Prof. J. L. Synge. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. vii+167. (Cambridge: At the University Press, 1954.) 25*s*. net.

GEOMETRICAL optics as well as Newtonian mechanics are based on the same variational principle $\delta \int v ds = 0$. In one case, v is the medium function; in the other, it is the velocity. Geometrical optics deals with rays and associated wave-surfaces. The same ray–wave relationship must, therefore, also be available for Newtonian mechanics. Starting with this important observation, Prof. J. L. Synge builds up the theory of "relativistic geometrical mechanics", in analogy with Hamilton's geometrical optics. Sources of light are replaced by space–time events, radiating world lines into the future; the wave-surfaces are three-dimensional surfaces in space–time—in fact, de Broglie waves, moving with a velocity which can be calculated from that of the associated ray.

If the concepts of wave-length, secondary waves, etc., are added semi-intuitively to the structure of geometrical optics, the resulting scheme (physical optics) suffices to give an adequate description of most optical phenomena. It provides easy solutions of problems where Maxwell's theory of electromagnetic waves would be difficult to apply. By analogy, Prof. Synge argues that a "primitive quantisation" of the scheme of relativistic geometrical mechanics (introduced by postulating that adjacent three-waves of equal phase are separated by a quantum of action h) would stand in the same relation to Schrödinger's wave mechanics as physical optics does to Maxwell's theory. A number of special cases are then discussed, among them the case of a particle in an electromagnetic field, and the case of the hydrogen atom.

Although one may wonder if Prof. Synge has not exhausted the possibilities of obtaining exact solutions, the novelty of his point of view is attractive and refreshing. The difficulty of the monograph comes from the relative unfamiliarity of the optical method of Hamilton, which had to be used, and the rather unfamiliar terminology. However, the effort of learning the new point of view is indeed very rewarding.

ABDUS SALAM

Three Abietaceous Cones from the Wealden of Belgium

(Mémoire No. 125 de l'Institut Royal des Sciences Naturelles de Belgique.) Par K. L. Alvin. Pp. 42+5 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1953.)

IN this sumptuous monograph, a beginning is made to the detailed description and classification of some of the remarkably well-preserved fossil plants in the collections of the late Prof. C. Bommer, from Wealden clays in the Hainaut district of Belgium. The plants are preserved as a kind of lignite, in clay, and they have yielded to examination by microtome sections prepared by softening the material and then embedding in celloidin. In the cones here described, it has thus been possible to make a critical study of anatomical features, including the vascularization of the seed scales.

The three species of cones identified illustrate the importance and diversification attained by the family of the Abietaceae at this critical horizon in early Cretaceous times. The author reserves judgment on generic affinity and uses the form genus *Pityostrobus* Nathorst for all of them, having regard to the absence of information on associated vegetative characters. It has been possible, however, to define the species on a range of characters which is unusually wide for fossilized conifers. *P. andraei* (Coemans), a widely-spread species, and *P. bommeri* Alvin probably both represent extinct species of the genus *Pinus*; while *P. corneti* (Coemans), which is taxonomically perhaps the most interesting of the three, shares some characters with *Cedrus* and some with *Keteleeria*, and no doubt represents an extinct genus.

The continuation of such detailed studies of Cretaceous and of younger members of the Abietaceae should do much to elucidate the later evolution of this highly successful family, and thus add to the remarkable history of the Coniferales which has been placed on so well documented a basis by the work of Florin on the earlier members.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Edited by Charles C. Price. Vol. 33, 1953. Pp. vi+115. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 28*s*. net.

THIS issue maintains the reputation of the series by recording reliable practical details for a further selection of forty compounds, of varied nature and interest. Among them, creosol (2-methoxy-*p*-cresol) is obtained by treating an ethanolic solution of vanillin with amalgamated zinc and concentrated hydrochloric acid, the aldehyde group being reduced to methyl; dimethylketene distils over in 50 per cent yield as a solution in ethyl acetate when α-bromo*iso*butyryl bromide is added dropwise to boiling ethyl acetate and zinc turnings in an atmosphere of pure dry nitrogen under a pressure of 300 mm. mercury; and 9-fluorenecarboxylic acid results almost quantitatively when benzilic acid is stirred with pure benzene and anhydrous aluminium chloride. Other preparations include nicotinonitrile from nicotinamide; α-phenylcinnamic acid, and pure *cis*-stilbene therefrom; pyridine-N-oxide from pyridine and 40 per cent peracetic acid; and stearone from stearic acid. The cumulative index covers Vols. 30–33 of the series. An inserted leaflet directs attention to the explosive nature of the sodium salt of nitromalonaldehyde, mentioned in Vol. 32.

JOHN READ

The Year's Work in Librarianship

Volume 17, 1950. Edited for the Library Association by W. A. Munford. Pp. x+270. (London: Library Association, 1954.) 40*s*.

THIS is the last of a series of seventeen volumes, for it is considered that *Library Science Abstracts*, together with the projected "Five Years' Work in Librarianship", the first volume of which will cover the period 1951–55, will better meet the needs of librarians. Besides the usual book list, this final volume includes chapters on national and university libraries by A. C. Townsend, special libraries (B. C. Vickery), library co-operation (C. C. Adams), library buildings (E. F. Patterson), library practice (G. R. Davies, M. Piggott and W. C. Berwick Sayers), and subject bibliography (P. D. Record). As usual, the volume is well produced, and though the claim is justified that present needs will be better met in other ways, some will nevertheless regret the displacement of a convenient reference work which has proved its value.

THE PROBLEM OF THE TWO TYPES OF DIAMOND

By PROF. G. B. B. M. SUTHERLAND, F.R.S., D. E. BLACKWELL* and W. G. SIMERAL†

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Introduction

EXACTLY twenty years ago, Robertson, Fox and Martin[1] reported the existence of two types of diamond having marked differences in infra-red and ultra-violet absorption, in photoconductivity and in birefringence. Somewhat later, Raman and Nikalantan[2] reported that many diamonds had extra spots or streaks in their X-ray diffraction patterns. This observation was confirmed by Lonsdale and Smith[3], who reported that extra streaks were characteristic of type I diamonds and also that in general type II diamonds appear to be much more mosaic in structure than type I diamonds. The principal characteristics of the two types of diamond as determined from these early investigations are summarized in Table 1.

Table 1. CHARACTERISTIC FEATURES OF THE TWO TYPES OF DIAMOND

Physical property	Type I	Type II
Infra-red absorption	Bands at 4–5 μ Absorption 8–10 μ	Bands at 4–5 μ None between 8 and 10 μ
Ultra-violet absorption	Complete beyond 3000 A.	Transparent to 2250 A.
X-ray diffraction	Shows extra spots and streaks	Normal
Photo-conductivity	Poor	Good
Birefringence	Present	Absent

Afterwards, Sutherland and Willis[4] and also Ramanathan[5] showed that type I diamonds are not uniform in their infra-red absorption, since the extinction coefficient of the 8–10 μ band varies very widely from diamond to diamond. Thus the type II diamond may be regarded as a limiting case in which the value of the extinction coefficient of the 8–10 μ band has become vanishingly small. A similar gradation has been found in the position of the ultra-violet cut-off and in the intensity of the extra spots in the X-ray diffraction patterns. Thus, diamonds may be more satisfactorily classed as extreme type I, medium type I, weak type I and type II. It should be added that Blackwell and Sutherland[6] have reported two types of type II diamond neither of which exhibited any absorption in the 8–10 μ region but which showed differences in the 3–5 μ region.

No explanation for these anomalies in the physical properties of diamonds has yet been put forward which has received general acceptance. In an attempt to seek a satisfactory solution of this puzzling phenomenon, we have made an extensive investigation of the infra-red and ultra-violet spectra of a selection of diamonds. In a short paper giving an account of some of the early results[6], we suggested that the type II diamond was a normal pure diamond, whereas all type I diamonds had some impurity or imperfection in their structure which would account for the anomalies. The purpose of the present article is to present briefly the main results of our investigations with particular reference to the imperfection theory.

Type I and Type II Diamonds

First, however, it is necessary to consider a little more carefully the distinguishing features of type I and type II diamonds. Although any one of the properties listed in Table 1 has been generally accepted as a reliable guide in distinguishing type II from type I diamonds, the parallelism of all the physical properties is not at all satisfactory in classifying type I as 'extreme', 'medium', or 'weak', and occasionally a diamond classed as type II on the basis of one physical property would be classified as type I if one of the other properties were used. In a paper primarily concerned with possible correlations between the counting properties of diamonds and their crystal texture (as shown by divergent beam X-ray photographs) Grenville-Wells[7] has listed various physical properties of thirty-eight diamonds. Four of these diamonds had a cut-off in the ultra-violet below 2400 A., yet exhibited anomalous extra-strong X-ray streaks; thus by ultra-violet examination these four diamonds would have been classed as weak type I, but by X-ray streaks as medium or strong type I. Similarly, three diamonds which showed no extra streaks (and would therefore have been classified as type II) had their ultra-violet cut-off at wave-lengths longer than 2830 A. (indicating that they were medium or strong type I). Through the courtesy of Dr. Grenville-Wells, we have been able to examine the infra-red spectra of thirteen of these thirty-eight diamonds. We have found that in every case there is excellent correlation between the infra-red and ultra-violet method of classifying diamonds, but very poor correlation between the infra-red and X-ray method. In this connexion it should also be added that the observations of Grenville-Wells have shown that mosaic character cannot be reliably correlated with type II diamonds as originally suggested by Lonsdale[3].

There is therefore strong evidence that the same cause operates in producing the extra absorption found in the infra-red and ultra-violet spectra of all type I diamonds, but that additional factors may be the cause of the extra streaks and of the mosaic character found in the X-ray photographs of certain diamonds. In view of this, we propose to use a modified nomenclature in the future for the description of type I and type II diamonds. A diamond which is found to be type I (or type II) by spectroscopic means will be denoted by I*S* (or II*S*), whereas a diamond classified by X-ray methods will be denoted by I*X* (or II*X*). The spectroscopic symbol can be elaborated to read *Sir* or *Suv*, depending on whether infra-red or ultra-violet radiation was used in making the classification; similarly, the X-ray symbol should be modified to read *Xl* or *Xd* to indicate whether the diamond was classified by extra streaks on a Laue photograph or mosaic character as shown by a divergent-beam technique. Possible extensions of this notation by using combinations of the *S* and *X* symbols together with *s*, *m* and *w* to denote extreme, medium and weak are sufficiently obvious and need not be discussed here.

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The distinctions just drawn between the various type I and type II diamonds are important in what follows, because in this communication we shall restrict our discussion to *IS* and *IIS* diamonds. It appears to us that at least some of the confusion in the diamond problem can be eliminated in this way. In other words, there are several type I and type II diamond problems and we propose to start with the *IS* and *IIS* types, since the classification by infra-red and ultra-violet absorption has been found (by the examination of several hundred stones) to give very consistent results.

We may begin by considering what would be predicted for the ultra-violet and infra-red spectra of diamond, assuming the Bragg structure and the current theories of molecular spectra.

Ultra-violet Absorption of an Ideal Diamond

From the examination of the ultra-violet spectra of large numbers of hydrocarbons, it has been found that only those hydrocarbons which contain a double or triple carbon–carbon bond exhibit absorption at wave-lengths longer than 2000 A. Since diamond presumably contains only single bonds, its ultra-violet cut-off might be expected to be below 2000 A. Since no *IIS* diamonds have been found with a cut-off below 2200 A., it appears at first sight as if all diamonds are anomalous in their ultra-violet absorption, with *IIS* less anomalous than *IS*. However, Klevens and Platt[8] in an investigation of the ultra-violet spectra of branched saturated hydrocarbons have shown that, as the degree of branching increases, the edge of the ultra-violet cut-off moves to longer wave-lengths; for example, from 1715 A. in *n*-pentane, to 1795 A. in 2,2,3,3-tetramethylpentane. One might, therefore, anticipate that diamond (which from this point of view resembles an extremely highly branched large hydrocarbon molecule) would have its ultra-violet cut-off in the neighbourhood of 2000 A. In order to test this hypothesis, we have examined the ultra-violet spectrum of adamantane ($C_{10}H_{16}$), which consists of four 'fused' *cyclo*hexane rings and which would yield diamond if it ever could be 'polymerized'. The ultra-violet cut-off of adamantane, while not as sharp as that of a *IIS* diamond, is indeed very close to 2200 A. We should add that Herman[9] has recently made a theoretical calculation of the separation between the filled and unfilled electronic energy-levels of diamond and obtained a value of approximately 6 eV. This corresponds to an absorption edge of about 2050 A. We therefore conclude that the *IIS* diamonds have perfectly normal ultra-violet absorption and that only the *IS* diamonds are anomalous.

Infra-red Absorption of an Ideal Diamond

From investigations on the infra-red absorption spectra of hydrocarbons, the force constants involving carbon–carbon bonds are sufficiently accurately known to make it certain that the fundamental frequency spectrum of the diamond lattice must extend from about 1,400 cm.$^{-1}$ (7·1 μ) to about 300 cm.$^{-1}$ (33 μ). The exact distribution of the normal modes over this range is a much more difficult problem, but calculations have been made by Smith[10] which give reasonable agreement with the observed second-order Raman spectrum, and her results can be regarded as a very good first approximation to the true distribution. It is necessary to consider next to what extent these frequencies may be expected to be active in absorption. Using the results of Teller[11] and Lifshitz[12], it can be shown that none of the fundamental frequencies should be active in absorption, but that combinations of fundamentals may give rise to absorption.

Now *IIS* diamonds exhibit no absorption between 1,800 cm.$^{-1}$ and 100 cm.$^{-1}$ (that is, the fundamental region), but do have bands between 3,500 cm.$^{-1}$ and 1,800 cm.$^{-1}$ (that is, the region of combination frequencies). Thus *IIS* diamonds are completely normal in their infra-red as well as their ultra-violet absorption.

Problem of the IS Diamonds

The conclusion that *IIS* diamonds are perfectly normal in their optical absorption properties is an important one. The problem of the *IS* and *IIS* types of diamond is now reduced to the problem of why *IS* diamonds show anomalous absorption. A few years ago, two of us suggested[6] that the extra absorption found in *IS* diamonds might be due to impurity centres in diamond. The exact nature of these was not specified. Impurity centres may consist of (1) foreign atoms, (2) missing carbon atoms, or (3) carbon atoms which are not in the same electronic state as the majority of carbon atoms in the diamond lattice. We may now consider what the effects of such impurity centres would be on the absorption spectrum of diamond.

(*a*) *Ultra-violet spectrum*. It is now well established that chemical impurities in silicon and germanium cause the edge of the main absorption band in these elements to move to longer wave-lengths[13]. Thus the shift of the absorption edge from 2250 A. in *IIS* diamonds to 3000 A. (or even farther) in *IS* diamonds could be due to chemical impurities. The effect of missing carbon atoms on the ultra-violet spectrum is not so easy to predict; but, in general, lattice defects of this type may be expected to decrease the gap between the ground state and the lower edge of the first band of energy-levels. Thus the observations are probably also consistent with this second type of impurity centre. The third type of impurity centre might also be expected to cause a shift of the absorption edge to longer wave-lengths, but in addition might be expected to give rise to discrete lines superimposed on the continuous absorption. Such discrete lines are observed, and we have been able to prove that certain of these lines are closely correlated with certain infra-red absorption bands in the range below 1,800 cm.$^{-1}$ (cf. (2) below).

We may conclude that the extra absorption shown by *IS* diamonds in the ultra-violet can be readily accounted for in a qualitative manner by an impurity theory and that, of the three types of impurity centre considered, that arising from carbon atoms in an abnormal state seems the most probable.

(*b*) *Infra-red spectrum*. Anything which destroys the centre of symmetry midway between each neighbouring pair of carbon atoms in the ideal diamond lattice can cause absorption to occur in the region of fundamental frequencies. Thus any of the three varieties of impurity centre considered could conceivably account for absorption by *IS* diamonds in the region below 1,800 cm.$^{-1}$. Before discussing which seems most probable, we shall summarize the most important results of our investigations on the infra-red spectra of *LS* diamonds.

(1) Absorption maxima of variable intensity have been found in *LS* diamonds at the following frequencies below 1,800 cm.$^{-1}$: 1,540, 1,520, 1,426, 1,372, 1,332, 1,282, 1,203, 1,171, 1,093, 1,003, 780, 480 and 328 cm.$^{-1}$. No absorption was found between 300 cm.$^{-1}$ and 100 cm.$^{-1}$. All but two of these bands appear to fall into two groups (as shown in Table 2) in the sense that the bands in each group always occur together and have the same relative intensity, but there is no correlation between the bands in the separate groups. The two maxima near 1,530 cm.$^{-1}$ have not so far been correlated with either group; but this may be due to the difficulty of making accurate intensity measurements on these weak bands. Many of the group *B* bands (for example, at 1,426, 1,372, 1,332 and 328 cm.$^{-1}$) are very sharp. All the group *A* bands are broad.

Table 2. DISTRIBUTION OF THE ABSORPTION BANDS OF *LS* DIAMONDS

Group *A* (cm $^{-1}$)	Group *B* (cm.$^{-1}$)
1,282	1,426
1,203	1,372
1,093	1,332
480	1,171
	1,003
	780
	328

(2) It has been found that as the intensity of the group *A* bands increases, the cut-off wave-length in the ultra-violet moves to longer wave-lengths and the intensity of an ultra-violet line at 3157 A. increases. However, in *LS* diamonds containing group *B* bands, the intensity of this group of bands is independent of the position of the ultra-violet cut-off, but is correlated with the intensity of an ultra-violet absorption line at 4155 A.

(3) Following the methods of Smith[13], we have calculated the branches of the vibration spectrum of the diamond lattice and have been able to explain the high frequency ($>$ 1,800 cm.$^{-1}$) bands of *LS* and *IIS* diamonds in terms of allowed combinations. The group *A* bands in the low-frequency ($<$ 1,800 cm.$^{-1}$) spectrum of *LS* diamonds can also be accounted for in this way; but most of the group *B* bands cannot be associated with calculated maxima for the ideal diamond lattice.

(4) When *LS* diamonds are heated to 400° C., the only detectable change in the infra-red spectrum (between 4,000 and 700 cm.$^{-1}$) is a decrease of about 30 per cent in the intensity of the 1,372 cm.$^{-1}$ band. This band also moves to lower frequencies as the temperature increases, the temperature coefficient being 1 cm.$^{-1}$/50° C. Diamonds (*LS* and *IIS*), which had been heated to 1,700° C. and were re-examined at room temperature, showed no change in infra-red spectrum.

(5) The infra-red absorption bands of *LS* diamonds show no dichroic effects in regions where optical birefringence is observed.

(6) Irradiation of *IIS* diamonds by neutrons, deuterons and γ-rays has so far failed entirely to produce any of the absorption bands characteristic of *LS* diamonds. Neutron irradiation appears to give rise to the formation of graphite. Deuteron irradiation caused colour changes in the surface layers (green for a *IIS* and brown for a *LS* diamond).

(7) There is no correlation between variations in the ratio of carbon-13 to carbon-12 in diamonds and the intensity of the characteristic *LS* bands.

It is clear from the foregoing results that there is probably more than one cause for the appearance of anomalous absorption in *LS* diamonds, since the absorption bands fall into at least two classes which exhibit different properties. Moreover, part of the absorption can be confidently assigned to the activation of normally forbidden frequencies of the ideal diamond lattice; but some of the bands appear to be due either to chemical impurities or to carbon atoms in an abnormal state. Isotopic effects cannot account for the anomalous absorption. Since deuteron irradiation fails to convert a *IIS* into a *LS* diamond, it seems unlikely that vacant sites are the cause of the *LS* anomalies.

Conclusions

Our present conclusion is that carbon atoms in an abnormal state and chemical impurities probably both contribute in varying degrees to produce *LS* diamonds. If some carbon atoms exist in a state which enables them to form double bonds in *LS* diamonds, then the bands near 1,530 cm.$^{-1}$ could be due to the vibration of carbon–carbon double bonds in an unsymmetrical environment, and the movement of the ultra-violet absorption edge towards 3000 A. is consistent with the introduction of a few conjugated double bonds into the structure. Since graphite is a more stable form of carbon than diamond, it is tempting to consider that in *LS* diamonds some parts of the structure have gone part of the way towards graphite. However, the neutron irradiation experiments seem to produce graphite without giving the typical *LS* features as an intermediate stage. With regard to chemical impurities, it should be realized that there is very good spectroscopic evidence[14] for the presence of many impurities in the average diamond, and some evidence[14] (although much weaker) that *IIS* diamonds are less impure than *LS* diamonds. This is a point on which we hope to conduct further investigations. The appearance of some very narrow absorption bands in group *B* (which do not seem to belong to the diamond lattice) is most easily explained by attributing them to the presence of chemical impurities.

What does seem certain from these investigations is that type I diamonds (specifically *LS* diamonds) are imperfect. This is an unexpected result, since in our experience all large diamonds of gem-stone quality are always type I diamonds. While some very small type II diamonds are perfect octahedra, all the large type II diamonds which we have examined are very far from any of the ideal crystalline forms of diamond (octahedron, cube, etc.) and, in fact, usually exhibit a layered structure with highly irregular faces and fractured edges. It would almost appear as though a large single crystal having the ideal Bragg structure is unstable and requires certain impurity centres to be incorporated to give stability. The beneficial effect of impurities in the growing of large single crystals is well known to workers in that field[15].

A full account of this work is now being prepared for publication in a more appropriate journal.

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WORLD POPULATION CONFERENCE IN ROME

THE World Population Conference which met in Rome during August 31–September 10 of this year was financed jointly by the United Nations and some of its Specialized Agencies, by certain governments, and by private institutions and individuals through the International Union for the Scientific Study of Population. It was the first international conference on this subject to be attended by participants from all over the world since the Paris Conference of 1937. Some four hundred persons participated, each of whom had been invited by the Secretary-General of the United Nations in his private capacity. Even though many held official positions in their own countries, they did not in any way represent their governments, and the Conference confined itself to discussion, and adopted no resolutions. A number of participants attended from the Communist countries, but there was none from the Chinese mainland although invitations had been issued to a number of Chinese known to be interested in the study of population. Prof. Liebman Hersch, professor of demography in the University of Geneva and president of the International Union for the Scientific Study of Population, was elected chairman of the Conference.

Many papers were submitted to the Conference and discussed in thirty-one different meetings. They dealt with a wide variety of topics, ranging from narrowly demographic problems, such as the nature and quality of vital statistics or techniques of projecting population figures, to wide issues such as the probable future development of population in a number of areas and the relation of such population to the available resources. Some meetings were devoted to fields in which a number of disciplines overlapped: thus anthropologists and demographers discussed methods of measuring population-growth in pre-literate societies; a session was devoted to the discussion of population genetics, and in another the relations between intelligence and fertility were studied. One meeting under the chairmanship of Mrs. Alva Myrdal, of the Division of Social Sciences of the U.N. Educational, Scientific and Cultural Organization, concerned itself with the social aspects of population changes, with special reference to inter-disciplinary studies.

From the wealth of documentary material presented it is difficult to pick out individual contributions, and in the rest of this article I can only comment on a few of the topics that were discussed. It is hoped that the papers submitted to the Conference will be published in the not too distant future.

Population trends and the probable future course of population naturally formed one of the main interests of the Conference, and a number of meetings were devoted to the discussion of these subjects. Mortality and fertility were discussed separately, and different meetings were devoted to the areas of the West in which mortality and fertility are low, and to Africa and Asia where both are high. Finally, in a meeting presided over by Mr. Harold F. Dorn, of the United States, the general prospects for future population changes were discussed.

A good deal of statistical and other information is, of course, available about Western countries. In those areas changes in mortality are unlikely to exert a major influence on total numbers in the near future; the main difficulty here lies in the assessment of the probable future course of fertility. It was pointed out that, in the past, predictions of future population growth have by no means been conspicuously successful, and there was marked predisposition to abstain from detailed forecasts for the future. But there seemed to be some consensus of opinion that although the small-family system has come to stay, the very low fertility-rates experienced by Western countries in the immediate pre-war period were exceptional. It was believed that in the majority of Western countries future growth will be very slow and that the rate of natural increase will not be far from replacement. In spite of the relatively advanced level of statistical development in those areas, the need for further data and continued research into the social factors influencing fertility was stressed. In particular, the lack of comparability between studies in different countries was adversely commented upon.

The position is completely different in Asia and Africa, where in general both fertility and mortality continue to be high and where data are scarce. In those areas the development of mortality is more important in determining likely future growth than are developments in fertility. It was pointed out that, in many of these areas, public health and other ameliorative measures have been successful in greatly lowering mortality and that this process may be expected to continue in the near future. In some areas these reductions in mortality have been achieved without any marked improvements in the nutrition of the people and without any major changes in the economic or social structure. Such reductions will naturally raise the rate of population-growth, and the rise in turn may react back on fertility-rates. It was pointed out that there are large regions of the world—Latin America was mentioned as an example—where an increased rate of population-growth caused by lower mortality might actually increase national welfare; but it was recognized that in some countries which are already densely populated—India and Japan were cited as cases in point—unchecked population-growth would in all probability react adversely on the standard of living.

It became clear in the discussion that many of the governments of the Asian countries are fully alive to the dangers of population-growth and are encouraging research on these topics. Such research has the aim of providing better data to help in the understanding of these problems and also in devising measures which would help to slow down the rate of increase. A number of important and interesting communications described field-studies in population in progress in India, Indonesia, Burma and Japan and in some parts of Africa. The application of sampling techniques to demographic research in particular has proved very fruitful. In India, the government is encouraging research on methods of birth control, and also conducting a field-survey, with the technical assistance of the United Nations, on the efficacy of the 'rhythm' or 'safe-period' method of birth control as a check on population in some Indian villages. It was clear that in societies in which there is a high degree of illiteracy, the introduction of even the simplest methods of birth control would be fraught with difficulty, although there was considerable evidence of a latent demand for it on the part of parents who have already had three or more children.

In contrast there were Prof. Y. Koya's findings in Japan. There, the dissemination of contraceptive information in a number of fishing villages has had the effect of reducing the general fertility-rate in those areas by about one-third within a fairly short space of time. The population of Japan is, of course, more literate than that of India; but the success of the experiment astonished the Japanese themselves, who were surprised by the absence of a demand for large families which they thought implicit in the Japanese system of values. Interesting facts were also presented regarding the response to the recent Japanese law which has legalized abortion on socio-medical grounds. Recent Japanese experience was cited in support of the views of those participants who believe that increasing industrialization would *ipso facto* bring with it lowered fertility. It was made clear, however, that even if fertility in the Eastern countries were to decrease as a consequence of industrialization and economic progress, the present age-structures of those populations are such that in any event considerable increases may be expected in the near future.

A forecast of the U.N. Population Division for the population of the world as a whole estimated that by 1980 the figure would lie between 3,300 and 4,000 million people, against an estimate of 2,500 million in 1950. This estimate was put forward with all due caution. There are many areas of the world for which the data are still rudimentary, and if recent reports putting the population of China at 630 million prove correct, even the basic estimate for 1950 may be in error by as much as 7½ per cent. In spite of this, it was considered valuable to have an extrapolation of present trends in different areas prepared by an impartial and expert body like the United Nations.

A word or two may be said about the attitude of participants from Communist countries. The absence of Chinese demographers has already been commented upon and was keenly felt in view of recent reports in the Press on the results of the latest Chinese enumeration. It was clear that there are considerable differences between the points of view of the Communist demographers and their Western and Asiatic colleagues. The Communists regard continued population-growth as a sign of a healthy society and refuse to be perturbed by the prospect of continued pressure of population upon resources. In a communication to the Conference, Mr. Ryabushkin, of the U.S.S.R., wrote: "The Neo-Malthusians proposed to bring the number of population into conformity with the level of production. But an elementary logic suggests that on the contrary levels of production should be brought into conformity with the number of population, because it is production that exists for population, but not population for production. And that production can be repeatedly increased in a relatively short period of time is evident from the historical experience of the Soviet Union."

This point of view, which implicitly assumes that natural resources are unlimited, has in practice aligned the Communists with the Roman Catholic Church in their attitude towards birth control. Neo-Malthusianism is a term of abuse, contraception is discouraged and it is not clear to what extent contraceptives are made available to those who desire them on other than medical grounds. Maternity and child-welfare services are available to mothers and high fertility is encouraged. But it is by no means clear from the addresses delivered at the Conference to what extent the right of individuals to decide on the size of family that they would like to have is recognized in Communist countries.

In concluding, tribute should be paid to the success of the administrative arrangements for the Conference, which was held in the building of the Food and Agriculture Organization, and to the skill of the interpreters, who were successful in providing simultaneous translation of addresses which were frequently highly technical into English, French, Russian and Spanish. E. Grebenik

POST OFFICE ENGINEERING RESEARCH STATION, DOLLIS HILL

OPEN DAY

The Post Office Engineering Research Station, Dollis Hill, was open to visitors from the universities, industry and government departments on September 24, the Press having been invited the previous day. The functions of the Station, its staffing and its relationships with the telecommunications industry remain much the same as on the last open day (see *Nature*, 168, 1022; 1951), though the buildings have since been increased, notably by one which provides a ground floor of nearly twenty thousand square feet devoted mainly to machine shops, an upper floor for drawing offices and part of another floor to a suite of laboratories devoted to thermionics. The individual problems being undertaken, whether basic studies or the development of new techniques or equipments to meet specific requirements, have, however, changed considerably, as the following descriptions of a few of the eighty exhibits presented will show.

The application of electronic techniques to telephone switching was shown in a private automatic branch exchange, devoid of electromechanical parts; it has an ultimate capacity of ninety-nine lines, exchange and extension, of which forty are now being connected. The switches use time-division-multiplex transmission, each line being allocated a fixed position, of duration 1 μsec., in a continuously repeated cycle of 100 μsec., for the transmission and reception of speech currents. Registers and markers control the switches. The former receives the numerical information from the calling subscriber and stores it on gas discharge tubes before passing it to the marker which causes the called line to be tested and, if free, to be connected to the electronic equivalent of a cord circuit to which the calling line was joined when the call originated. A register is in service for as long as it takes a subscriber to dial, the marker for about 20 m.sec.

The Station has designed an electronic digital computer called MOSAIC and installed it at an establishment of the Ministry of Supply. The computer could be shown, therefore, only by way of photographs of key parts. It uses a pulse repetition frequency of about 600 kc./s.; storage is in ultrasonic delay lines with a full capacity of 1,030 words (instructions) and numbers, each of 40 bits, that is, each number corresponds to twelve digits in the scale of ten. A four-address system is used: each instruction to the machine defines the location of the two numbers to take part in the next arithmetical step, the destination of the answer and the location of the next instruction. The instructions and the numbers to be operated on are fed in, and the answers fed out, on punched cards.

Recently new attempts have been made to extract the essential information in speech in such a way as to enable it to be conveyed over a channel of bandwidth much less than that conventionally used in telephony ($\sim$ 3,000 c./s.). It is well known that speech can be synthesized sufficiently well by using only six slowly varying parameters—the level and pitch of the larynx tone, the level of hiss excitation and the frequencies of the three major resonances (formants) in the vocal tract—but until now it had not been possible to extract the last three instantaneously from speech. Progress was demonstrated, however, with equipment which sets up a spectral display differentiated with respect to frequency to find the resonances. The display is followed by circuits which generate the control signals of a synthesizer. The six signals may require a total bandwidth of only 180 c./s., to which must be added, however, that required by the filter designer to ensure satisfactory assembly and separation.

Transistors have yet to make any impact on the telegraph and telephone systems in Great Britain, but some simple line amplifiers and a quartz-controlled oscillator using germanium junction transistors showed some of the advantages of small size and power consumption which may later be obtainable. The great and almost immediate susceptibility of fully exposed germanium junction diodes and triodes to water vapour at room temperature and at a pressure of about 1 cm. of mercury was demonstrated; the maximum voltage which the diode or the collector-base junction could sustain fell drastically—recovering equally rapidly on sudden lowering of the vapour pressure to below 1 mm. For reliability, therefore, water vapour must not be allowed access to the active element.

Two new pieces of spectrographic equipment were on show. A compact source unit can produce a d.c. arc, a high-voltage spark and some triggered arcs, and a projector-comparator enables spectra on one or two plates to be seen and compared at a magnification of twenty times for the purposes of identification and semi-quantitative analysis.

Magnetic materials, so widely used in telecommunications, have been the subject of several developments. Nickel–iron strip as thin as 0·00015 in. has been rolled by a novel technique; its low-field permeability can be as high as 20,000 and its coercive force as low as 0·025 oersted after suitable treatment; thicker material (for example, 0·002 in.), similarly treated, can have values of 75,000 and 0·0075 oersted.

Repeaters (amplifiers) for inclusion in submarine cables have engaged more and more attention since 1945 (the first one was laid by the British Post Office in the Irish Sea in 1943) and have continually thrown up new problems as submarine schemes became more ambitious. The practical solutions to some, such as that of making the gland between cable and repeater capable of preventing the entry of water at the pressures encountered at depths of a mile or two and that of making reliable all the components (the failure of any one of which could, without other safeguards, involve a cable ship in many days of work) often entail meticulous attention to detail with no spectacular results; they are, however, being obtained. Ingenuity in the electrical design of the amplifier has eased some of the problems. Much improved accuracy in the measurement of the electrical properties of submarine cables has been necessary to engineer some of the longer systems; when obtained, it has brought to light new effects affecting the properties. Progress towards an oxide-cathode valve of high performance and long life (perhaps twenty years) has been made using a passive platinum core, the fundamental behaviour of which is becoming understood, rather than the active nickel core so widely used in commercial valves. Careful attention must be continuously given to pre-processing, assembly and vacuum techniques.

British deep-sea repeaters, though still housed in rigid cases, are streamlined and more easily handled during laying than the earlier shallow-water types. Telemetering devices fitted within a dummy repeater, for measuring shocks, spin, inclination and pressure, have been developed in order to investigate the conditions encountered between the time a repeater enters the water and when it finally settles on the sea bed.

The Post Office continues to give much attention to the methods of producing quartz resonators; the Essen rings which the Post Office has recently supplied as standards to the Greenwich, Ottawa and Naval (Washington, D.C.) Observatories and to the National Physical Laboratory (Teddington), the National Research Council of Canada (Ottawa) and the National Bureau of Standards (Washington, D.C.) illustrate some of the newer techniques. The quartz is now cut by an annular saw which reduces waste and surface damage and permits thinner wafers to be specified.

Quartz continues to play a part in narrow-band filters. At the same time, coil-condenser filters, so widespread in multi-channel telephony, still find new uses in radio engineering. The output stages of a radio transmitter generate harmonics which, if the fundamental frequency is up to, say, 20 Mc./s., may interfere with the local reception of television, particularly in fringe areas; a low-pass coil-condenser filter capable of dissipating that fraction of the transmitter power at the fundamental frequency which it absorbs (perhaps 0·3 per cent or up to 50 W.), inserted between the output stage and the aerial, can sufficiently attenuate the harmonics. Filters play an increasing part in multi-channel microwave systems; Darlington's and Cocci's methods of network synthesis are being successfully applied to designs involving irises and posts in rectangular wave-guides.

The transmission of telephony and television at microwave frequencies could not be successfully undertaken without precision measuring equipment. Group-delay distortion of a frequency-modulated multi-channel telephony system results in intermodulation products of which little can be tolerated. The distortion introduced by filters, travelling-wave tube amplifiers and other components, over a bandwidth of 50 Mc./s. centred at about 4,000 Mc./s., can now be displayed on a cathode-ray tube with a sensitivity of 1 cm./mμsec.

Equipment for long-distance radio communication in the 4–30 Mc./s. band is judged in part by its ability to combat the fading and multipath effects characteristic of ionospheric propagation. Because testing in service is slow and inconvenient, a fading machine simulating the natural effects is a great asset. An early machine, producing frequency-selective fading by combining two or three differently delayed signals of constant amplitude, but varying relative phase, has recently been modified so that the differently delayed signals individually fade in a near-random way, more closely simulating field conditions.

NEWS and VIEWS

Nobel Prize in Physics:

Prof. Max Born, F.R.S.

PROF. MAX BORN, who has been awarded a share of the Nobel Prize in Physics for 1954, is known for many contributions to modern theoretical physics, particularly to the development of quantum mechanics and to the theory of crystals. The work mentioned specifically in the announcement of the Nobel award is the interpretation of the wave functions as probabilities for the positions of particles, a vital step in the development of the modern view of the relations between particle and wave aspects of atomic theory. This dates from a period when, in collaboration with Heisenberg and others, Born took an important part in the development of quantum mechanics, which form one of the two independent approaches to modern quantum theory. Other important work of that period, which has become classical, includes his use of perturbation theory for scattering problems and the Born–Oppenheimer theory of molecules. The theory of crystal lattices has formed another continuing interest, from the earliest papers which showed the basic ideas of lattice vibrations and their relation to the inter-atomic forces, to several treatises covering all aspects of the theory. Born has also taken an active interest in many other aspects of quantum theory. His effect on theoretical physics should, however, be measured not only by his own papers, numerous as they are, but also by the work of his pupils. His school at Gottingen was for a long time one of the most important centres to which young theoreticians went to find guidance and inspiration and to be infected with that enthusiasm and optimism which characterize Born's own work. The men who worked with him later at Cambridge and Edinburgh also include many who have made their mark on modern physics.

Prof. W. Bothe

PROF. W. BOTHE, of the University of Heidelberg, who shares the 1954 Nobel Prize in Physics with Prof. Born, is known for many important contributions to modern physics. The best known of these include his introduction of coincidence methods into counting techniques and the work in which, together with Geiger, he applied the coincidence method to the Compton effect and showed that the conservation laws are satisfied in each individual event and not merely on the average. This was fundamental for the interpretation of atomic processes. With Kohlhorster he applied coincidence methods to the study of cosmic rays and thus helped to establish the presence of penetrating charged particles. Later, in the course of systematic work on nuclear reactions, he discovered the unusual radiation, emitted by beryllium under α-particle bombardment, which was later identified as neutrons. Other fields in which he did pioneer work include the study of hard γ-rays and the nuclear photo-effect produced by such rays and the problems of multiple scattering of electrons and of neutrons. On problems of scattering he has not only done experimental work of great importance but has also made valuable contributions to the theory.

Nobel Prize for Chemistry:

Prof. Linus Pauling, For.Mem.R.S.

THE Nobel Prize for Chemistry for 1954 has been awarded to Prof. Linus Pauling, of the California Institute of Technology. This award will be acclaimed by chemists of all kinds, for Prof. Pauling's contributions have brought about a revolution in the entire field of chemistry. His early work was concerned with the determination of crystal structures by X-ray crystallography, an interest which he has retained; his recent views on the constitution of proteins are based largely on detailed crystallographic analyses of amino-acids and peptides. The study of crystal structure led him to consider the nature of chemical bonds, and already in 1926 he published a remarkable paper on the structures of benzene and its analogues in terms of the Bohr atom. This, however, was soon followed by an impressive series of papers in which the new methods of wave mechanics were applied to chemical problems of all kinds, and in which the resonance theory was developed as a general qualitative approach to such problems. This work led to the recognition of additivity of bond energies and covalent radii in unconjugated molecules (that is, those with a unique classical structure), to the concept of resonance energy and intermediate bond character in conjugated molecules, and to the concept of electronegativity as a factor in determining covalent bond energies. Prof. Pauling's original tables of bond energies, covalent radii and electronegativities are still widely used, and later work has altered them only in detail. Many of these covalent radii were deduced from bond-lengths measured in his laboratory by the newly developed and difficult technique of electron diffraction. In recent years Prof. Pauling has made further notable contributions in fresh fields: a new theory of the metallic state, a theory of immunochemical reactions, and new structures for polypeptides and proteins. Last but not least, he combines with all his other talents a remarkable gift of exposition; the impact of his work on the chemical world has been due largely to the brilliant lucidity of such treatises as "The Nature of the Chemical Bond".

Memorial Tablet to Sir William Herschel

ON November 8 a memorial tablet was dedicated to Sir William Herschel in Westminster Abbey, not far from the graves of Newton and of Sir John Herschel, the son of Sir William. Newton had been buried in the Abbey in 1727, but it appears that at the time of Herschel's death in 1822 it had not been recognized that outstanding men of science should be buried there. From the epitaph on Herschel's grave at Slough, it is clear that his contemporaries realized that he had been one of the greatest astronomers of all time. He was known as the discoverer of the planet Uranus and of great numbers of double stars, star clusters and nebulæ. Some of these discoveries had been made when he was attempting to determine the distances of stars by their parallactic displacement; and although he had failed to determine the distance of any stars, he formed estimates which were not much in error. He had himself constructed telescopes of far greater power than any made by the instrument makers of that time for use in the national observatories, and the observations he made with these instruments made him the founder of sidereal astronomy on an observational basis. He was a pioneer in collecting and discussing astronomical statistics. He conceived our galaxy as the great flattened system it is. He determined the motion of the sun and planets through that system. He believed that some, at least, of the nebulæ might be island universes, that is, systems comparable with our own Milky Way but lying far beyond it. As there was no one with instruments comparable in light grasp with his, and no one with his great experience in observing, some of his ideas remained dormant until in the present century they could be taken up with the great Californian reflectors in combination with fast photographic plates.

The cost of the tablet in Westminster Abbey has been borne by Mr. J. E. Bullard, who had pointed out the absence of any memorial and the desirability of having one to the greatest of British observational astronomers. The service was conducted by the Dean of Westminster, Dr. A. C. Don, and an address on Herschel was given by Dr. J. Jackson, president of the Royal Astronomical Society.

Royal Society Medal Awards for 1954

THE following awards of medals have been made by the President and the Council of the Royal Society:

Copley Medal to Sir Edmund Whittaker, emeritus professor of mathematics in the University of Edinburgh, for his distinguished contributions to both pure and applied mathematics and to theoretical physics.

Rumford Medal to Dr. C. R. Burch, of the H. H. Wills Physics Laboratory, University of Bristol, for his distinguished contributions to the technique for the production of high vacua and to the development of the reflecting microscope.

Davy Medal to Dr. J. W. Cook, principal of University College, Exeter, recently regius professor of chemistry in the University of Glasgow, for his distinguished fundamental investigations in organic chemistry.

Darwin Medal to Dr. E. B. Ford, reader in genetics, University of Oxford, for his distinguished contributions to the genetical theory of evolution by natural selection, particularly in natural populations.

Hughes Medal to Mr. Martin Ryle, lecturer in physics, University of Cambridge, for his distinguished and original experimental researches in radio astronomy.

Nature Conservancy: Scientific Research

IN an adjournment debate in the House of Commons on October 22, Mr. Geoffrey de Freitas, one of the two members of Parliament who are themselves members of the Nature Conservancy, directed attention to the work of the Conservancy, particularly to research work being carried out and the importance of both adequate finance and public understanding if the work of the Conservancy is to be effective. With regard to research, Mr. de Freitas said that, in accordance with a suggestion of the Waverley Committee in its report on coastal flooding, the Nature Conservancy has again investigated the possibility of using vegetation to stabilize the shifting coast-line and, in co-operation with the Somerset River Board, is experimenting in this way in Bridgwater Bay. In co-operation with the Agricultural Research Council and other bodies, it is also examining the effect of spraying roadsides to kill weeds. So far as the Conservancy can judge, spraying has not proved effective in killing the most troublesome weeds, and it appears that indiscriminate spraying is doing real damage to insect life and small fauna. Before the outbreak of myxomatosis in Britain a year ago, the Conservancy asked Mr. R. M. Lockley to investigate the matter, and his survey of the problem, its repercussions and the progress of the disease has proved a valuable guide. Mr. Lockley has concluded that the rabbit flea is the most important transmitter, and work is still being done in studying the consequence of the drastic reduction in the rabbit population on vegetation and animal life.

Finance and Land Transference

APART from finance and the bearing of public relations on the prosecution of fundamental research, Mr. de Freitas raised the question of the policy of land transference in connexion with the Conservancy. Replying on the debate, Mr. J. R. Bevins, parliamentary secretary to the Ministry of Works, promised to bring before the Chancellor of the Exchequer the question of land transference and the use of the National Land Fund for the Nature Conservancy. He pointed out, however, that the Conservancy already possesses powers of compulsory purchase under the National Parks and Access to the Countryside Act, 1949, but these powers have not been invoked and they are not to be used without the sanction of the Lord President of the Council. With regard to finance, the present annual expenditure of the Conservancy is about £200,000, and in this context Mr. Bevins stated that government expenditure on civil research is at the present of the order of £20,000,000 a year. Referring also to the ploughing up of sites of scientific interest, Mr. Bevins stated that the problems involved here are being discussed between the Nature Conservancy and the Ministry of Agriculture, and also with the National Farmers Union and the Council for the Preservation of Rural England.

Nuffield Foundation Support for Research in Rheumatism

During the past five years the Nuffield Foundation has been supporting much chemical and other work on adrenal hormones, but, with the gradual fading of the original hopes of cortisone and adrenocorticotrophic hormone as panaceas for the chronic rheumatic diseases, the Foundation is now reverting to its original policy of supporting fundamental and clinical research into the nature of the rheumatic diseases. As in the past, this programme will be supported both from the resources of the Oliver Bird Fund, which was created in 1948 by the gift of £450,000 from Captain Oliver Bird, and from the Foundation's original Nuffield endowment. Two large grants and two smaller ones are being made. The Foundation has made a grant of £70,000 to the University of Manchester, payable over the next eight years, to extend the work of the rheumatism centre under the director, Prof. J. H. Kellgren, professor of rheumatology in the University. This will be an addition to the original grant of £100,000, spread over ten years, which was made in 1946 to establish a pioneer centre in Manchester of the kind advocated by an expert medical advisory committee of the Ministry of Health at the end of the Second World War. For the past five years the Foundation has been supporting, with general grants for research staff, the clinical and fundamental work of the rheumatic unit directed by Dr. J. J. R. Duthie, senior lecturer in the Department of Medicine, University of Edinburgh. This unit, sponsored by the University to promote teaching and research in chronic rheumatism and to improve standards of treatment, was opened in the Northern General Hospital in October 1947. Limited accommodation has always been a handicap, and a new building is being erected on a site adjoining the unit's ward at the Northern General Hospital. This building, which will be associated with the name of Captain Oliver Bird, will have consulting and research rooms, clinics and laboratories. £27,000 has been given to meet the cost of the building and its furnishing, and in addition, the Foundation will continue its annual grant to assist the unit's work, £38,000 over the five years 1954–58 being provided for this purpose. The two smaller grants are as follows: £8,000 to the University of Sheffield to finance a research fellowship in the Sheffield Centre for the Investigation and Treatment of Rheumatic Diseases, directed by Dr. H. F. West; and £6,000 to the Oxford Regional Hospital Board for an experimental pathologist to work under Dr. A. G. S. Hill on the pathogenesis of rheumatic diseases at the Rheumatic Diseases Research Centre at Stoke Mandeville Hospital.

Hungarian Scientific Exchanges

In September 1953, when the Hungarian Federation of Scientific and Technical Societies acted as host in Budapest at the Third Assembly of the World Federation of Scientific Workers, it was announced that it was intended that scientists from Western countries should be invited to Hungary in future years. This proposal was, in fact, carried out this year. Ten British and French scientists were invited to spend three weeks in Hungary, partly at the holiday resort on Lake Balaton and the rest of the time in visiting scientific institutes. Altogether, some one hundred and thirty individual visits were made, and every facility was given for the visitors to meet those working in their own fields of research. The visitors gave seventeen lectures to various sections of the Hungarian Federation. It is intended that invitations shall be extended to Hungarian scientists to visit Great Britain and France during the summer of 1955, so that the initiative of the Hungarian Federation in attempting to improve communication between scientists in the West and the East shall be followed up and, if possible, improved upon. Members of learned societies who might be interested in such exchanges should write to the Secretary-General of the World Federation of Scientific Workers, 15 Half Moon Street, London, W.1.

Rust Infection Studies

An important study of the infectivity of single-spore strains, that is, physiological races, of the brown rust fungus (belonging to the group species *Puccinia dispersa*) to brome grasses, undertaken during a period of fourteen years, has now been reported on by J. Bean, P. W. Brian and F. T. Brooks (*Ann. Bot.*, N.S., 18, 129; 1954). Each rust strain was maintained as a stock culture on a suitable host, kept permanently under 'Cellophane' covers to prevent contamination. The method of inoculation and techniques used to prevent cross-infection are described. By their infection reactions on a representative selection of *Bromus* spp. at least five physiological races have been characterized. Two of these have host-ranges confined to a single section of the genus, but others have a much wider host-range within the genus. The uredospore stage of all was identical. Studies of the teleutospores have been limited and knowledge of the species of rust involved is incomplete. All belong to the group-species *Puccinia dispersa* Erikss. and Henn.; the species *P. bromina* Erikss. and *P. symphyti-bromorum* Müller were included among the cultures studied, possibly also *P. bromi-maximi* Guyot. In a large series of inoculations, over a period of in all fourteen years, all physiological races have been remarkably stable in their infection types and host-range, and no confirmation of Marshall Ward's 'bridging-host' theory has been obtained. Cultivation of two physiological races for 164 generations on *Bromus arduennensis*, a species considered by Ward to have special significance as a bridging-host, induced no changes in their host-range.

Engineering Study of the Southern Californian Earthquakes

A detailed study of damage to buildings and other structures caused by the earthquake of July 21, 1952, has been published by the Seismological Society of America under the title of "An Engineering Study of the Southern Californian Earthquake of July 21, 1952, and its Aftershocks", by Karl V. Steinbrugge and Donald F. Moran (*Bull. Seis. Soc. Amer.*, **44**, No. 2*B*, 199 (April 1954). 2 dollars). The earthquakes, with the number of shocks shown in brackets, occurred on the following days: July 21 (7), 22 (2), 23 (3), 25 (3), 29 (2), 31 (1), and August 1 (1) and 22 (1), 1952. A further shock occurred on January 12, 1954. The epicentre of the first shock was at Wheeler Ridge, lat. 35° 00′ N., long. 119° 02′ W., and its magnitude was 7·6. The aftershocks, of lesser magnitude, were a little to the north and east of the first shock, in Kern County. The study includes sections on damage to structures, schools, dams, roads and bridges, and the earthquake effects on oil production and agriculture. Appendixes detail effects on particular buildings, such as Brock's

Department Store and Kern General Hospital. It is concluded that one- and two-story buildings, designed to resist earthquake forces, generally suffered no damage. No internal failures were found in wood diaphragms (straight or diagonally sheathed) or in steel diaphragms, although fastening details were deficient. Excessive deflexions of these diaphragms may have contributed to wall cracking, and contributed to failures along the diaphragm boundaries. The hazard to life of parapets on street fronts has been recognized. The use of competent technical help is necessary where earthquake resistance is desired; and if earthquake insurance is a factor, structures (in California) should be designed to meet the Pacific Fire Rating Bureau recommendations.

Scholarships for Personnel Management

An allocation to the Institute of Personnel Management from Counterpart Conditional Aid Funds has made it possible for the Institute to award a small number of scholarships designed to assist men and women, not less than twenty-four years of age, who are already in industry or commerce, to attend full-time courses of training in personnel management at one of the following: London School of Economics; College of Technology, Manchester; Glasgow and West of Scotland Commercial College and Royal Technical College (jointly); University College, Cardiff; and the University of Liverpool (post-graduate course in industrial sociology). The scholarships, which are tenable for one year, will amount to £300, with a dependants' allowance of £100 for a married candidate with one or more children and, in special circumstances, an additional grant not exceeding £50. Application forms, to be returned by January 31, can be obtained from the Secretary, Institute of Personnel Management, Management House, 8 Hill Street, London, W.1.

Geneva Laboratory of the Battelle Memorial Institute

On the occasion of the official opening on November 20 of a research laboratory in Geneva of the Battelle Memorial Institute, a symposium will be held on "The Influence of Scientific Research in the Modern World". The speakers at the symposium will be Prof. G. Colonnetti, president of the National Research Council of Italy; Prof. L. Jacqué, of the École Polytechnique, Paris; and M. Denis de Rougemont, director of the European Centre for Culture. A number of representatives of industry and finance in Belgium, France, Italy and Switzerland have been invited to participate at the symposium. On the same day the laboratory will be open for inspection. Further information can be obtained from the director of the laboratory at 7 Route de Drize, Genève-Carouge.

Precision Electrical Measurements: Symposium at Teddington

A symposium on precision electrical measurements will be held in the National Physical Laboratory, Teddington, during November 17–20, the last day being reserved for a visit to the Electricity Division of the Laboratory. The other days will be devoted to five sessions on the following topics (with the chairman shown in brackets): capacitance and dielectrics (Dr. L. Hartshorn); inductance and magnetics (Mr. B. G. Churcher); electrotechnics (Mr. R. S. J. Spilsbury); high-voltage measurements (Dr. L. G. Brazier); and high-voltage impulse-testing techniques (Mr. R. Davis). Further information can be obtained from the Director, National Physical Laboratory, Teddington, Middlesex.

Mineralogical Society: Officers and Council for 1954–55

The following have been elected officers and members of council for 1954–55 of the Mineralogical Society: *President*, Prof. L. Hawkes; *Vice-Presidents*, Dr. F. A. Bannister and Dr. F. Dixey; *Treasurer*, Prof. J. H. Taylor; *General Secretary*, Dr. G. F. Claringbull; *Foreign Secretary*, Dr. L. J. Spencer; *Editor of the Journal*, Dr. L. J. Spencer; *Ordinary Members of Council*, Mr. B. W. Anderson, Mr. S. H. U. Bowie, Mr. T. Deans, Prof. W. A. Deer, Prof. K. C. Dunham, Mr. P. M. Game, Dr. A. G. MacGregor, Dr. S. R. Nockolds, Dr. F. C. Phillips, Mr. L. A. A. Thomas, Dr. E. A. Vincent and Dr. M. K. Wells.

Italian Genetics Society

An Italian Genetics Society (Associazione Genetica Italiana) has been formed with the aim of uniting all Italian workers in genetics to further knowledge in this field. Officers for the current year are as follows: *President*, G. Montalenti; *Councillors*, C. Barigozzi, A. Buzzati-Traverso and A. Chiarugi; *Secretary-Treasurer*, G. Magni (Istituto di Genetica, Università di Pavia).

Announcements

The Duke of Edinburgh is to open officially the new laboratories of the Research Association of British Rubber Manufacturers at Shawbury, near Shrewsbury, on November 23.

The Franklin Medal of the Franklin Institute, Philadelphia, has been awarded to Dr. C. E. Kenneth Mees for his "contributions to knowledge of the photographic process and for his development of the first organized scientific laboratory in the United States which resulted in new products advancing the photographic process". The Medal is awarded annually "to those workers in physical science or technology, without regard to country, whose efforts . . . have done most to advance a knowledge of physical science or its applications".

The Royal Agricultural Society of England has decided to offer annually a medal together with an award of a hundred guineas for research work of outstanding merit carried out in the United Kingdom which has proved, or is likely to prove, of benefit to agriculture. The award will be known as the R.A.S.E. Research Medal. Heads of university departments, research stations and institutes, and other research establishments should submit to the secretary, Royal Agricultural Society of England, 16 Bedford Square, London, W.C.1, in January of each year, the name of any member of their staff they may wish to recommend for the award. No direct applications by candidates will be considered.

Reference was made in *Nature* of September 25 to the position in the United States of Dr. J. R. Oppenheimer. We are informed that copies of the relevant documents are available from H.M. Stationery Office (York House, Kingsway, London, W.C.2, and provincial depots); they are the "Transcript" of the evidence (price 23*s*. 6*d*.; by post, 24*s*. 9*d*.) and "Documents and Letters" (price 2*s*. 3*d*.; by post, 2*s*. 6*d*.).

LIBRARY ASSOCIATION

ANNUAL MEETING

IN his presidential address to the Library Association on September 28, Mr. C. B. Oldman, principal keeper in the Department of Printed Books, British Museum, considered three or four general questions relating to the keeping of books. Are libraries, as at present organized, doing all that they should to ensure the preservation of recorded knowledge, as well as facilitating its dissemination? Is the emphasis to-day too much on the supply of day-to-day requirements, including specialized information for the research worker? Is the general, comprehensive library already outmoded, or should there continue to be at least one library aiming, as (in theory, at any rate) the British Museum Library at present does, at acquiring everything and keeping everything that it acquires?

These are obviously questions bearing closely on the proposals for library reorganization that are implicit in the project for a Science Centre, and, although not limiting them specifically to science and technology, Mr. Oldman's remarks in the final section of his survey were concerned especially with the general research library, of which the British Museum is the acknowledged chief. Referring briefly to the functions of the specialist libraries, in stressing the importance of such libraries being able always to supply their users with the latest information, he perhaps overstressed the extent to which this permits such libraries to discard freely what was once important. Nevertheless, he correctly indicated the inadequacy of most such libraries for historical purposes, even in the field in which they specialize, and in pointing out that the term 'research' is often misapplied, for example, to hunting for information, he reminded his audience that science has no monopoly of research, if one defines research as original investigation involving the search for untapped or hitherto imperfectly appreciated sources and the drawing of new conclusions from what is found.

The discussion of the function of research libraries has so far not been very conclusive, and Mr. Oldman, in pointing out that what distinguishes the great research libraries is the large proportion of research material they contain, remarked that their strength derives from the extent as much as from the character or quality of their accumulations, and this is the root of the problem confronting them. If the great research libraries of the world continue to grow as they have in the past half-century, and if, while retaining all that has been already acquired, they are to endeavour to meet the new demands that are constantly being made upon them, with the multiplication of faculties and the springing up of new fields of study, they must face a prospect of infinite expansion, with all the problems of accommodation, staffing and finance involved. In the United States, in particular, they are beginning to wonder whether they will not be forced to call a halt. Mr. Fremont Ryder in 1944 estimated that, on an average, the American university library is doubling its stock every sixteen years, and in different degrees the same problem faces the whole group of general research libraries. So far as the British Museum is concerned, within a few years the present policy will lead to saturation point, and a new library on a new site will be required. Nevertheless, Mr. Oldman thought that completeness should remain the target and, when it is no longer possible to pursue the present policy, he suggested that it would be better to create separate subject libraries which will remain constituent parts of the one national library rather than to reduce current holdings or future intake. Such problems clearly demand close consideration in formulating plans for a national reference library for science and technology.

Several other papers presented at the conference were also of general interest to the scientific worker. Two papers read on September 30, for example, dealt with standards of service and the individual library and its place in the national system. In the first of these, Mr. J. H. Haiste, of Rugby, dealt with the question of standards and co-operation generally from the point of view of the library of the smallish authority, representing about a quarter of all library authorities in Great Britain. Mr. Haiste insisted that the service provided by such a library must be in harmony with the community it serves, but on the highest possible level for that community, and he thought that failure to adjust service to the conditions and needs of the community is mainly responsible for the failure of the library service in Britain to achieve its proper status. While fully recognizing the difficulties and disadvantages of the smaller library, Mr. Haiste thought that it should be less docile about its limitations: a cleaner, clearer scheme of co-operation would make for better standards of service, but the energy is derived from the individual libraries in each region able to do their own communal jobs first, and willing also to accept responsibility for providing on their own shelves a strong subject representation for the general benefit. He agreed with the Vollans's report that the most effective contribution the individual library can make to the success of library co-operation is to improve its own bookstock and its services to its own readers.

The second paper, by Mr. A. H. Chaplin, deputy keeper in the Department of Printed Books, British Museum, was concerned with the place and function of the British Museum. Describing the position of fundamental importance which the Museum occupies in building up a comprehensive national stock of books and the way in which the policy already indicated by Mr. Oldman is implemented, Mr. Chaplin, before he went on to consider the important contribution made by the Museum to the complete national bibliography, noted some classes of printed matter of potential historical interest which, although technically 'published', often failed to reach the Museum. There is, however, also need for a centre for co-operative work in supplementing the information contained in the original "Short Title Catalogue" of English books printed down to 1640, in Wing's list of English books published between 1640 and 1700 and in such lists as the "English Catalogue", relating to the nineteenth and twentieth centuries. Mr. Chaplin believes that the resources of the Museum and of a number of other important libraries could be both more economically and more effectively used if there were close co-ordination between them in their purchases of foreign books. The British Museum does not to-day attempt to cover systematically certain kinds of foreign publications, particularly scientific and technical literature, but there is no certainty that the publications not taken by the British Museum will be found in some other British library, still less that, if acquired, they will be preserved. He suggested that the consultation and co-operation in this field already begun between the British Museum and other government libraries should be extended to the various national and university libraries and put on a systematic basis. Each library, while continuing to acquire the publications likely to be called for by its own readers, would undertake responsibility for acquiring, in particular fields to be allotted to it, the publications which, because of their obscurity or very restricted interest, are at present neglected. The British Museum, apart from developing more thoroughly its collections in the fields where it is already particularly strong, would acquire the books to which no one else is prepared to give house-room and would store those which every other library would prefer to discard. A natural corollary of such a system of co-ordination would be the making of a union catalogue of all the books to which it applies, giving at least one location for each book. In conclusion, Mr. Chaplin indicated the willingness of the Museum authorities, as part of any such projects, to make, after wide consultation, such changes in Museum practices as would bring them into harmony with the majority of co-operating libraries and remove present obstructions. Any such scheme, however, would require greatly increased resources in staff, in money and in buildings, and they will only be forthcoming if these demands are presented to Parliament backed effectively by influential opinion.

The place of the non-public library in the library system was considered by Mr. E. A. Baker, librarian in the Ministry of Food, in a paper also read on September 30. Stressing the need for greater co-operation between all types of libraries, Mr. Baker suggested that each public library participating in one of the subject specialization schemes recently set up in some of the regional bureaux should be able to look to a specialist library in its particular field for assistance in book selection and bibliographical information. He also suggested that the time has come for a thorough investigation into the constitution and organization of the Library Association with special reference to the representation of the non-public libraries.

Mr. W. B. Paton's paper on "Standards of Library Staff: Recruitment and Training", read on September 29, stressed the dependence for success of a library service on the quality of its staff. The general education of librarians should, he maintained, reach the standard at present demanded by the Library Association from examination candidates, and for preference should surpass it. This could be possible if the same rigid standards were not applied to the non-professional categories whose service is likely to be temporary. He also thought the division of staffs into professional and non-professional categories should become the declared policy of the Library Association as soon as possible, that university graduates should be welcomed as recruits to the library service and that in time this would be a normal standard of entrance. He urged that the time has come for the Library Association to reconsider its examination syllabus to relate it more closely to the needs of special libraries. He also suggested that the conduct of the examinations should be integrated with the activities of the schools of librarianship. The number of these schools should be reduced, but the qualifications of their teaching staffs should be raised and opportunity sought to link the schools with universities. A personal interpretation of the office of librarian, given by Mr. F. Raymond Smith, librarian of the Guildhall, on September 28, also stressed the importance of the professional ideal and discussed the closer adjustment of professional training to the needs of special libraries, and the related issues of the common structure and functions of both special and municipal libraries and librarians. On October 1, Mr. Bengt Hjelmqvist, head of the Library Board in Sweden, described the operation of public libraries in Sweden under fifty years of State aid.

FIFTH INTERNATIONAL SPECTROSCOPY COLLOQUIUM

THE fifth International Spectroscopy Colloquium, organized by Prof. F. X. Mayer, chairman of the Spectrochemistry and Colorimetry Group of the Austrian Society of Chemists, was held at Gmunden, Salzkammergut, Upper Austria, during August 30–September 3. More than five hundred members attended, representing twenty-three countries, and the importance to practical spectroscopy of these international gatherings is shown by the significant increase in the number of participants on each successive occasion. Two days were allotted to each of the principal sections—emission spectroscopy and molecular spectroscopy—with a mid-week excursion to the Nitrogen Works and Steel Works at Linz. The meetings were held at the Town Theatre, while a one-day symposium on direct-reading spectroscopy was held concurrently at the Kurhotel.

Emission spectroscopy. Three papers dealt with the analysis of silicates and silicate rocks and similar materials, for which various types of arc excitation are used. Progress in the detection of sulphur and halogens by high-current, low-voltage, short-duration spark discharges was reported, followed by studies of arcs and sparks in different atmospheres, highly reproducible 'sparking-off' phenomena and the stroboscopic examination of controlled sparks. A new atomizer using electrostatic spraying for flame analysis was described, and the use of amyl alcohol has been found to give a three-fold increase in accuracy and sensitivity in detecting calcium and magnesium.

Further studies of the Standard Paper Density Scale were discussed; improved results have been obtained with scale lines having a profile similar to that of spectrum lines. In determining the absolute error of photometric measurements, the use of polarization prisms is least open to objection, provided that the prisms are in perfect condition. Other subjects included errors in the 'method of additions', calibration with the rotating step-sector and devices for producing linear calibration graphs. Advances in equipment concerned microphotometers (one incorporating a recording electro-dynamic oscillograph, and the other an electric comptometer with a printing device), stigmatic grating spectrographs, and a plane grating in convergent light for the study of hyperfine structure and isotope shifts.

Direct-reading spectroscopy. A new universal quantometer and two British designs of the polychromator type (a grating instrument and an attachment to a quartz instrument) were described. Other papers dealt with the analysis of aluminium alloys and steels, the use of the reflected image as an internal standard and a systematic study of iron + nickel + 1 per cent chromium and iron + cobalt + 1 per cent chromium alloys.

Molecular spectroscopy. Analytical applications of emission and absorption spectra in the vacuum ultra-violet were reviewed; photo-ionization of oxygen and other gases was reported in this region of the spectrum, and cross-sections have been calculated from intensity measurements. Other contributions dealt with the structure and composition of siliceous materials, the estimation of the insecticide parathion and the identification of components of fats and metal soaps.

A method of correcting ultra-violet spectra of macromolecules (proteins) for Tyndall or Rayleigh scattering was described. Changes of spectra with *p*H have been assigned to ionization of phenolic groups of tyrosin in albuminoids. The results given on double bonds in relation to the dependence of Raman line intensities on excitation frequency are not in accord with Placzek's theory. Vibration-rotation bands of O_2, CN, CH and CO in infra-red flame spectra and determinations of flame temperatures were discussed. Microwave data on deuterated derivatives indicate the exact structure of the pyridine molecule, and the effect of solvent and hydrogen bonding on the dipole moment of pyrrole is related to shifts in the NH frequency. Work on hydrogen bonding, particularly water in silica gels, was reviewed. It is concluded from infra-red studies of structure and intermolecular interactions of the amide group that dipole–dipole interaction rather than hydrogen bonding is the controlling factor in polyamide and polypeptide structures. Many overtone and combination bands have been identified in near infra-red spectra of polypeptides and proteins, using polarized radiation. Studies of the spectra of amorphous and crystalline celluloses, using the hydrogen–deuterium exchange, were reported, and the ultra-violet absorption of cellulose xanthogenate has been analysed by analogy with simpler organo-xanthates.

New designs of spectrophotometers and a partly mechanical, partly electronic, 'memory system' for converting a single-beam spectrometer to give percentage absorption traces were described. A punched-card system of documentation was demonstrated, and the 1954 Ohio State meeting was reviewed. In addition, three papers were presented on X-ray fluorescence spectroscopy.

The innovation of holding pre-arranged evening discussions proved successful, and it is hoped to extend this feature on future occasions. The four topics selected were: experiences with methods not requiring standards for comparison, using different techniques; the evaluation of spectrograms (in this discussion the desirability of international standardization of symbols, definitions and analytical methods was stressed and referred for action at the next Colloquium); a comparison of relative sensitivities of the eye, the photographic emulsion and electrical radiation receivers, in spectrophotometric work; and the equipment and technique of Raman spectroscopy—its analytical possibilities and scope in comparison with infra-red methods.

A somewhat fuller summary of the proceedings of the Colloquium, giving the authors and brief notes on the papers presented, is being published in a "Spectroscopic Conferences Supplement" to the forthcoming December issue (No. 14) of the *British Bulletin of Spectroscopy*. A complete record of the papers and discussions will be published in a special volume of *Microchimica Acta* (Springer-Verlag, Vienna) in 1955. Proposals for the Sixth Colloquium were discussed at a committee meeting attended by delegates from fourteen countries. Possible broadening of the scope to include the physics of spectra, with joint or consecutive meetings with other bodies, was considered. However, it was decided to continue the organization on lines similar to those of previous occasions, but with more emphasis on prearranged discussions on selected topics. It was finally agreed that the next Colloquium should be held in Holland in the autumn of 1956.

D. M. SMITH

APPLIED RESEARCH IN TECHNICAL COLLEGES

A SPECIAL committee of the London and Home Counties Regional Advisory Council for Higher Technological Education has issued a report on applied research in technical colleges*, based on information supplied by seventeen out of the twenty-five colleges in the region approached by the committee. The Council is satisfied that the report covers substantially all the published research undertaken in technical colleges in the region during 1947–52, and some 330 original contributions to scientific or technological knowledge are listed in an appendix, the great majority being in physical, inorganic and, especially, organic chemistry. There is also some bias towards biology; but the Council comments that relatively few of the published researches in organic chemistry appear to have been undertaken in direct co-operation with industry.

An appended list of research projects undertaken at the direct request of industry indicates that technical colleges have helped and are helping in the investigation of engineering problems in circumstances in which no question of publication arises, and a further appendix gives examples of co-operation between technical colleges, research organizations and government departments, including the Department of Scientific and Industrial Research. The Council considers, however, that there is room for a considerable increase in the amount of work done in consultation with industry or for industry's direct benefit, and supports the view that one important function of technical colleges is to train research technologists for industry (especially, perhaps, for the engineering industry) and that fundamental research provides an admirable training in research methods. It suggests that here the technical colleges could be of particular assistance to the small firm, and that the investigations now in progress by part-time students, possibly working for a master's or a doctor's degree, represent a fruitful line of co-operation by which the resources of the colleges may, by agreement, be used by an individual nominated by a firm to conduct a relatively long-term investigation in which the firm is interested. An appendix to the report shows that during the period four doctorates in science, 105 Ph.D.s and 104 M.Sc. degrees of the University of London were awarded for research carried out in the technical colleges of the region.

* Applied Research in Technical Colleges. Pp. 44. (Publication No. 18.) (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1954.) 2s. 6d.

Since January 1950, about two dozen posts of research assistant or demonstrator have been approved in London and the home counties. Most of these have now been filled, and at about a dozen colleges research by staff and advanced students is accepted as a normal part of the curriculum. At other colleges, research by members of the staff is recorded and the report emphasizes that staff of the calibre required will never be attracted unless some opportunity for original research is provided. The close contact of the staff with neighbouring firms should avoid any difficulty in suggesting lines of investigation likely to be of service to local firms, nor should members of the staff necessarily be required to carry out such research on the college premises.

The evidence shows that departments of chemistry have usually found it easier to provide facilities for research than have departments of engineering, and that the principal obstacle to the further development of industrial research in many technical colleges, even the largest, is lack of laboratory space. This position is attributed partly to the simpler apparatus and less space required in chemical research than in engineering research, and partly also to the absence of sufficient workshop staff; and the Council recommends that the needs of the engineering industry should be kept in mind in allocating research demonstratorships. It also urges authorities to press forward especially with extension plans for those departments in which the standard of work shows that more research could be undertaken successfully in co-operation with industry. Commenting on the circumstances in which staff should be given relief from teaching duties, the Council sees no objection to lecturers undertaking consulting work, and would support *ad hoc* investigations in colleges by members of the staff which are not of the kind that normally lead to publication; it also stresses the importance of personal relations between the colleges and industry.

THE AMERICAN PHYSICAL SOCIETY

REPORT FOR 1953

THE 1954 annual meeting of the American Physical Society was held at Columbia University, New York City, during January 28–30, and the twenty-third annual meeting of the American Association of Physics Teachers was held simultaneously at Columbia University, Barnard College, and the City College of New York. At the joint ceremonial session of the two bodies on January 29, the retiring presidential address of the American Physical Society was delivered by Prof. E. Fermi, of the University of Chicago, who spoke on "What can we Learn with High-energy Accelerators?" The 1953 Oersted Medal of the American Association of Physics Teachers was presented to Prof. C. N. Wall, of the University of Minnesota (*Amer. J. Phys.*, **22**, 363; 1954). The twelfth Richtmyer Memorial Lecture was delivered by Prof. J. A. Wheeler, of Princeton University, who took as his subject "Fields and Particles". At the joint banquet which followed, the after-dinner speakers were Prof. Grayson Kirk, president of Columbia University, who discussed the position of physics in the social structure, Prof. Leon Brillouin, of International Business Machines Corporation, who spoke of Prof. H. A. Lorentz, and Prof. S. A. Korff, of New York University, who referred to the International Geophysical Year and recounted some of his experiences in a high-altitude laboratory in northern Alaska. The second O. E. Buckley Solid-State Physics Prize was presented to Dr. J. Bardeen, of the University of Illinois, for his outstanding contributions to semiconductor research.

At the business meeting of the Society it was reported that the total membership had reached 11,200, the financial position was satisfactory and that the *Physical Review* continued to expand. The following were elected to hold office for 1954: *President*, H. A. Bethe; *Vice-President*, R. T. Birge; *Secretary*, K. K. Darrow; and *Treasurer*, G. B. Pegram. The annual meeting was again a very large one, with a registration of 2,100 and with more than three hundred contributed papers. Columbia University, which has been host to the Society on many occasions during the past fifty years and in particular for eleven of the past twelve annual meetings, has now reluctantly admitted that such a large convention involves too great a burden, and accordingly it has been agreed to hold the 1955 annual meeting in hotels in the vicinity of Pennsylvania Station, New York City. As a valedictory to Columbia University and as a tribute, which was made doubly fitting by the fact that 1954 is the bicentennial year of the University, a special session of the annual meeting was devoted to a survey of the University's association with physics and with the American Physical Society. This consisted of four addresses and the presentation of a plaque, to be affixed to a wall in the Pupin Physics Laboratories, commemorating the Society's inaugural meeting on May 20, 1899, at Columbia University. Prof. G. B. Pegram reviewed the early years in the history of physics at the University, Prof. E. Fermi the genesis of the nuclear-energy project, Prof. I. I. Rabi the more recent years, and Dr. K. K. Darrow, the Society's secretary, discussed the link between the Society and the University.

The scientific programme of the Physical Society meeting, details of which together with abstracts of the contributed papers are given in the minutes of the meeting (*Phys. Rev.*, **94**, 742; 1954), included a joint session of the Division of Fluid Dynamics and the Institute of the Aeronautical Sciences, at which four papers dealing with high-speed flow phenomena were read; four symposia; a group of four papers in which plans for accelerators of the future, including the designs of the 25-BeV. proton synchrotron for CERN and a 15-BeV. accelerator, were discussed by E. D. Courant, J. P. Blewett, M. S. Livingston and H. G. White; and nineteen invited papers. At the Brookhaven–Nevis symposium the subjects of discussion were the use of the cosmotron as a research tool and the interpretation of high-energy experiments; at the symposium of the Division of Fluid Dynamics there were four papers dealing with aspects of shock waves in liquids and solids; at the symposium of the Division of Electron Physics the conduction mechanism, interface compound formation and noise mechanisms in oxide-coated cathodes together with a review of electronic processes in barium oxide crystals were considered; and at the separate symposium devoted to the subject of nuclear size and density of distribution four different methods of determination were described. Of the invited papers, two, by members of the Bell Telephone Laboratories, dealt with the theory of secondary electrons; two, including a discussion by J. R. Zacharias of precision measurements, with molecular beams; two with the neutrino; three, "Microwave Resonance in Colour Centres", by E. E. Schneider, of the University of Durham, "Polarization of Nuclei in Metals by Magnetic Resonance", by A. W. Overhauser, and "The Solid-State Cyclotron", by C. Kittel, with magnetic resonance; and two with cryogenics. In addition, P. W. Bridgman spoke of the effects of pressure on twelve rare-earth metals, W. A. Pomerantz on cosmic radiation at very high altitudes near the geomagnetic equator, and E. W. Corson on the properties of new V-particles.

The programme of the meeting of the American Association of Physics Teachers (*Amer. J. Phys.*, **22**, 426; 1954) consisted of two panel and one round-table discussions, three invited papers, twenty-seven contributed papers, a film session and a business meeting in addition to the joint sessions with the Physical Society. C. N. Hoyler, of the Radio Corporation of America, gave a demonstration of colour television in which recent developments of the R.C.A. were described and illustrated. In the panel discussion on "Research Subsidies and College Teaching", various problems involved in combining teaching and research were considered; and in the session devoted to a discussion of the functions and mission of the Association, H. K. Schilling reviewed the history of the Association and T. H. Osgood, editor of the *American Journal of Physics*, spoke on "What goes into the Journal". At the business meeting of the Association on January 30, it was agreed to confer honorary membership on D. Bronk, former president of Johns Hopkins University, president of the National Research Council and head of the Rockefeller Institute for Medical Research; and for noteworthy service to the Association T. D. Cope, P. Kirkpatrick, C. J. Overbeck and M. H. Trytten were voted special citations. The need for increased income to cover current expenses was emphasized and a change in the by-laws was approved to permit the increase of subscriptions to a maximum of eight dollars per annum. The following were elected to hold office for 1954: *President*, P. M. Marsh; *President-elect*, R. R. Palmer; *Treasurer*, F. W. Sears; and *Secretary*, R. F. Paton.

BREEDING FOR BEEF IN TROPICAL AND SUB-TROPICAL CLIMATES

CLIMATE, and temperature in particular, is directly concerned with the success or failure of animal production in tropical and sub-tropical territories. It has been established in various parts of the world that wide variations exist between different breeds and types of farm animals in their ability to adapt themselves to the climatic conditions peculiar to a particular environment. Because of their low powers of adaptability, the introduction of European breeds has failed in most tropical territories, and this has focused the attention of research workers on the wide range of ecological problems confronting the livestock industry in those parts of the world (D. M. Joubert, *Colonial Plant and Animal Products*, **4**, No. 1; 1954).

In the breeding of livestock for tropical and sub-tropical environments, it is important to pay attention to the conformational features and breed characteristics which promote adaptability. First, for maximum radiation to be possible, the animal must possess a large skin area. It is a noticeable feature of cattle native to tropical regions that they have a well-developed dewlap which extends down to the navel, together with easily extensible skin folds which are especially numerous in the neck and thoracic regions. These characters are illustrated in the Afrikaner bull and cow, a tropical breed indigenous to South Africa and belonging to the lateral-horned zebu group. In the zebu cattle of India the ears, too, are considerably larger than those of *Bos taurus* (European) cattle.

Hair covering, which includes the thickness of the coat and structure of the hair fibre, is of equal importance in heat regulation. The critical temperature of smooth-coated cattle lies several degrees below that of woolly-coated individuals. In recent investigations, Bonsma and his associates have showed that, with the progeny of a mutant woolly-coated Afrikaner bull, tropical degeneration is possible also in the native stock should they lack any of the essential attributes which promote adaptability.

Earlier studies showed that a light-coloured coat is superior to black in the dry tropics. White or cream-coloured individuals do even better than reds provided that the hide is protected by pigmentation. Colour is regarded as playing a part in heat regulation by influencing the amount of sunlight that is reflected from the skin. Dark colours presumably tend to increase the heat load of the animal. Measurements of the reflexion of light from various coat colours indicate that the coat of white Afrikaners absorbs about 45 per cent of the solar radiation impinging upon it, as against 89 per cent in the case of the black hairy coat of Aberdeen-Angus cattle, 78 per cent of red Afrikaners, 93 per cent of red Sussex cattle and 50 per cent of cream-coloured Simmenthalers.

The effect of a tropical environment on the conformation of an unadapted beast is shown by comparing an unadapted woolly-coated Shorthorn cow with a normal individual of similar breeding and age. Whereas the beef Shorthorn is normally a digestive type—that is, relatively round in cross-section and equally deep through both chest and belly—the exotic animal in tropical environments tends to develop into a respiratory type. This may be explained by the fact that the Shorthorn has a limited skin area and also a woolly coat, both lowering its capacity of heat loss. The burden of thermolysis thus falls almost entirely on the water-evaporating capacity of the lungs, and the obvious conformational change to take place is an increased lateral depth of chest, flattening of ribs and a contracted belly.

Joubert has also considered the effects of the nutritional environment on cattle in tropical countries. In regions with fluctuations in the nutritive value of the natural pastures, as well as with high summer temperatures, the problem of adapting the exotic beast is complicated. As the body temperature increases during the hot months, metabolism is stepped up, the time spent in grazing is reduced and that of lying in the shade increased. In short, the animal suffers from a constant fever or hyperthermia. If the grazing is exceptionally poor, it is quite impossible for the leeway to be made up during the period of the year when temperate cattle are not affected by the climatic conditions. In the case of the animal surviving, it virtually exists in a state of chronic undernourishment.

Although animal breeding still presents many problems, both genetical and physiological, the knowledge gained from scientific approaches to the subject during the past three decades has made it considerably more exact and practicable. Scientific investigations provide the evidence to prove that the high-grade European breeds of cattle, which are the result of selection for maximum performance under temperate climatic conditions, do not maintain the same qualities when transferred beyond the borders of their natural habitat or of regions with approximately similar conditions. Hence, improvement of animal production by merely replacing the cattle native to tropical and sub-tropical regions with highly improved breeds of temperate origin is out of the question.

The genetical variation occurring within the exotic breeds makes possible the selection of individuals possessing those attributes required for increased adaptability to tropical conditions. By basing their selection on such characters as coat covering and colour, Bonsma and his associates have achieved considerable success in increasing the heat tolerance of British beef breeds, especially Herefords, at the Mara Research Station, which is situated in the dry-tropical zone of South Africa. The limit of such a policy is indicated, however, by the fact that when these investigations were repeated at the Messina Experimental Farm, situated in a lower-lying tropical belt, they met with complete failure. The high mortality-rate of the British beef breeds in the tropics, compared with the indigenous stock, also seriously limits the value of breeding adapted strains of European cattle.

Cross-breeding between the indigenous stock and exotic types presents a second possibility. During the early stages of livestock improvement in tropical regions, a policy of grading up with European breed bulls was advocated. The first generation cross-breds excelled because of hybrid vigour and the genetical dominance of heat-tolerant characters; as the percentage of indigenous blood diminished in subsequent generations, the cross-breds also deteriorated.

The most constructive and successful of all long-term policies for livestock breeding in tropical and sub-tropical regions seems to lie in improvement of the indigenous stock by means of judicious selection. The high standard of animal production of temperate countries can never be attained in tropical regions, while the indigenous stock of the tropics are inherently of lower productivity than their cousins of the temperate zone. Nevertheless, in the Afrikaner, it has been demonstrated that improvement of beef qualities is possible without any loss of those characters which give the breed superiority over exotic types in the tropics and sub-tropics. As for its slower growth and maturing characters, these actually are inherent qualities of practical significance and value in the production of beef under varying conditions of climate, and especially nutrition. As a result of a slower growth-rate, the influence of periodic nutritional depressions is not so acute as is the case with the rapidly growing, early-maturing breeds of beef cattle.

LIBRARY CO-OPERATION IN BRITAIN

THE final recommendations on Library Co-operation of the Joint Working Party set up by the National Central Library and the National Committee on Regional Library Co-operation have now been issued in the name of the Library and the National Committee*. The working party was satisfied that the general structure of library co-operation and inter-lending is sound, and recommended that university and special libraries outside the area covered by the London Union Catalogue and the South Eastern Region should become participant members of their appropriate regional system on the basis on which many of them at present co-operate, and that they should also retain the existing right to send applications direct to the National Central Library. Within this area, however, it recommends that, as at present, university libraries should apply direct to the National Central Library for inter-library loans, but special libraries should have direct relations with the Central Library; and that membership of the London and South Eastern Regional Library systems should remain restricted to the public library authorities within the area.

The working party is also satisfied that the Union Catalogue is necessary for effective inter-lending, and recommends that the existing Union Catalogue should be brought up to date. The Yorkshire, North Western and West Midland Regions should consider how best they may provide Union Catalogues of stock prior to a specified date, which would be adequate for regional and national purposes, and from that date all regional union catalogues should contain entries for British books, and for all other books published outside Great Britain, and those published in Great Britain prior to the specified date. The working party also recommends that each region should consider what co-operative arrangements could be made to ensure that all applications to the bureaux for current British material are supplied from resources within the region, and to ensure that at least one copy of every non-fiction book in the region is retained permanently in that region. Each region should also investigate the methods by which the range of periodicals can be improved and their permanent preservation ensured.

The working party recommends the exclusion from the scope of all inter-lending agencies of: (*a*) those works of English and American fiction outside the scope of the joint fiction reserves to be set up in the various regions; (*b*) sets of copies of plays for acting and reading outside the scope of any joint play collections to be set up in the regions; (*c*) children's books; (*d*) 'quick reference' books (that is, dictionaries, atlases, encyclopædias, etc., likely to be regularly consulted in a library); (*e*) current year-books, annuals and directories; (*f*) current numbers of periodicals.

It also suggests that all books in print costing 25*s*. or less should be outside the scope of the National Central Library.

The working party considers that any long-term plans for bringing these regional bureaux to a state of greater efficiency and maintaining them adequately should attract a grant from H.M. Treasury. It is indicated that the National Central Library proposes to institute, in consultation with the National Institute of Adult Education and the other bodies concerned, an inquiry into the present provision of books for adult education classes, with the view of considering how far the type and the extent of the services require modification.

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* Recommendations on Library Co-operation. Pp. 8. (London: National Central Library and National Committee on Regional Library Co-operation, 1954.)

THE FILM AND THE SOCIAL SCIENCES

ALTHOUGH film processes are being increasingly used for research in the physical and biological sciences, little attention is paid to the cinema as a medium for investigating, teaching and propagating new knowledge in the social sciences (*Science and Film*, 3, No. 2; June 1954). This may perhaps arise from an old-fashioned but not entirely played-out attitude of disdain for the place to be given, within the hierarchy of knowledge, to the study of human relations and human behaviour. An over-narrow view of the film-medium itself may also at times colour our outlook on its applications to science. The camera has, of course, special qualities for the observation of time and of mechanical movement, and the roles it can fulfil in the 'exact' sciences are obvious. But its usefulness does not end there.

The camera as an instrument of research in the social sciences has so far been little developed. Even for investigating manipulative processes, of such demonstrable value to the study of workshop skills and of industrial conditions generally, its use still remains the exception rather than the rule. For more subtle and less tractable problems of human behaviour, its use has been even less explored. Two recent examples of the use of the camera in psychological inquiry—of maternal separation and of the reactions of children to the cinema—illustrate well some of the possibilities. A rather similar, though brief, use of the motion-picture camera occurred in "Children Learning by Experience", itself a remarkable 'anthology' of children's behaviour as an aid in the training of teachers. Less normal phenomena form the subject of a pioneer Canadian series of filmed case-histories for the use of psychopathologists. Here the camera records permanently, unobtrusively and 'objectively'. To take another branch of the social sciences, no subject offers perhaps so wide a scope for the film record as does anthropology. Among many instances, Dr. Mountford's "Tjurunga" and his other films of the Australian stone-age men reflect the interest, not only scientific but also sometimes æsthetic, of such visual reports. Indeed, the trained cinematographer might well be considered an indispensable member of all field-teams engaged in anthropological or ethnological studies.

The dramatic qualities of the film medium are also available to the social scientist for explaining his purposes and methods to the general public. The cinema can illumine, too, the social relations of science; and this is perhaps one of the most important of its functions. There is need for films which will explain to the man in the street what science is, how scientists think and work, and the limits and freedoms affecting their activities. To this task the cinema as an art can bring special qualities of imagination and human warmth.

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1953

THE thirty-fourth annual report of the Research Council of Alberta, to which are appended lists of committees, staff and publications, covers the calendar year 1953* and emphasizes a shift in emphasis in coal research towards the exploration of the chemical potentialities of coal. Besides this a palæobotanical study was made of the flora and biological origin of Alberta coal measures, as well as investigations into the chemical and colloidal structure of coals. The vertical electric tube furnace for the determination of volatile matter in coal, built in 1929, was redesigned and a 14-in. rotating, self-clearing grate and ancillary control and recording equipment, installed in 1952, was used to complete an evaluation of the combustion characteristics of typical Alberta coals; a study of water retention by coal was also completed. Investigation of the trace metals in oil-sands oil and other Alberta oils suggests that occurrence of vanadium and nickel may serve as a precise correlative for crude oils and that cretaceous oils in general have a common origin. Attention is being directed to the origin of the trace-metal carriers, the porphyrins, and studies are proceeding on the properties of the heavy oils of Alberta and the viscosity of dispersions of wet oil containing mineral matter. The survey of the quality of Alberta gasoline continued, further tests were made on the storage of aviation gasoline, and work also continued on the partial oxidation of butane, in which a new reaction system was designed and built, and on the production of carbon black in a tubular furnace.

Field work by the Geological Section included detailed studies of selected areas for uranium in north-eastern Alberta, along the north shore of Lake Athabasca, and in the north-central portion of the Pre-Cambrian outcrop area in Alberta and especially north of Fidler Point and Leggo Lake, as well as a Pleistocene study in east-central Alberta. A fundamental mineralogical investigation of montmorillonite, the chief constituent of bentonite, in which forty samples of montmorillonite were subjected to X-ray and differential thermal analysis, indicates that every montmorillonite is a complex and intimate mixture. Further work under the Highway Research Project indicates that the dispersing and other properties of lignosol are important factors, as well as the viscosity effects, in preventing the migration of soil moisture to the frost line, and that sodium hexametaphosphate is equally effective in preventing frost action. Soil surveys were concentrated largely in the Peace River area, and a reconnaissance survey of the Grande Prairie sheet completed the field work on some 750,000 acres. Irrigation research was commenced on the solonetzic soils of the projected Red Deer irrigation area to determine the response to irrigation of various methods of treatment.

In the Industrial Projects Section research and testing for industry are of increasing importance. The ten-year biological cycle now appears to have reached the collapse predicted, and various publications on these extensive investigations are now being prepared. Two other investigations in animal science related to the effect of 'management factors' on the percentage hatch of turkey eggs and to the nutritive value of varying types of grass silage. A committee was appointed to study the fluoridization of municipal water-supplies. Routine measurements of solar ultra-violet radiation continued.

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* Thirty-fourth Annual Report of the Research Council of Alberta, 1953. Pp. 41. (Edmonton: Queen's Printer, 1954.)

FREE NERVE ENDINGS AS TRANSDUCERS OF THERMAL STIMULI

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RECENT evidence suggests that the encapsulated nerve endings postulated by von Frey to subserve specifically the sensations of warmth and cold (Ruffini corpuscles and Krause end bulbs, respectively) are not related to thermal sensibility, for, among other things, thermal sensations are as easily evoked from regions devoid of them as from regions where such encapsulated endings occur[1-3]. Moreover, it has now been shown[4] that thermal sensations can be aroused from the cornea, a tissue devoid of blood vessels and innervated solely by nerves the terminals of which are unencapsulated (free). In normal hairy skin, which is not being subjected to deformation, there is evidence which suggests that free nerve endings do not give rise to propagated action potentials under isothermal conditions; they only discharge when thermal gradients occur in the skin in which they lie[5]. In support of this, Hodgkin and Katz[6] have shown that under isothermal conditions the resting potential of the giant squid axon is practically constant (the mean value being 47 mV.) between −1° C. and 20° C. It is also known[7,8] that a burst of propagated action potentials is evoked when a nerve trunk is heated or cooled relative to an adjacent region.

The mechanism by which a free nerve ending gives rise to a propagated disturbance when conditions are not isothermal has been compared[9] to the principle upon which a thermopile type of bolometer gives rise to an electromotive force. This analogy, though useful, must eventually be capable of expression in terms of the ionic hypothesis if the mechanism postulated is to be validated. What follows is an attempt to explain the discharge of propagated disturbances by free nerve endings under non-isothermal conditions.

A difference in temperature between the two junctions in a metallic thermocouple gives rise to a thermo-electric potential. This has two components: (1) due to the difference in potentials at the two metal–metal interfaces (Peltier e.m.f.), and (2) due to the difference in potentials in the two homogeneous metal conductors due to the temperature gradient (Thomson e.m.f.). Depending upon the metals used, the Peltier e.m.f. is ten to a hundred times greater in magnitude than the Thomson e.m.f. The free nerve terminals are less than 1 micron in diameter. Since the light microscope cannot resolve boundaries in objects so small, it is not known whether an axoplasmic filament is in fact a homogeneous medium in equilibrium with the extracellular fluid or whether it is a miniature of the axon with two interfaces, for example, extracellular fluid/membrane/axoplasm[9]. It is likely that the effects which are postulated below will occur in either case, but for the sake of brevity it is assumed that the nerve terminal can be regarded as a medium in which ions are adsorbed in equilibrium with extracellular fluid containing free ions. A phase boundary potential will exist at the interface, and if a portion of the interface is heated or cooled with reference to another portion, a potential difference consisting of the following components will be set up in the system:

(1) The difference in the interface potentials at the two temperatures. This is analogous to the Peltier e.m.f.

(2) The thermal diffusion potentials in the extracellular fluid and in the nerve terminal due to the temperature gradient. This is analogous to the Thomson e.m.f.

The effect of the thermal diffusion potential in the extracellular fluid can be estimated approximately, since the initial thermal diffusion potential in solution before the Soret equilibrium is established is given by:

$$-\sum_{i} \frac{t_i Q^*_i}{z_i F T},$$

where t_i, z_i and Q^*_i are the transference number, valency and heat of transfer respectively of the ith ion and the summation is taken over all ions in the solution[10]. For extracellular fluid in the giant squid axon this potential may be calculated (on the assumption that all ionic heats of transfer are equal to 1 kilocal./mol.) to be about 40 microvolts per degree. This e.m.f. would not be enough to cause the discharge of a giant squid axon. It is known that the capacity of a nerve membrane[11] is of the order of 1 microfarad. cm.$^{-2}$. A change of potential of 1 mV. across such a capacity requires a charge transfer of 10^{-9} coulomb cm.$^{-2}$, or approximately 10^{-14} gm. equivalents cm.$^{-2}$ of a univalent ion. This is a small fraction of the amount of any diffusible ion transferred per second across the membrane (10^{-10} to 10^{-12} gm. equivalents cm.$^{-2}$, ref. 12). Clearly a local potential change of a magnitude greater than a thermal diffusion potential in a homogeneous phase would be produced across the membrane if the diffusion-rate of any one ion was affected, even to a relatively small degree, by a change in temperature. In this connexion, it is of great interest to note that Hodgkin and Keynes have recently observed that the activity of the 'sodium pump' in extruding sodium ions from the surface of the membrane of the giant squid axon has a high temperature coefficient[13]. It is therefore not unreasonable to assume that for a free nerve terminal in contact with extracellular fluid, the major contribution to the thermal e.m.f. would also arise at the interface between the phases. In this case there would be an exact analogy with a metallic thermocouple, the electrons of the latter being replaced by ions common to both phases. The existence of such a thermopotential would provide a stimulus to nerve terminals identical with that provided by the passage of a d.c. current across the nerve[14]. The sign of the potential will depend upon whether the tip of the fibre is heated or cooled with respect to the parent axon. The local ionic currents will change in direction accordingly; however, in either event, the nerve may discharge, being 'triggered' either at the tip of the fibre or near the stem axon. There is no need, therefore, to postulate different mechanisms to account for the response of free nerve endings to 'warm' and 'cold' stimuli. The spontaneous activity of end-organs in the ampullæ of Lorenzini[15] and the spontaneous activity of thermal receptors in the tongue of the cat[16] are explicable on the basis of non-isothermal conditions across the nerve terminals involved.

An attempt to measure this effect was made by Bernhard and Granit[7]. They neglected, however, to ensure that both their test electrodes were at the same temperature. Hence, the measured potentials included the variation in potential of the electrode system with temperature. This phenomenon is well known[17-19]. Experiments have shown that the temperature coefficient of the e.m.f. of the cell,

$$\underset{T}{\text{Ag—AgCl}} \mid 0{\cdot}9\%\ \text{NaCl} \mid \underset{T + \Delta T}{\text{Ag—AgCl}},$$

is 400 microvolts per degree (heated electrode positive), which is comparable with the value obtained by Bernhard and Granit in their system, which included a nerve fibre.

Any experiment to detect thermo-electric potentials in nerve must be so arranged as to exclude this electrode effect by keeping the electrodes at the same temperature. In any such experiment it is impossible to avoid thermal diffusion potentials in the salt bridges or other devices used, but these effects are certainly much smaller than potential changes at the electrodes if they are not kept at the same temperature. [Aug. 14.

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BIOLOGICAL ROLE OF DEOXYRIBONUCLEIC ACID

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ACCORDING to the most widely accepted theory, deoxyribonucleic acid or deoxyribonucleic acid-protein is the primary genetic material and functions by acting as a template. Another theory has been proposed which postulates that ribonucleic acid-protein is the primary genetic material, specificity at each genetic locus being determined by different types or proportions of ribonucleotides and polyribonucleotides released by the ribonucleic acid-protein at that locus, alleles representing conditions at a locus that result in different rates of release of nucleotides[1]. The former hypothesis requires among other things that deoxyribonucleic acid be continually present in the nucleus and chromosomes. Some previous observations[2,3], together with results that will be briefly presented here, indicate that it is absent from the pronuclei of some echinoderm eggs. If these observations are correct, they would invalidate the deoxyribonucleic acid – template theory, but would offer no cause for embarrassment of the hypothesis that ribonucleoproteins are primary genetic materials.

The pronuclei of the eggs of *Asterias forbesii* and *Arbacia punctulata* have been shown to give a Feulgen-negative reaction which could not be attributed to dispersion of the deoxyribonucleic acid in an unusually large nuclear volume[2,3]. In a suspension of mature *Arbacia* eggs it was possible to account for the deoxyribonucleic acid found by isotope dilution analysis with ^{14}C-thymine as being contained in contaminating somatic cells[3], the polar bodies, and the egg cytoplasm. A similar but more precise analysis has been carried out on a preparation of mature eggs of the sea urchin *Tripneustes ventricosus*.

The specific activity of the thymine added was 4,020 counts per minute per microgram and of that recovered 1,389, with maximum deviations of 1·16 per cent and 1·57 per cent respectively for triplicate aliquots assayed. Agreement of the absorption spectrum of the recovered thymine with that of pure thymine was better than 1 per cent. The amount of thymine found in the preparation, which contained $1{\cdot}435 \pm 0{\cdot}50 \times 10^{6}$ eggs, was 68·18 μgm. The proportion of contaminating somatic nuclei to eggs in the preparation was $0{\cdot}512 \pm 0{\cdot}016$. Analyses on sperm of the same species gave the amount of thymine per sperm as $12{\cdot}14 \pm 0{\cdot}15 \times 10^{-6}$ μgm. Making the assumption, which appears to be justified by various reports in the literature, that each somatic nucleus contained twice the amount of deoxyribonucleic acid found in the sperm, the amount of thymine which could be assigned to the contaminating somatic nuclei was 17·85 μgm. The remainder was equivalent to $35{\cdot}07 \times 10^{-6}$ μgm. of thymine attributable to each egg and its polar bodies. This quantity was 2·89 times the amount of thymine per sperm, or almost exactly the amount expected in the polar bodies alone if each contained the haploid quantity of deoxyribonucleic acid. Alternative assignment of the thymine equally to all members of the meiotic tetrad resulted in each having only 70 per cent of the amount found in sperm. The 30 per cent deficiency is 32 times the standard error of the determinations and therefore quite unlikely to occur by chance. Such equal distribution was not justified by the cytological observations, which showed that the polar body nuclei were Feulgen-positive, whereas the egg pronucleus was Feulgen-negative. Thus within the limits of error of the determinations, there appeared to be no deoxyribonucleic acid-thymine and hence no deoxyribonucleic acid in the eggs themselves. The possibility that the deoxyribonucleic acid of sperm and of immature oocytes would contain thymine, while that of a hypothetical deoxyribonucleic acid in the mature egg would not, was rejected as highly improbable.

Mature eggs of *Arbacia* were centrifuged at 78,000 *g* for 30 min. and then treated by the Feulgen procedure after fixation. No aggregates of Feulgen-positive material could be found in the nuclei of these eggs as had been reported by Brachet for eggs in the germinal vesicle stage[4]. By direct analysis of isolated nuclei of *Asterias* eggs in the germinal vesicle stage, the deoxyribonucleic acid content per nucleus was found to be 6·2 times that of sperm of the same species. In the three species investigated, both staining procedures and chemical analysis revealed an abundance of deoxyribonucleic acid in the nuclei of young oocytes, although no clear evidence could be found for its presence in the pronuclei of the mature eggs of the same species.

Since these eggs can be induced to develop parthenogenetically, absence of deoxyribonucleic acid from their nuclei would argue against the theory that this acid is the primary genic material in the sense that it is the initiator of gene reactions. However, a regulatory role for deoxyribonucleic acid would not be so excluded. In the hypothesis mentioned previously, it was proposed that deoxyribonucleic acid had such a function. Structural similarity between ribonucleic and deoxyribonucleic acid is suggested by the observations that deoxyribonuclease (or depolymerized deoxyribonucleic acid) will reduce the rate of removal of ribonucleic acid nucleotides from nuclei by ribonuclease[5], and that after removal of its purines, deoxyribonucleic acid is digested by ribonuclease[6]. With sufficient structural homology in the two types of nucleic acids, competition between them in cellular reactions may be assumed to be probable, as is indeed suggested by the first of the observations mentioned above. Furthermore, since the rate of turnover of ribonucleic acid *in vivo* is known to be rapid, whereas that of deoxyribonucleic acid is very slow, it follows that where such competition exists, the latter will act as an inhibitor of the former. The hypothesis may be generalized to include similar inhibitory action of deoxyribonucleic acid derivatives toward analogous ribose compounds. Support for this generalization may be found in Carter's finding of inhibition of mitochondrial oxygen consumption by deoxyriboside-5′-phosphate, which is overcome by adenine ribose phosphate[7].

The hypothesis will satisfactorily account for a variety of biological observations, involving nucleic acids such as the *Ds—Ac* modifiers of *Zea*[8], maternal influence in inheritance in mammals and somatic influence on pollen in plants[9,10], the behaviour of bacterial transforming substances[11,12], and of provirus[13]. Its usefulness becomes especially apparent in providing an interpretation of turnover studies on bacteriophage[14] and behaviour of interspecific hybrids in the genus *Rana*[15], for which no adequate explanation has been found in terms of other current theories. In the case of bacteriophage, it has been shown that synthesis of new deoxyribonucleic acid after infection occurs in excess of and in advance of the need for actual incorporation into the new phage particles[14]. The deoxyribonucleic acid synthesized before any new phage particles are formed is approximately equal to the amount originally present in the bacterium—that is, in terms of the present theory, an amount which is sufficient for the antagonism of the genic apparatus of the bacterium. As described by Brachet, the hybrid *Rana* embryos ordinarily cease to develop at the end of the blastula stage, at which time the amount of nuclear deoxyribonucleic acid they contain is markedly diminished, ribonucleic acid turnover is enhanced, while oxidations are diminished as compared with the normal. Since transplantation of the blastopore lip to a normal embryo will permit continued growth and development, diffusible substances seem to be involved[15]. In terms of the present hypothesis, the following interpretation of the observations is possible. The deficiency in deoxyribonucleic acid suggests the release of unusual amounts of its derivatives to the cytoplasm, with the result that oxidations will be reduced by blocking of the ribonucleotides involved, and since a good portion of the deoxyribonucleotide has been removed, the nuclear ribonucleic acid which is normally more reactive than that of the cytoplasm will be capable of more rapid turnover than normal. Growth after transplantation becomes possible by diffusion into the transplant of ribose compounds of the host, or by removal of excess deoxyribose compounds of the transplant into the host.

A full account of the experimental details and of the hypothesis will be presented elsewhere. This investigation was supported by a grant from the Division of Biology and Medicine of the United States Atomic Energy Commission. [June 27.

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DIFFERENTIATION OF GROWING AND NON-GROWING BACTERIA BY A STAINING TECHNIQUE

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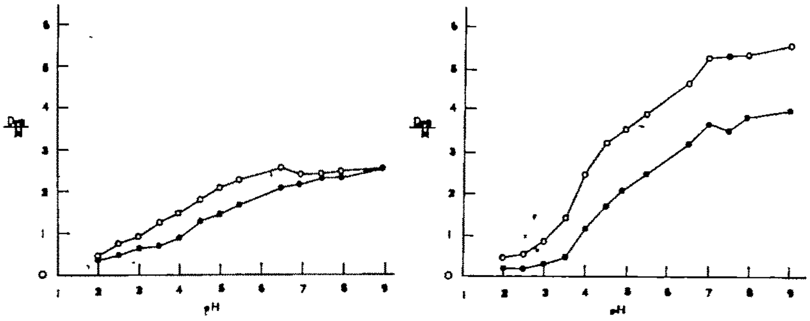
It has been known for some years that growing bacteria are more strongly basophilic than non-growing bacteria. In *E. coli* this difference has been attributed to the presence of unbound ribonucleic acid in growing bacteria[1]. That ribonucleic acid is responsible in all bacterial species is improbable in view of the presence in some of inorganic polyphosphates[2] the abundance of which appears to vary like ribonucleic acid with the physiological condition of the bacterium. In order to supplement other evidence for the presence of unbound ribonucleic acid and to seek a convenient microscopic means of assessing the abundance of this constituent in *E. coli* (*N.C.T.C.* No. 1100) the affinity of this bacterium for the weakly basic dye toluidine blue was investigated.

It became evident that, by an initial acid extraction of the bacteria and by the application of the dye at a pH which would reduce interference from protein to a minimum, a staining technique, applicable to all the bacteria tested (including Gram-positive bacteria), could be obtained by which growing cells alone showed marked basophilia.

A quantitative assessment of the basophilia of growing bacteria, taken from an aerated casein/casein/



(A) (B)

Fig. 1, *A*. Absorption of toluidine blue by non-growing and growing *E. coli* bacteria; *B*. Absorption of toluidine blue by acid-extracted non-growing and growing *E. coli* bacteria. —●—●—, non-growing bacteria; —○—○—, growing bacteria. The basophilia is expressed as weight of dye absorbed/weight of bacterial nitrogen

yeast[3] culture during the period of maximum growth and division-rates, and non-growing but viable bacteria, taken from the culture when growth had ceased, was obtained by suspending the washed bacteria in 0·2 per cent toluidine blue solution in 0·05 *M* buffer and extracting the dye absorbed with normal hydrochloric acid.

The influence of an acid extraction on the basophilia of growing and non-growing bacteria and the influence of *p*H can be seen in Figs. 1 *A* and *B*. The contrast between growing and non-growing bacteria is optimal in acid-extracted bacteria at *p*H 3·5; the quantitative difference in dye absorption is optimal above *p*H 4·0. For the purpose of microscopical observation, however, the staining of rapidly growing cells is sufficiently intense at *p*H 3·5 for advantage to be taken of the optimal contrast afforded by this *p*H.

At *p*H 3·5 untreated growing bacteria appear to absorb approximately 80 per cent more dye than untreated non-growing bacteria; acid-extracted growing bacteria appear to absorb approximately 200 per cent more dye than acid-extracted non-growing bacteria. Under the conditions of determination, however, part of the dye measured as absorbed by the bacteria is derived from dye passively contained in the bacteria and dye present in solution retained with the bacteria after centrifugation. This accounts for the fact that the assessment of basophilia by microscopic observation of stained bacteria suggests a far greater contrast between acid-extracted growing and non-growing bacteria than expected from the measurements made. Fig. 2 shows an artificial mixture of acid-extracted growing and non-growing *E. coli* bacteria stained with toluidine blue in the manner described below. The very weakly basophilic non-growing cells have absorbed sufficient dye to make them just visible.

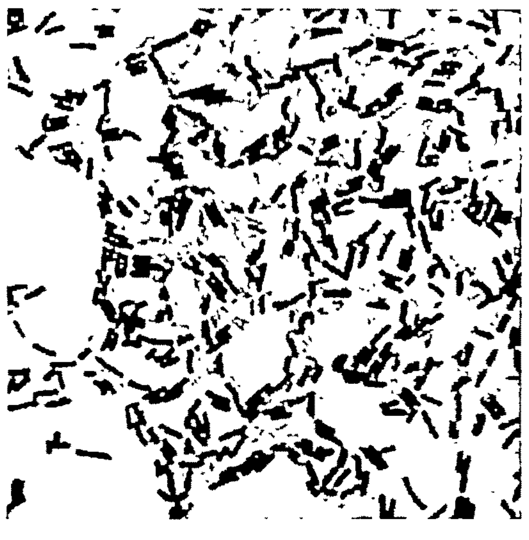


Fig. 2. An artificial mixture of acid-extracted growing and non-growing *E. coli* bacteria treated with toluidine blue at *p*H 3·5

In order to render weakly basophilic bacteria more visible and to facilitate the distinction between growing and non-growing bacteria, the staining procedure finally adopted and described below includes the use of eosin as a counter stain.

The culture was treated immediately upon reaping with sufficient concentrated hydrochloric acid to give a concentration of 0·33 *N* hydrochloric acid. The bacteria were centrifuged down, washed once in 0·33 *N* hydrochloric acid, then taken up into a little water and treated gradually with '*IR* 400' (OH) resin until the *p*H was 3·5–6·0. A loopful, applied to a slide, was air-dried and heat-fixed. The preparation was stained at 45° C. for at least 10 min. in 0·5 per cent toluidine blue made up in 0·05 *M* formate buffer at *p*H 3·5, washed for 0·5 min. with distilled water, blotted and dried. It was then stained for 30–60 min. in 0·05 *N* acetic acid saturated at room temperature with eosin (water-soluble, yellowish), washed briefly with tap water, blotted and dried. This staining procedure resulted in non-growing bacteria staining pink and growing bacteria blue-violet.

If, as is most likely, the high content of ribonucleic acid in growing Gram-negative bacteria is responsible, the intensity of the blue staining will depend upon the growth-rate after the first generation[4].

The potential use of the staining technique for assessing the viability of bacterial suspensions has been considered. For the assessment of the viability of a suspension of bacteria derived from a fully-grown culture, two methods have been entertained.

One method involves the counting of pink-staining bacteria before and after incubation of the bacteria in a medium that supports very rapid growth and for a period that allows the viable bacteria present to attain a high rate of growth and change their staining reaction. This method requires the counting of pink-staining bacteria by a ratio count to inert particles of known concentration.

Another method requires some knowledge of the behaviour of the bacteria. If the stationary phase of the bacterium when incubated in fresh medium is known, a direct assessment of the degree of viability can be obtained from a ratio count of pink-staining and blue-violet-staining bacteria after incubation for the duration of this phase.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication. [Aug. 27.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

World-wide Frequency and Time Comparisons by Means of Radio Transmissions

For many years standards of frequency have been made available to users over a wide area by means of radio transmissions, the carrier waves of which are controlled by the standard; and the frequencies of 2·5, 5, 10, 15, 20 and 25 Mc./s. have been allocated to this purpose by international agreement. Frequency standards can now be maintained in operation with a stability of a few parts in 10^9 per month, and they can be intercompared in the laboratory with a precision of ± 1 part in 10^{10}. There is, however, a loss of accuracy due to transmission, and although it has been found that ± 1 part in 10^8 can be achieved under suitable conditions, the accuracy in general is limited to about ± 2 parts in 10^7 because progressive movements of the ionospheric layers at which the waves are reflected cause a steadily increasing or decreasing path-length and a consequent Doppler-effect frequency change. In view of this limitation, an experimental transmission on 60 kc./s. was included in the United Kingdom service when this was resumed in 1950, with the call sign *MSF*. The ionospheric layer at which such low-frequency waves are reflected is known to be comparatively stable, and the ground-wave of the transmission, which is, of course, not affected by changes in the ionosphere, is received over a useful area. Results[1] obtained at the National Physical Laboratory show that this transmission can be used in the United Kingdom with an accuracy of ± 1 part in 10^9 in an observation time of a few minutes; and in spite of its low power of 10 kW., it has been received and measured at Harvard University with the same precision by a somewhat different technique in a time of about 10 min. Higher accuracies of comparison can be obtained by averaging the observations over longer periods.

The *MSF* transmissions are operated from the Post Office Radio Station at Rugby, where the powerful 16 kc./s. transmitter *GBR* is also located. The carrier wave of this transmitter is now controlled by the standard used for the *MSF* transmissions in order to facilitate measurements at great distances whenever *GBR* is in operation.

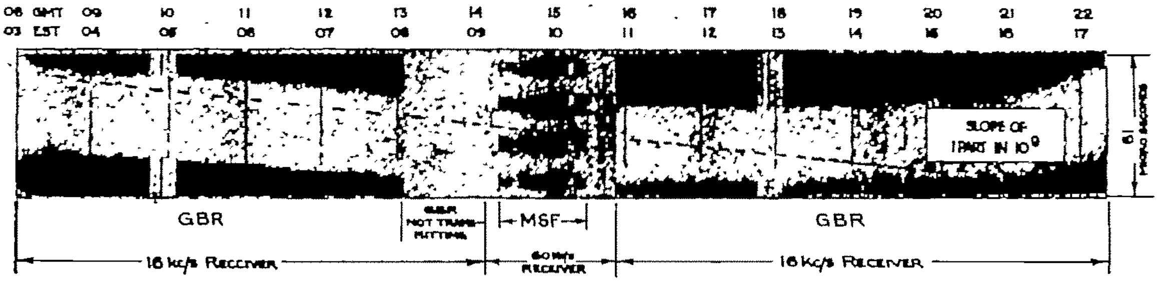

Fig. 1

A typical photographic record taken at Harvard and including the results obtained with both the 60 kc./s. and the 16 kc./s. transmissions is reproduced as Fig. 1. The edge of a dark band represents the arrival time of a particular phase of the carrier wave on a time-scale derived from the local standard; and when it forms a horizontal line the frequency of the received signal is in exact agreement with that of the local standard, or is in simple relationship with it, such as 16/100 and 60/100 in this case. The slope corresponding to a deviation from the local value of 1 part in 10^9 has been indicated in the diagram. The smoothness of the edges of the trace demonstrates that the propagation path is relatively free from short-period fluctuations, but the changes in slope are due to gradual changes in the height of the reflecting layer. Closer checking by independent means of the frequency of the local standard will enable the frequency changes associated with the diurnal movements of the layer to be accurately measured and compensated in the frequency comparisons.

These results, which will be reported more fully elsewhere, are clearly of significance in problems of frequency control, international frequency and time standardization, and navigational aids based on phase comparison; and the possibility of securing comparisons of frequency and therefore of time-interval to a precision of ± 1 part in 10^9 on a world-wide basis is probably also of interest in a much wider field. Measurements to this accuracy must at first be on a comparative basis, since the unit of astronomical time cannot be predicted with an accuracy greater than ± 1 part in 10^8; but this restriction may be removed if work on other possible units of time based on the natural resonant frequency of an atom proves to be successful.

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Preparation of Aluminium of Extreme Purity by the 'Zone Fusion' Process

THE special properties of aluminium refined by double electrolysis and of conventional purity 99·99–99·998 per cent are well known. We have considered the application to this material of the 'zone fusion' process, which permits the production of germanium of extreme purity[1]. In our experiments we have employed a bar of such refined aluminium about 40 cm. long and 4 cm.^{2} in cross-section. This bar was placed in a boat of pure alumina and a length of 6–8 cm. raised to the melting point in a high-frequency furnace, the zone of fusion being traversed through the furnace at the rate of 5 mm. an hour.

In our first experiments notable purification of the 99·998 per cent metal after three such treatments was obtained[2]. After cold work, such material recrystallizes in large grains at a temperature of − 20° C.

After nine such fusion processes, the analyses being carried out with the aid of radioactive elements[3], we are led to believe that the conventional purity clearly exceeds 99·999 and is probably very near 99·9995.

By the classical strain-anneal technique we have prepared this aluminium in the form of single crystals. For this the ingot was rolled at a temperature near that of liquid nitrogen, since this metal recrystallizes at − 50° C., after which it was subjected to the usual treatment.

Measurement of the resistivities in liquid hydrogen and liquid helium[4] shows very considerable differences as compared with the refined aluminium of 99·99 and 99·998 per cent.

Fig. 1 shows the very important differences in the ratio $R_0/R_{20\cdot4°\mathrm{K}}$ (the ratio of the resistivity at ordinary temperatures to that at the low temperature) for aluminium purified by three treatments (curve 3) and nine zone fusions (curve 4).

It was important to know what proportion of the metal had been purified after nine treatments; that is, what length of the bar consisted of metal of the highest purity. In Fig. 2 we have plotted the distances from the head of the bar as abscissæ and the ratio $R_0/R_{20\cdot4°\mathrm{K}}$ as ordinates. This shows that the first 30 cm. of the bar, of total length 45 cm., consist of this highly purified material.

Such experiments demonstrate the interest which this method has for ordinary metals. The extreme degree of purity leads to new properties in many different fields, among which we are at present studying, in the laboratory at Vitry, problems of recrystallization, polygonization[5], electrical conductivity, corrosion and grain boundary fusion[2–6].

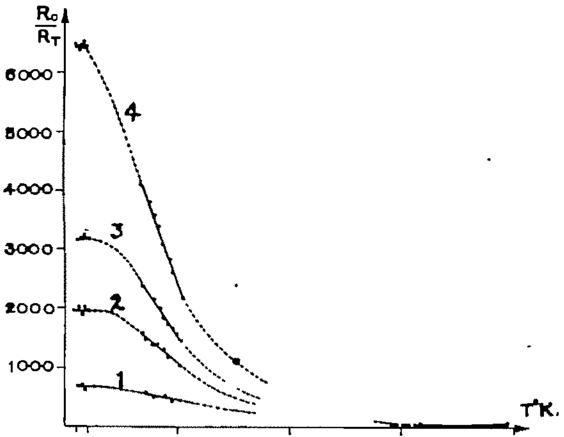

Fig. 1. Changes in the ratio R_0/R_T for different specimens. (1) 99·99 per cent aluminium; (2) 99·998 per cent aluminium; (3), as (2), after three treatments; (4), as (2), after nine treatments

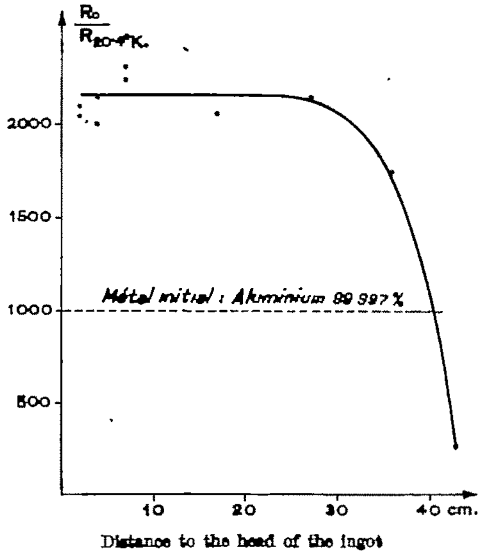

Fig. 2. Purification of 99·997 per cent aluminium after nine treatments. Note that the first 30 cm. of the bar consists of highly purified metal

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Photoelastic Effects in Microscopic Fibres

THE application of fairly high pressures to fibre specimens on the microscope has been found to produce types of photoelastic stress patterns in cotton and nylon fibres. The method, which is modified from the original technique devised by Boddy[1] and that due to Merton[2], consists in applying a load to a lever system which exerts pressure on the condenser. The front lens of this is replaced with a sapphire sphere $\frac{1}{16}$ in. or $\frac{1}{8}$ in. in diameter. This operates through the cover slip on the specimen. Thus light rays can be focused through the sphere and through the material while pressure is applied or released, and the behaviour of the fibres watched throughout the process.

The interferometric slides and cover-slip of semi-metallized glass due to Merton give rise to optical path differences by reflexion, and the stress fringes in the materials may be observed without using polarizers.

Fig. 1 shows them in a cotton fibre after the pressure has been removed, and it is interesting to note that they remain in this material for some considerable time. A similar fringe system can be produced in a

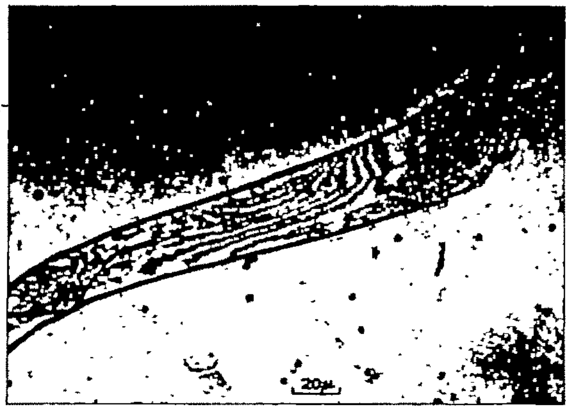

Fig. 1. Cotton fibre showing stress fringes after applying pressure

nylon fibre, where they also remain after releasing the pressure.

With collagen fibres the stress fringes also occur, but are rapidly released with the release of pressure. With cotton, two pressure impacts at different places will produce two series of fringes which may interfere like two sets of ripples on a pool.

The impact of pressure if applied suddenly results in waves of fringes which, particularly with collagen, appear to travel along the fibre axis some considerable distance before being damped.

Further work on the elastic properties of such fibres is in progress and will be reported elsewhere.

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A New Approach to the Study of Electric Fields produced by Growing Roots

The electric fields primarily developed across the walls of plant cells give rise to an integrated field associated with a growing plant organ. Information from the literature with regard to such electric fields associated with plant organs is contradictory and has led to conflicting theories; and the conflict in experimental evidence has never been satisfactorily resolved. An investigation of the literature seems to us to show that artefacts developed at points where measuring probes make contact with the plant would, in most cases, swamp the normal field which it is desired to investigate.

We have made an essentially new approach by studying the currents which are generated by a plant organ in a weakly conducting medium. Potential differences are measured between points in the medium near the plant without disturbing its normal growth in any way. If these measurements are made in a suitable pattern, information about current density and direction, and the electric power developed by the plant, can be obtained. Consistent results have been obtained with bean and onion roots grown in water. As a first step in the investigation of the electrical processes associated with an organ as a whole, the changes have been observed in the pattern of electric potentials in the water which occur when growth is rapid and when it is inhibited.

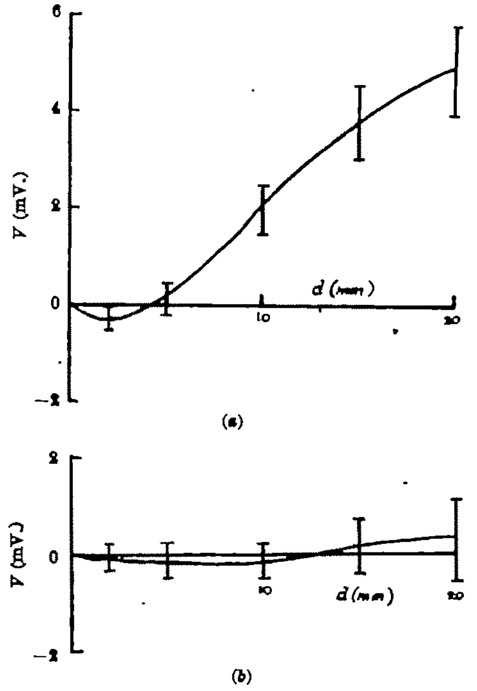

Fig. 1

Fig. 1(*a*) shows the pattern observed with bean roots growing rapidly and uniformly in aerated water at 25° C. V is the potential relative to that of the root-tip of points close to the root in the external medium (0·0001 N potassium chloride solution) and this is plotted against the distance d from the tip. The growth-rate is about 0·8 mm. per hour.

Fig. 1(*b*) shows the corresponding pattern produced when growth is inhibited. Inhibition has been produced by methods as different as the addition of indole acetic acid to the water in which the root was growing, and raising the temperature of the root. In the case of the addition of indole acetic acid, the effect was reversible, and when growth was resumed the electrical pattern returned to that associated with normal growth.

Figs. 1(*a*) and 1(*b*) show averages in experiments each of which comprised about twenty-five plants, the vertical lines through the points giving the 95 per cent confidence limits.

The electrical pattern is seldom static and shows small slow variations with time even when all environmental factors known to affect the electric field are controlled. In conditions other than that of straight rapid growth, the potential pattern may differ considerably from that discussed. In some conditions the root is observed to produce persistent and relatively rapid oscillations in its electrical pattern. These oscillations are often practically sinusoidal, with periods ranging from 4 to 15 min. or more. The more rapid oscillations are more common.

Observation of these rapid changes of electrical pattern has been made possible by the development in this laboratory of an automatic apparatus which records at frequent intervals the electric potential differences between a number of points adjacent to the root grown in water. The oscillations can be induced by experimental treatment, such as by introducing an obstacle which impedes elongation of the root, or by inducing bending by wounding. They also appear spontaneously, accompanying variations

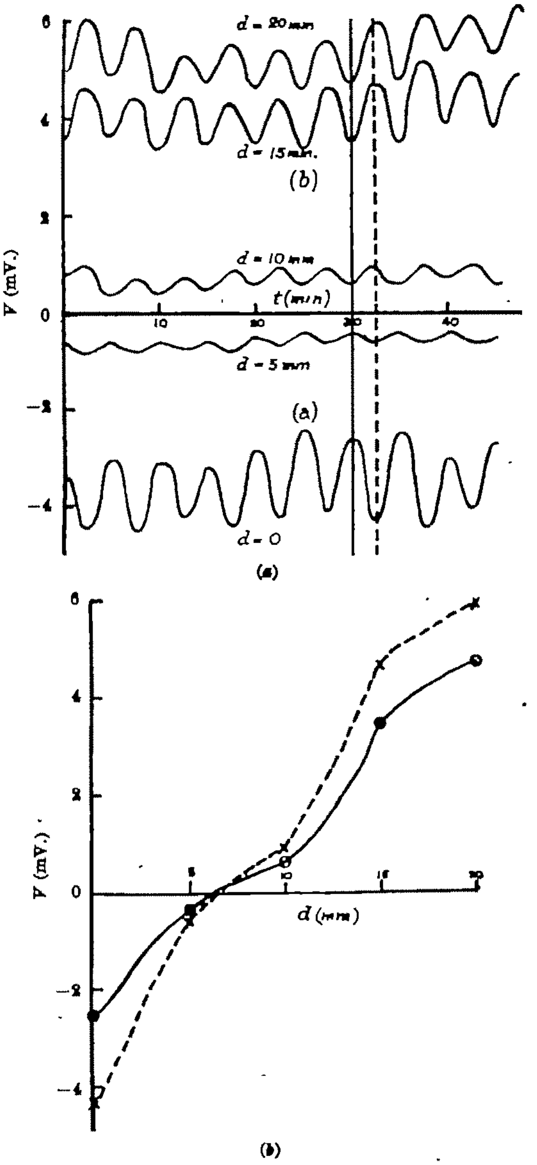

Fig. 2

in growth such as spontaneous bending. They do not occur when the root grows rapidly and evenly.

Fig. 2(*a*) shows a graph of potential against time in a typical case where electrical oscillation accompanied bending. Each trace shows the potential V relative to a distant point in the bath plotted against time t, for a point near the root at a distance d from the root-tip. The graph shows simultaneous potentials for several values of d. Note the phase differences at *a* and *b*. Fig. 2(*b*) shows the corresponding graph of potential plotted against distance from the root-tip. Two traces are shown giving potentials at times corresponding to a crest and a trough of the oscillatory potential. Where the two traces cross, the phase changes by π.

These investigations, which are part of a general study of patterns of morphogenesis, are being continued and will be described in more detail elsewhere.

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5-Hydroxytryptamine : its Occurrence in Cowhage

The trichomes from the pods of *Mucuna pruriens* DC., which constitute cowhage, have long been known to cause intense itching, and some pain, when applied to the human skin. Broadbent[1] concluded, from pharmacological and histological studies, that the itching was not a mechanical effect of the trichomes but was due to the presence of a histamine-liberating substance.

In seeking to identify the active principles, we have examined a crude extract of cowhage prepared by Dr. P. Hey. 5-Hydroxytryptamine was found to be present. The concentration of the substance in the trichomes, as determined by pharmacological assay, was of the order of 0·015 per cent.

Though 5-hydroxytryptamine has been found in certain mammalian tissues and serums[2], in the gastro-intestinal and splenic extracts of fish and ascidians[3], in toad venom[4], in the salivary glands of octopods[5], and in wasp venom[6], we believe this to be the first record of its occurrence in a plant.

Armstrong *et al.*[7] have shown 5-hydroxytryptamine to be more effective than histamine as a cutaneous pain-producer in man. It is thus probable that 5-hydroxytryptamine is a factor in the causation of pain following the application of cowhage to the skin. We cannot yet say, however, whether it is the principle responsible for the sensation of itching. Further work is in progress.

An active extract of cowhage was prepared by moistening with alcohol, extracting with cold water and evaporating the aqueous extracts to dryness below 35° ; 100 gm. of the crude drug gave 10 gm. of extract. This material elicited the same type of response from guinea pig ileum and rat uterus as did 5-hydroxytryptamine (acid oxalate), and was not antagonized by atropine (5 ng./ml.) or mepyramine (50 ng./ml.)[8]. Under the same conditions the responses to acetylcholine and histamine were almost completely abolished. Lysergic acid diethylamide, at a concentration[8] of 0·1 μgm./ml., reduced the ileum responses to equi-effective doses of the crude extract and of 5-hydroxytryptamine to the same extent.

Fractionation of the original crude extract was controlled by pharmacological assay of the fractions on the guinea pig ileum. By re-extraction of the crude material with limited amounts of water, followed by chromatography of the soluble material on a powdered cellulose column using *n*-butanol/acetic acid/water (100 : 10 : 30), a fraction with 125 times the activity of the original was obtained. When this fraction was subjected to ascending chromatography on Whatman No. 1 paper, using *n*-butanol/acetic acid (10 : 1) saturated with water, 85 per cent of the total activity was concentrated in a zone corresponding to a substance with R_F = 0·42, which is the value shown by 5-hydroxytryptamine in the same system. Material eluted from this zone was also identical with 5-hydroxytryptamine in its reactions with ammoniacal silver nitrate, with diazotized sulphanilic acid, with Ehrlich's reagent, and with Jepson and Stevens's ninhydrin/acetic acid reagent[9], which last is specific for a very narrow range of tryptamine derivatives. Aqueous solutions of the most active fractions had the following light absorption : $\lambda_{\text{min.}}$ = 247 mμ, $\lambda_{\text{max.}}$ = 273 mμ, $\lambda_{\text{inf.}}$ = 300 mμ. Hamlin and Fischer[10] give the absorption of 5-hydroxytryptamine at pH 5·4 as $\lambda_{\text{min.}}$ = 250 mμ, $\lambda_{\text{max.}}$ = 275 mμ, and $\lambda_{\text{inf.}}$ = 299 mμ.

Further details of this work will be published elsewhere.

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Perpendicular Orientations in Polyethylene

PERPENDICULAR orientation (chain-molecules perpendicular to an axis of rotation) has been frequently reported in studies on polyethylene. I have shown[1] that very similar X-ray patterns can be given by two entirely different perpendicular structures: (i) where the *a*-axis is parallel to the fibre-axis and consequently *b* and *c* are perpendicular to it; (ii) where the *b*-axis is an axis of cylindrical symmetry, and the *b*-axes themselves are randomly arranged in planes perpendicular to the direction of draw, which itself is perpendicular to the X-ray beam.

The finer details of the X-ray patterns have now been examined more closely in order to establish the existence of (i) and (ii) from X-ray evidence alone. The samples were prepared in two different ways in an attempt to produce these structures: (*a*) fully drawn and relaxed at 110° C.; (*b*) crystallized during flow while cooling from the melt[1]. The randomization of the *b*-axes in planes perpendicular to the fibre-axis in structure (ii) causes a characteristic spreading of the 200 and 110 arcs[1], as shown in the first part of Table 1. This spread could always be observed in samples (*b*).

Table 1. THEORETICAL POSITION OF MAXIMA OF SOME REFLEXIONS IN STRUCTURES (i) AND (ii) AND THEIR THEORETICAL SPREADS IN STRUCTURE (ii).
The spread given is inherent in the structure and is not due to disorientation

Reflexion	Structure (i) Maxima	Structure (ii) Maxima	Spread
110	33° from equator	34° from equator	Arc of 69° bisected by the equator
200	Meridian	Meridian	Along the whole ring
020	Equator	Equator	None
011	Equator	25–30° off meridian	The whole ring except for 44° on the meridian
201	38° off equator	Meridian	The whole ring
121	15° off equator	45–60° off equator	The whole ring except for 52° on the meridian

To obtain more conclusive X-ray evidence, reflexions other than *hk*0 were investigated, in particular, 011, 201 and 121. These are very weak, especially when drawn out in more or less extended arcs. Close comparison revealed that the patterns of samples (*a*) and (*b*) are different. Table 1 shows what is to be expected from structures (i) and (ii). The figures were obtained by the method given in ref. 1. Because of the difficulty of reproducing the photographs the effects will be described.

Reflexion 011. In samples (*a*), this reflexion was in the form of two arcs on the equator as expected from structure (i). In samples (*b*), only faint traces of the reflexion were visible on the equator, whereas there were pronounced maxima at about 25°–30° off the meridian. Caution was needed in the localization of the latter, because the 310 reflexion, corresponding to a nearly identical spacing, has maxima at a similar angle for both (i) and (ii). However, it was possible to establish that the maxima in samples (*b*) are composed of both reflexions, in agreement with structure (ii).

Reflexion 201. Here samples (*b*) gave the clearer answer, as the maxima were found to be on the meridian, as follows from (ii). With samples (*a*), the position of the maxima appeared to be at 38° from the equator, but the effect was not clear enough to be conclusive. To remove possible doubts, drawn samples were relaxed successively in small steps by exposing them to increasing temperatures from 94° to 108° C. It was found that the relaxation proceeded by a continuous tilting of the crystallites around their *b*-axes until the *c*-axes were perpendicular to the fibre direction. Also, the doubtful 201 reflexion followed the course required by this tilting until the last stage, where it merged with the 220 reflexion, its definition being further reduced by an increasing spread towards the meridian (arising from the geometry of the reciprocal lattice). These results leave no doubt about the fully relaxed samples having structure (i) as stated previously, also by other authors.

Reflexion 121. This reflexion gave the clearest evidence on the points in question. Samples (*a*) gave extended equatorial arcs consistent with structure (i) as the small split is not expected to be resolvable. With samples (*b*) the maxima were broad but clearly at about 45–60°, being connected across the equator, and having abrupt ends at about 30° off the meridian, in agreement with (ii).

These observations confirm that the samples prepared by relaxation and by crystallization under flow have basically different structures, although the principal features of their X-ray patterns are very similar.

According to private information from Holmes *et al.*, the commercial polyethylene samples used by them in their earlier work[2] have been re-examined. The positions of the relevant reflexions indicated that a few of their samples had structure (ii) and not (i) as previously published, and for the majority the X-ray evidence alone was not sufficient to distinguish between the two alternatives. In my opinion the existence of structure (ii) in commercial films is to be expected, as crystallization might occur during flow while the solidifying film is being wound up in the course of manufacture[3].

I wish to acknowledge the contribution of Dr. D. R. Holmes and Mr. R. P. Palmer, Imperial Chemical Industries, Ltd., Welwyn Garden City, whose first observations on their commercial samples initiated the present work; further, I wish to thank Dr. A. F. Wells for his interest and help.

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A Simple Microtitration Method for the Determination of Calcium and Magnesium in the Hæmolymph of Insects

According to several authors[1,2], the direct titration of calcium and magnesium with ethylenediamine tetraacetate has yielded very good results, especially in the determination of water hardness and in clinical investigations of blood plasma. Since other methods described for the determination of calcium and magnesium are rather laborious, and micro-scale determination is liable to large errors, we have tried the direct titration with ethylenediamine tetraacetate using the well-known Linderstrøm-Lang micro-titration technique. Determinations have been carried out on some species of Blattaria: *Periplaneta americana*, *Periplaneta australasiae* and *Blabera fusca*.

A small amount of hæmolymph (5–20 µl.) is obtained from the insects by puncturing the ventral side of thorax or abdomen. The light yellow hæmolymph appearing on the wound is sucked up in a capillary pipette, and blown out into a small titration vessel (capacity *c.* 500 µl.) and immediately diluted with distilled water (*c.* 100 µl.). After bringing the mixture to the appropriate *p*H with sodium hydroxide and, in the case of magnesium titration, adding a buffer solution, the indicator is added and titration carried out. Murexide is used as an indicator for the presence of unchelated calcium, whereas eriochrome-black *T* is used to indicate the presence of unchelated magnesium.

As ethylenediamine tetraacetate has a much greater affinity for calcium than for magnesium, the calcium concentration may be calculated from the amount of the reagent used in the murexide titration, whereas the sum of calcium and magnesium can be found by performing an eriochrome-black titration; the magnesium concentration is therefore obtained by subtraction. Calculations are very simple since one mole of ethylenediamine tetraacetate chelates one mole of divalent cation.

The reliability of the method was tested by performing determinations of calcium and magnesium in solutions containing known amounts of calcium chloride and/or magnesium sulphate, in human sera to which known amounts of magnesium sulphate had been added, in samples from pooled hæmolymph, in samples taken successively from the same insect and in hæmolymph to which known amounts of magnesium sulphate had been added. Moreover, the results of micro-titration were compared with those of macro-titration with ethylenediamine tetraacetate and in a few cases with those of the calcium-oxalate precipitation method. The results of these checking experiments were quite satisfactory.

A large number of determinations have been carried out on hæmolymph of single individuals of *Periplaneta americana*, and some for *P. australasiae* and *Blabera fusca* (see Table 1). From these data it may be concluded that the intraspecific as well as the interspecific differences are rather small, especially in the case of calcium. Sex differences are not significant. The ratio calcium/magnesium is about the same for all three species.

Table 1

Species	Calcium* (mgm. per 100 gm. of hæmolymph)	Magnesium* (mgm. per 100 gm. of hæmolymph)	Calcium/magnesium ratio†
P. americana	(107) 17·8+1·9	(83) 13·5+3·0	0·79
P. australasiae	(17) 19·4+2·8	(20) 14·8+4·1	0·79
Blabera fusca	(7) 20·2+2·9	(3) 15·7+2·0	0·77

* Numbers in brackets indicate the number of determinations.
† Calcium and magnesium concentrations expressed in molarities.

As our purpose is to offer a reliable micro-method for the determination of low concentrations of calcium and magnesium in small amounts of biological fluids, it is interesting to compare our results with the few found in the literature. Calcium values are in full agreement with those of Clark and Craig[3]. This, however, is not the case for the magnesium determinations; Clark and Craig found 27·5 mgm. per 100 gm. of hæmolymph, Tobias[4] gives a value of only 7 mgm. per 100 gm. of hæmolymph, both for *P. americana*. In our view the dry-ashing of the hæmolymph as used by both authors may lead to erroneous results, as by this procedure organic phosphorus is converted to possibly interfering inorganic phosphates. However, differences in the animal material may also have played a part, although we do not consider this very probable.

Our experiments permit no conclusion as to the state in which the elements investigated are present.

A more detailed report of our investigations will be published elsewhere.

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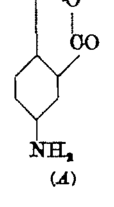
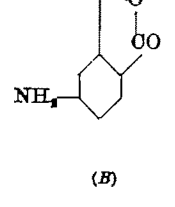
A Chromatographic Separation of the Aminofluorescein Isomers

In the preparation of aminofluorescein by the condensation of 4-nitrophthalic acid and resorcinol followed by reduction, two isomers (*A*) and (*B*) are formed at the condensation stage, and these must



(*A*)



(*B*)

be separated if unequivocal results are to be obtained in the subsequent reaction of the derived fluorescein isocyanate with proteins to give fluorescent protein conjugates[1].

The conventional method of separation of the two isomers consisting of fractional crystallization of the nitrofluorescein diacetates[1] is laborious and wasteful; to obviate this we have devised a chromatographic separation of the two isomers.

A kieselguhr column ('Hyflo-Supercel') is used with 0·2 *M* sodium phosphate buffer *p*H 8·0 (3 ml. of buffer to 5 gm. of kieselguhr) as stationary phase and a mixture of *n*-butanol and *cyclo*hexane as mobile phase. In Fig. 1 is shown the result obtained with a mixture of the aminofluoresceins that had been originally purified as the nitrofluorescein diacetates, using in this case as mobile phase *n*-butanol (65 per cent v/v) and *cyclo*hexane (35 per cent v/v). Peak 1 represents an impurity present in the crystalline aminofluorescein II (using the nomenclature adopted by Coons *et al.*[1]), peak 2 represents aminofluorescein II, peak 3 represents an impurity in the crystalline aminofluorescein I and peak 4 is aminofluorescein I. The time required for the separation was decreased by using gradient elution, the column being started with *n*-butanol (30 per cent v/v) – *cyclo*hexane (70 per cent v/v), and the concentration of *n*-butanol was raised continuously using an apparatus similar to that described by Donaldson *et al.*[2] with the addition of a magnetic stirrer. (Alcoholic alkali was added to the column eluate in order to increase the light absorption of the first two peaks.)

The method was scaled up to deal with larger amounts of material by the use of a column 70 cm. long and 3 cm. in diameter, containing 100 gm. of kieselguhr, attached to an automatic fraction collector. From 365 mgm. of crude aminofluorescein soluble in the column mobile phase, 179 mgm. of aminofluorescein I and 105 mgm. of aminofluorescein II were obtained, the impurities (peaks 1 and 3) running as separate bands being discarded. This gave yields based on the original nitrofluorescein of 36·2 per cent of aminofluorescein I and 21·2 per cent of aminofluorescein II (reduced to 23 and 14·3 per cent respectively after crystallization), whereas the use of fractional crystallization as the separation technique gave only 11·7 per cent of aminofluorescein I and 4 per cent of aminofluorescein II. The purity of the fractions obtained from the large column was checked by comparing them with those obtained by fractional crystallization by means of a paper chromatogram.

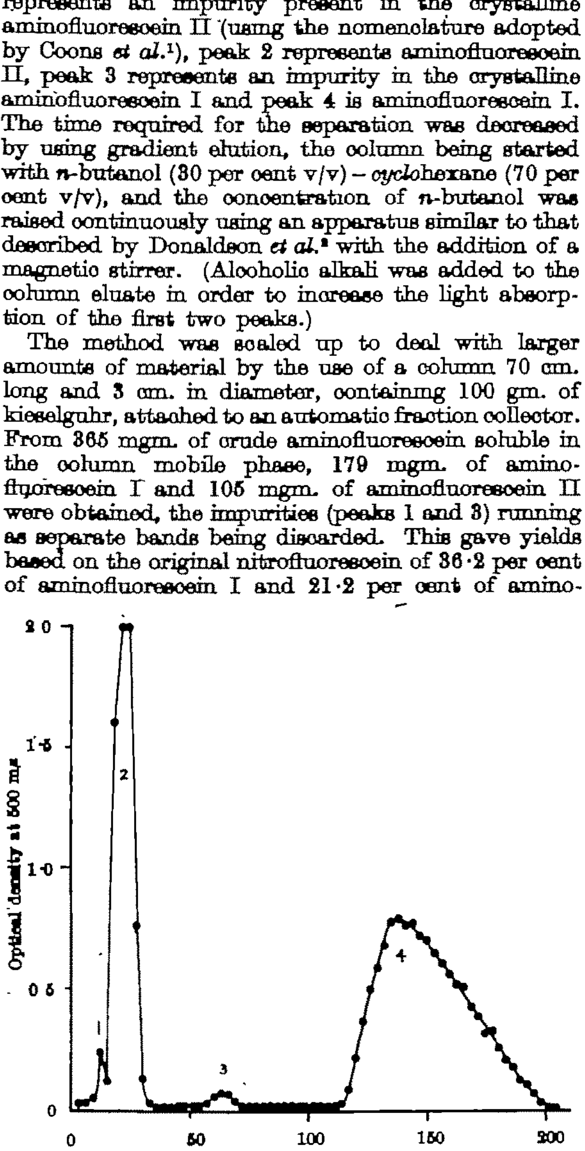


Fig. 1. Chromatogram run with a mixture of the two aminofluoresceins purified as the nitrofluorescein diacetates; mobile phase, *n*-butanol (65 per cent v/v) – *cyclo*hexane (35 per cent v/v). Peak 1, impurity present in aminofluorescein II; peak 2, aminofluorescein II; peak 3, impurity present in aminofluorescein I; peak 4, aminofluorescein I

Although this chromatographic technique is not suitable for very large quantities of material, the fact that only a few milligrams of aminofluorescein is required at any one time makes chromatography particularly suitable for the separation of the aminofluorescein isomers.

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Ability of Normal and Sickle-Cell Hæmoglobins to form Complexes

The electrophoretic examination of hæmoglobin samples from Africans with sickle-cell trait, collected by one of us (Griffiths[1]), showed that the mobilities were not constant and did not agree with values reported by other observers (for example, Pauling *et al.*[2]). Among nine specimens we found values ranging from $-1 \cdot 6$ to $-3 \cdot 0 \times 10^{-5}$ cm./sec./V./cm. for the normal hæmoglobin component and from $-1 \cdot 2$ to $-2 \cdot 4 \times 10^{-5}$ cm./sec./V./cm. for the sickle-cell component. Seven normal hæmoglobin samples gave values between $-1 \cdot 7$ and $-3 \cdot 8 \times 10^{-5}$ cm./sec./V./cm. Not only did the mobility vary from individual to individual, but also samples taken from one subject varied from time to time. The values were all determined by electrophoresis in the Tiselius apparatus at a concentration of about 1·5 per cent of hæmoglobin, prepared by Drabkin's method[3], in phosphate buffer at *p*H 7·5 and ionic strength 0·1. Similar variations in mobility were shown by paper electrophoresis. The variations were not due to technical errors, because replicate determinations with a given specimen of blood gave concordant results. The absence of methæmoglobin or similar derivatives was shown by spectroscopic examination.

Many workers have reported that normal hæmoglobin can be resolved into fractions with differences in solubility, resistance to alkaline denaturation and gel formation. It is possible that the differences in electrophoretic mobility described here are a reflexion of such heterogeneity.

Usually the proportions of normal and sickle hæmoglobin components were reversed in the ascending and descending columns; a typical example is shown in Table 1. This reversal is the same as that found by Longsworth and McInnes[4] on electrophoresis of albumin – nucleic acid complexes. Jayle *et al.*[5] state that hæmoglobin forms a complex with haptoglobin, and Cheesman[6] showed that a complex is formed between hæmoglobin and ribonucleic acid. These facts suggested to us that such complex formation between hæmoglobin and some other constituent of the red cells might be responsible for the different mobilities observed, and that sickle-cell hæmoglobin

Table 1. MOBILITIES AND PROPORTIONS OF NORMAL AND SICKLE COMPONENTS IN SICKLE-CELL TRAIT HÆMOGLOBIN

Components	Mobility (cm./sec./V /cm. × 10^{5})	Proportion of total	
		Ascending (per cent)	Descending (per cent)
Sickle-cell hæmoglobin	2·3	54·0	32·1
Normal hæmoglobin	2·8	46·0	67·9

Table 2. MOBILITIES OF HÆMOGLOBIN COMPLEXES

Mixture	Mobilities (cm./sec./V./cm. × 10^{5})			
	Ascending		Descending	
	Slow	Fast	Slow	Fast
Hæmoglobin	2·1	—	2·0	—
Nucleic acid	16·5	20·0	16·9	—
Hæmoglobin + nucleic acid	2·5	19·9	2·2	17·6
Carbonic anhydrase	—	2·6	—	2·6
Hæmoglobin + carbonic anhydrase	1·1	1·6	1·1	1·6

might differ from normal hæmoglobin in being such a complex with some unidentified macromolecule.

To test the feasibility of this hypothesis, normal hæmoglobin was mixed with nucleic acid and the mixture dialysed against phosphate buffer and submitted to electrophoresis. The mobility of the original hæmoglobin was altered and a new peak, presumably corresponding to a hæmoglobin – nucleic acid complex, appeared (Table 2). Mixtures of carbonic anhydrase and hæmoglobin gave similar results, whereas globin – hæmoglobin mixtures gave three peaks. Reversal of the proportions of the components in the ascending and descending columns was also noted.

A corollary of this suggestion is that, if two samples of sickle-cell trait hæmoglobin with different mobilities are mixed and submitted to dialysis and electrophoresis, the original complexes may dissociate and then recombine to give two fresh peaks with mobilities intermediate between those observed in the separate samples, due to rearrangement between the sickle-cell and normal hæmoglobin components. Alternatively, if the original complexes are more firmly bound, the mixture of the two samples might give rise to four peaks with unaltered, or only slightly altered, mobilities and areas. We have found both sorts of result in such tests.

These results suggest that the abnormal hæmoglobins which have been described may not, in fact, be actual different hæmoglobins but complexes of normal hæmoglobin with some other macromolecule which is constantly present and genetically inherited, and which, in some instances, may so alter the solubility properties of the hæmoglobin as to give rise to the 'sickle' phenomenon.

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Hæmolytic Anæmia produced Experimentally in the Guinea Pig by *T*-transformation of the Erythrocytes *in vivo* with Purified Concentrated Enzyme

DURING the continuation of work aimed at explaining the development and possible significance of the Thomsen phenomenon[1] *in vivo* (so-called polyagglutinability), it proved practicable to produce hæmolytic anæmia in guinea pigs by *T*-transformation of their erythrocytes *in vivo*. The term '*T*-transformation' applies to the production of the specific receptor-*T* in erythrocytes through the activity of an enzyme formed by various bacterial species[1].

In a preceding communication[2], it was described how *T*-transformation of the erythrocytes of guinea pigs *in vivo* can be induced by infecting animals with pneumococci. It has been found that *T*-transformation of the erythrocytes may also appear in guinea pigs in the course of spontaneous infection with *pnc.* 19. Furthermore, *T*-transformation *in vivo* can also be produced by giving animals intravenous injections of a solution of enzyme from *pnc.* 19. The present work was carried out with concentrated enzyme prepared by elution of the enzyme, combined with erythrocytes, on the lines described by Burnet *et al.*[3].

The investigation was commenced with several animals, but unfortunately some died early from irrelevant causes so that eventually only four experimental animals were available. The result appears so clear-cut, however, that its publication is thought to be of interest. As a matter of fact, in various ways, it has been confirmed by other experiments now proceeding.

The four animals were uniform as to size, age, sex and colour. Initially the amount of hæmoglobin, erythrocyte count and reticulocyte count were determined; and, for some time, the urine had been examined daily by the benzidine test and was found to be free from blood. The anti-*T* content of the serum was found to be considerable in two of the animals, but low in the other two.

In the two animals with high anti-*T* titre the erythrocytes were now *T*-transformed by intravenous injection of concentrated enzyme. The other two animals were given injections of the same amounts of saline, and they served as controls. Then, on every other day, hæmoglobin determination as well as erythrocyte and reticulocyte counts were carried out on all the animals. On every other day the erythrocytes were examined for *T*-transformation. The urine was examined daily for the presence of hæmoglobin. The animals—the *T*-transformed as well as the controls—suffered a loss of blood amounting to ¼–1 c.c. every other day. (The blood was taken from the ear as capillary blood, not withdrawn by heart puncture as the latter would have entailed a risk of internal hæmorrhage.)

In one of the animals whose erythrocytes were *T*-transformed, in the course of three days the hæmoglobin fell from 84 to 43 per cent; in the other animal of this group it fell in seven days from 99 to 46 per cent. The erythrocyte content showed a corresponding fall. The presence of hæmoglobin in the urine could be demonstrated in these animals during the first two days. No positive benzidine reaction could be ascertained in any of the other cases. The controls showed a fall in hæmoglobin from 91 to 90 and from 86 to 79 per cent, respectively, which corresponds to the presumably small loss of blood through sampling of the blood.

The two animals in which anæmia was produced were pale and weak, but icterus was not ascertained at any time. During the following two to three weeks, the hæmoglobin percentage and erythrocyte count rose again to normal values. In all the animals the fall in hæmoglobin was followed by a transitory increase in reticulocytes in the peripheral blood. Thus, in the two animals with pronounced fall in hæmoglobin, the reticulocyte count rose respectively from 0·2 and 0·4 per cent before the injection of enzyme to 17·8 and 19·0 per cent nine days after.

For the two controls the increase in the reticulocyte count was from 0·6 and 0·0 to 2·4 and 3·0, respectively.

The experiments described above will be reported in detail elsewhere.

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Isolation of Mucic Acid from Fruits

MUCIC acid has only been recorded twice as occurring in natural products, namely, in putrified blood[1] and in the diffusion juice from sugar beet[2]. Pure mucic acid has now been isolated from sound ripe peaches and pears by methods which make it appear certain that the acid was present in the free state in the fresh fruit.

The extraction and separation of the acids was carried out as described previously[3], except that the solution of acid and sugars (after removal of the bases and amino-acids with a cation-exchanger) was run straight on to a column of a strong-base anion-exchanger in the acetate form. This column was placed above two or more smaller columns of the same resin in the acetate form, and the acids were displaced with $0\cdot1\,N$ hydrochloric acid. Paper chromatograms of the fraction(s) between the malic and citric acid bands contained an acid with $R_F = 0$ in methyl ethyl ketone – cineole – aqueous formic acid (53 per cent w/v) (50 : 50 : 36 v/v)[3], and $R_{\text{malic}} = 0\cdot9$ in alcohol – ammonia – water (80 : 5 : 15)[4]. The isolated acid and mucic acid behaved identically on paper chromatograms and ion-exchange columns. The acids were revealed by rapidly pulling the paper through a solution of silver nitrate in acetone, followed by (*a*) heating the paper for a few minutes at about 100° C., and then (*b*) spraying it with alcoholic sodium hydroxide (cf. ref. 5). The chromatogram was then fixed with sodium thiosulphate (5 per cent). After treatment (*a*), all acids gave a white spot; after (*b*) acids having an α,β-glycol or an α-keto group gave an intense black spot on a grey background.

When the fractions containing mucic acid were allowed to stand at + 1°, crystals separated. Recrystallization from sodium hydroxide – hydrochloric acid yielded an optically inactive acid of melting point 215° (decomp.)[6], not depressed by authentic mucic acid. The diphenylhydrazide had melting point 242° [6]: The acid from peaches gave on analysis C, 34·2; H, 4·8; O, 61·0; that from pears C, 34·1; H, 4·9; calc. for $C_6H_{10}O_8$: C, 34·3; H, 4·8; O, 60·9 per cent. About 100 mgm. of mucic acid was isolated from 2 kgm. of ripe peaches or pears. Apricots, passion fruit and blackberries probably contain mucic acid in variable amounts, since crystalline precipitates, melting point 214–215°, were isolated from them by the same method.

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Effect of Silver Ions on Mitochondrial Adenosine Triphosphatase

Abood, Gerard and Ochs[1] claim that the respiration of cell-free dispersions and mitochondria of brain tissue was increased by the passage of electrical impulses between silver electrodes in the suspension medium. In general, increase in the respiratory rate of well-prepared mitochondria is consequent upon increase in the rate of removal of adenosine triphosphate, by addition of systems which catalyse its dephosphorylation, or through activation of the mitochondrial adenosine triphosphatase[2]. We were thus led to test the effect of electrical impulses on the adenosine triphosphatase activity of mitochondria, obtained from rabbit cerebral cortex, using the medium which had enabled the preparation of mitochondria of low initial adenosine triphosphatase activity from pigeon breast muscle[3]. For the adenosine triphosphatase assays the particles were incubated for 10 min. at 20° in a medium of the following approximate composition: $0\cdot1\,M$ potassium chloride, $0\cdot05\,M$ ammo*tris*hydroxymethylmethane-hydrochloride buffer *p*H 7·4, $0\cdot005\,M$ magnesium sulphate, $0\cdot005$–$0\cdot0075\,M$ sodium adenosine triphosphate, and $5 \times 10^{-5}\,M$ ethylenediaminetetraacetate. With $0\cdot0075\,M$ adenosine triphosphate, mitochondria from 60 mgm. of tissue liberated about 20 μgm. of inorganic phosphate under these conditions, and the activity was increased three-fold on addition of $10^{-4}\,M$ 2 : 4-dinitrophenol.

Electrical impulses (2–3 V., 25–75 m.amp., 50 c./sec.) were applied during the incubation through dipping electrodes (type *G* of Ayres and McIlwain[4]). With gold and molybdenum electrodes, there was no effect on the adenosine triphosphatase activity; but with silver electrodes the rate of phosphate liberation increased two- to three-fold. However, the mere presence of the silver electrode, without passage of current, or addition of low concentrations (10^{-6} to $10^{-5}\,M$) of silver nitrate, led to similar increases in adenosine triphosphatase activity.

In a paper[5] which appeared after the conclusion of these experiments, Narayanaswami and McIlwain state that pulses from molybdenum electrodes did not affect adenosine triphosphatase activity of dispersions of cerebral tissue, and, indeed, caused only a small increase in the respiration of brain mitochondria. Our experiments, however, disclosed the stimulation of mitochondrial adenosine triphosphatase by silver ions; and, since dinitrophenol also has this effect, it was of interest to determine whether silver ions behave similarly to dinitrophenol in other systems. The adenosine triphosphatase activity of pigeon breast muscle mitochondria was increased some five times by 10^{-5} *M* silver nitrate (optimal concentration). The reversal of the spontaneous swelling of muscle mitochondria *in vitro* by adenosine triphosphate, an action inhibited by dinitrophenol[5], was also inhibited by low concentrations of silver nitrate; brain mitochondria behaved similarly. On the other hand, the calcium-activated adenosine triphosphatase of myosin, which is stimulated by dinitrophenol[6] in rather high concentrations (for example, 60 per cent acceleration at 2×10^{-3} *M* [7]), is not stimulated by silver ions; under our conditions (*p*H 7·0, L-myosin 17 μgm. nitrogen/ml.) there was inhibition above 3×10^{-6} *M* silver ions (cf. ref. 8), and no acceleration at lower concentrations down to 10^{-7} *M*.

If silver ions stimulate adenosine triphosphatase activity of mitochondria, they might be expected to accelerate their respiration. Abood *et al.*[1] found no effect of 10^{-5} *M* silver ions on the respiration of brain dispersions; but we observed, with pyruvate together with malate as substrates, about 200 per cent acceleration of the respiration of brain mitochondria by 5×10^{-6} *M* silver nitrate.

We thank Dr. S. V. Perry for helpful discussions, and Dr. D. M. Needham for help in the preparation of the myosin. Acknowledgment is made to the Medical Research Council for continued support in the form of a research training grant to one of us (J. B. C.).

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Electrolyte Concentrations in Red Blood Cells of British Breeds of Sheep

DURING preliminary experiments on the electrolyte balance of adrenalectomized Scottish Blackface ewes, it became apparent that the concentrations of potassium and sodium in the red blood cells in this breed were not constant. Further examination revealed that they fell into two distinct groups in phenotypically similar animals.

This observation has now been extended to a larger sample of the breed. As the plasma sodium and potassium concentrations were the same in the two groups, a photometric examination of the whole blood enabled a satisfactory separation of the two electrolyte types to be made. It was found that the whole-blood sodium concentration varied inversely with that of the potassium. A separation into the two electrolyte types using sodium concentrations alone was not possible, however. Results are plotted in Fig. 1.

Ninety-three Scottish Blackface sheep were examined: eighty for both potassium and sodium and thirteen for potassium only. Of these, forty-seven were shown to belong to a type in which the concentration of potassium ranged about a mean value of 36 m.equiv./l., whereas forty-six belonged to a group which ranged about a mean of 13 m.equiv./l. These will be referred to as type *HK* and type *LK* respectively.

Sodium and potassium determinations were made on both plasma and whole blood in sixteen of these Blackface sheep—eight of each type—together with hæmatocrit readings. The red cells, by difference, were calculated to contain mean values of 34 and 80 m.equiv./l. sodium and mean values of 89 and 24 m.equiv./l. potassium.

As a 1 : 1 ratio for *HK* and *LK* types of sheep had not been reported previously, it was decided to examine another breed to see if this ratio was peculiar to the Scottish Blackface sheep or whether the ratio varied from breed to breed. A total of forty-three Cheviots was examined, thirty-nine for both potassium and sodium and four for potassium only. Of these, seven were shown to belong to the *HK* type and thirty-six to the *LK* type.

While this work was in progress, Widdas[2] published the results of an examination of twenty-two pregnant Welsh ewes, in which he found eight animals to belong to the *HK* type and fourteen to the *LK* type.

It is clear that, so far as the concentrations of sodium and potassium in the red cells are concerned in the three breeds examined, two types exist, and the distribution between groups varies from breed to breed.

The majority of merino sheep[1] appear to belong to the type *LK*, whereas representatives of both types have been recorded together with intermediate types in the Lebanese fat-tailed sheep[3]. It is intended to examine further the percentage distribution of the two types already recognized in the British breeds of sheep and to see whether intermediate types exist. Should the homogeneity of the merino and the heterogeneity of the fat-tailed sheep be confirmed when larger numbers are examined, there may then exist a method for a further study of the evolution and migration of the Ovidae. The role of electro-

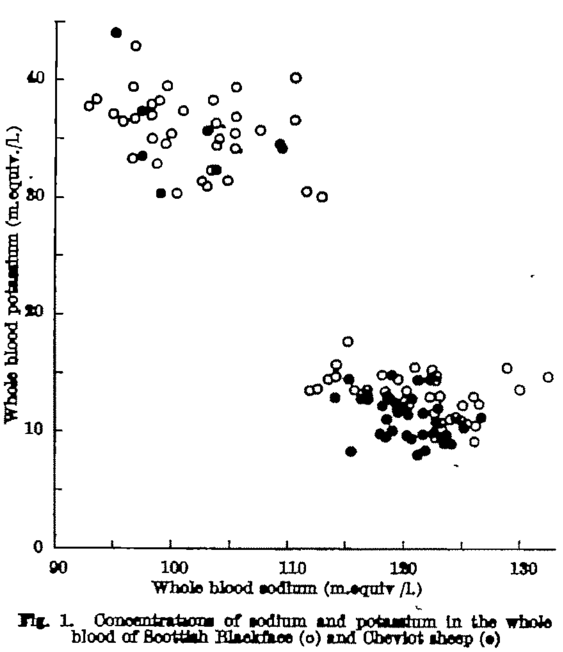

Fig. 1. Concentrations of sodium and potassium in the whole blood of Scottish Blackface (○) and Cheviot sheep (●)

lytes, and particularly of sodium and potassium, in the reaction of the body to unfavourable circumstances, suggests that it is important to determine whether there is any fundamental difference in the reaction of these two distinct types of sheep.

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Storage of Plant Mitochondria

ONE of the difficulties encountered in the purification of many plant enzymes is their low concentration in the intact cell. When enzymes are contained in the mitochondria, considerable concentration of such enzymes can be achieved by using isolated mitochondria as the starting material for further purification. An example of this approach is the purification of the acetate-activating enzyme of beef heart[1]. Millerd and Bonner[2] have pointed out that the difficulty in using this method in the case of plants is that no convenient sources exist for the isolation of large quantities of plant mitochondria. It has now been found that plant mitochondrial suspensions may be stored in the frozen state for at least thirty days. Although the activity of the mitochondria gradually decreases, the ability to store such suspensions makes possible the accumulation of relatively large quantities of material which can then be used for the isolation of specific enzymes.

Seeds of Algerian oats, *Avena sterilis* (L.) Mal. s. sp. *byzantina* (C. Koch) Thell., were soaked in water for 2 hr. and sown in moist vermiculite. They were grown in the dark at 26·6° C. for 6 days. At this stage, the above-ground portions of the plants, representing the coleoptiles, first leaves and first internodes, were about 6 cm. high. Mitochondria were prepared from the above-ground portions of the plants as previously described[3], using 0·5 *M* sucrose–0·01 *M* ethylenediaminetetraacetic acid, *p*H 7·0, as the homogenizing medium. The mitochondria were freed of ethylenediaminetetraacetic acid by suspension in 0·5 *M* sucrose and recentrifugation. The washed pellet was suspended in 0·5 *M* sucrose and the volume adjusted so that the nitrogen content of the suspension was 0·6–1·0 mgm. per 0·5 ml. The suspension was divided into 3–5 ml. portions and stored in 25-ml. Erlenmeyer flasks at approximately – 19° C. The mitochondria were assayed immediately after preparation and after various periods of storage. Thawing was accomplished by swirling the flasks for about 45 sec. in a constant-temperature bath maintained at 30° C.

The rate of oxidation of pyruvate in the presence of catalytic amounts of succinate was taken as an index of the activity of the mitochondria. Oxygen uptake was measured manometrically by the method of Warburg[4], and nitrogen was determined as previously described[3]. Results of representative experiments are presented in Table 1. The values given are for the total oxygen consumed in 60 min. and were corrected for the endogenous oxygen uptake. The rates of oxygen uptake were linear for 60 min. when the mitochondria were assayed immediately after preparation; but after storage, the rates usually declined somewhat during the second 30-min. period. The endogenous oxygen consumption, and the consumption in the presence of 0·001 *M* succinate, were of the order of 16 and 28 per cent respectively of the oxygen uptake in the presence of pyruvate plus succinate.

Table 1. OXIDATION OF PYRUVATE BY *Avena* MITOCHONDRIAL SUSPENSIONS AFTER VARIOUS PERIODS OF STORAGE IN THE FROZEN STATE. Final concentration of reagents: phosphate buffer (KH_2PO_4–K_2HPO_4) at *p*H 7·2, 2 × 10^{-2} *M*; magnesium chloride, 2 × 10^{-3} *M*; adenosine triphosphate, 10^{-3} *M*; diphosphopyridine nucleotide, 10^{-4} *M*; sucrose, 0·4 *M*; pyruvate, 2 × 10^{-2} *M*; succinate, 10^{-3} *M*; enzyme suspension, 0·5 ml. Final volume, 3·0 ml.; 0·2 ml. 10 per cent potassium hydroxide in side-arm. Gas phase, air. Temperature, 30° C.

Exp.	mgm. Nitrogen per 0·5 ml. mitochondrial suspension	Storage in days	mm.^{3} Oxygen absorbed per mgm. nitrogen in 60 min.
1	0·97	0	124
		8	101
		12	100
2	0·64	0	178
		21	92
		30	70
3	0·75	0	130
		23	79

In Fig. 1, the relative activity of the mitochondria is plotted as a function of the length of storage. The initial activity of a suspension was taken as 100. From these results, it appears that *Avena* mitochondria retain about 50 per cent of their initial activity after 25 days in storage at – 19° C. During this length of time, it is possible to accumulate large quantities of mitochondria.

The rapidity with which the mitochondrial suspensions are thawed appears to be a critical factor in the maintenance of activity. The results of two experiments to determine the effect of rapidity of thawing on the activity of mitochondrial suspensions are presented in Table 2. Rapid thawing at 2° and at 30° C. gave equally active preparations; but considerable loss of activity occurred when suspensions were thawed slowly at 2° C. After standing at 2° C. for 20 hr., even freshly prepared mitochondrial suspensions were completely inactive.

Experiments are in progress to determine the sensitivity of individual mitochondrial enzymes to low-temperature storage, and also the optimum conditions for storage.

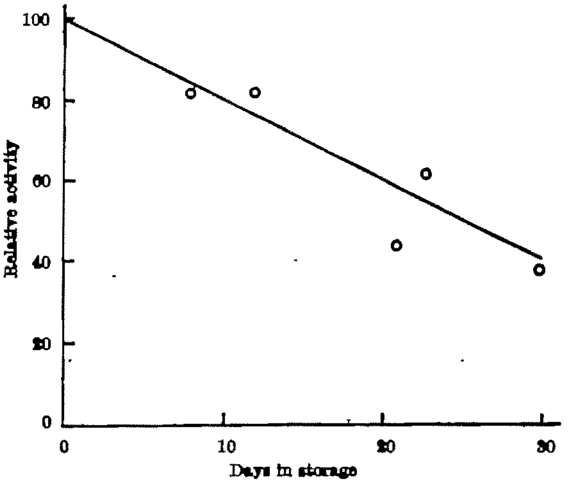

Fig. 1. Relative activity of *Avena* mitochondrial suspensions as a function of the length of storage. Data calculated from Table 1

Table 2. Effect of Rapidity of Thawing on the Activity of *Avena* Mitochondrial Suspensions after Storage in the Frozen State. Addenda as for Table 1. Exp. 1: 0·60 mgm. nitrogen per 0·5 ml. mitochondrial suspension. Exp. 2: 0·48 mgm. nitrogen per 0·5 ml. mitochondrial suspension

Exp.	Storage in days	Conditions of thawing	mm.^{3} Oxygen absorbed per mgm. nitrogen in 60 min.	Relative activity
1	0	—	226	100
	1	30 sec. at 30° C.	261	115
	1	5 min. at 2° C.	249	110
	1	2 hr. at 2° C.	133	59
2	0	—	272	100
	2	30 sec. at 30° C.	303	111
		6 min. at 2° C.	270	99
		5 hr. at 2° C.	161	59

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Effect of Thyroxine on Sexual Behaviour in the Ewe

The administration of thyroprotein to female rats caused an increase in weight of the ovaries, with histological evidence of intense luteinization[1]. It was found that iodinated casein proved beneficial in improving libido and fertility in inactive bulls. It has also been found to overcome 'summer sterility' in rams[2]. So far, little work has been carried out to investigate the effect of thyroxine on the various reproductive processes in the ewe.

In an experiment conducted at the Animal Research Station, Cambridge, to investigate the effect of orally administered L-thyroxine on wool production in the ewe, nineteen ewe lambs were used. Five of them were given L-thyroxine in gelatin capsules daily for eleven months from August 15, 1952, to July 17, 1953. For the first six weeks the dosage was 3·5 mgm.; it was raised to 5 mgm. for the next six months and then maintained at 4·5 mgm. for the last three and a half months. After two months of the cessation of thyroxine administration and at the beginning of the breeding season (October 1953), when the treated ewes were allowed to run with the ram, they exhibited hyper-sexual activities characteristic of male behaviour, namely, jumping and mounting other animals. These symptoms took place at the normal breeding season. It appears that an intensification of the normal œstrous behaviour took place at about the time of ovulation. However, these ewes were served and lambed as normal.

Another experiment was conducted to investigate this effect and also the possibility of bringing the ewes on heat during the anœstrous period. Of ten ewes, five were fed daily 7 mgm. L-thyroxine from April 1 to May 20, 1954, the other five being used as controls. They were running continuously with a vasectomized ram. The ram's briskets were ochred daily and the ochre colour was changed every fourteen days. Observations for œstrous were carried out daily. None of the treated ewes was served by the ram. However, two ewes showed the same type of hypersexual activity as had been observed previously. The two ewes did not attract the attention of the ram running with them, and neither did the other ewes. The ram was changed and replaced by another ram known to have recently served artificially œstrous ewes, but this ram also did not serve the two ewes. Moreover, the two ewes did not show normal œstrous periodicity. They were active intermittently, with never more than four or five days rest. Laparotomy was performed on the more active of the two ewes the day after it was observed to be active. Both ovaries were very small and showed no sign of follicular activity. These observations seem to be a more abnormal type of behaviour not linked to ovarian activity. Perhaps the best way to explain these results would be to attribute this behaviour to an effect on the central nervous system. It is well known that, in the human, hyperthyroid individuals tend to be over-excitable.

J. Hammond, jun.[3], observed jumping on other ewes by an ancestrous ewe injected with stilbœstrol. He also observed it once in a normal ewe at œstrous and often in normally œstrous ewes after stilbœstrol injection (personal communication). He offered the opinion that such male behaviour seems to be due to prolonged stimulation rather than to heavy dosage of œstrogen. However, there is no evidence that in the animals treated with thyroxine œstrogen secretion was at all enhanced.

So far as bovine fertility is concerned, it is of great importance to have a wider knowledge of the effects of hyperthyroidism induced by the administration of thyroxine on ovulation and implantation of the fertilized ova.

I am indebted to Dr. John Hammond for his guidance and advice, and to Mr. J. Hammond, jun., for suggestions during the course of the present investigations.

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Phenetidine in Urine

The urinary substance referred to as *B* in a previous communication[1] has now been isolated in pure form. It can be shown to be *p*-phenetidine by its infra-red and ultra-violet spectra, the melting point of a picrate (176–180° C.) and lack of depression of melting point in a mixture with authentic *p*-phenetidine picrate (179–181° C.). It is present in urine as a labile acidic substance which can be precipitated by lead acetate and purified by paper chromatography from butanol–acetic acid (R_F about 0·5). The precursor seems to be a conjugate with sulphuric acid. About 2–3 per cent of administered phenacetine is excreted in this form.

Substance *B* was believed to be a tryptophan metabolite because a compound with the melting point of quinaldic acid was isolated from the urinary concentrates, and spectroscopic evidence for a derivative was compatible with *o*-aminobenzyl alcohol until comparison with authentic samples became possible. Numerous compounds with similar ultra-violet spectra could be differentiated using the characteristic shifts of the absorption maxima in three solvents: 0·05 N hydrochloric acid, 0·1 N ammonia and ethylether.

The reported biological relationship of substance B (*p*-phenetidine) can be explained by (*a*) suppression of kynurenine excretion by some constituent of the antipyretic–analgesic mixtures containing phenacetine. Phenacetine itself fails to suppress the excretion of kynurenine. The second factor (*b*) seems to be increased need of analgesics in patients on a meat-free diet. The occurrence of phenetidine in apparently healthy people may be an index of self-medication (about 10 per cent).

Thanks are due to the National Cancer Institute of Canada for financial assistance, and to Drs. J. Patrick and K. Wiesner for samples of *o*-aminophenylmethylcarbinol and *o*-aminobenzylalcohol, respectively.

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Chromosomal Biotypes in Emmer Wheat

THE emmer wheat (*Triticum dicoccum* Schrank) and some of its varieties are known for their resistance to black rust, and the Indian emmer or khapli is extensively used in breeding rust-resistant varieties. It is usually grown in Central and Southern India and is commonly known as khapli wheat; botanically it is *Triticum dicoccum* Schrank var. *farrum* Bayle. According to Percival[1], the Indian and Abyssinian emmers have had a common origin and both are allied to *T. dicoccum* Schrank var. *ajar* Percival.

In a collection of the Indian emmer wheats (khapli) at the Indian Agricultural Research Institute, New Delhi, two distinct races have been discovered differing from each other with respect to certain characters. These are shown in Table 1.

The two types also differ cytologically in having either one or two pairs of *SAT*-chromosomes. As is well known, all the tetraploid wheats ($2n = 28$), including *T. dicoccum*, have two pairs of *SAT*-chromosomes, whereas these types, provisionally called biotypes 1 and 2, breed true to their chromosome type, that is, the number of *SAT*-chromosomes (Fig. 1). So far as we know, such chromosomal biotypes have not been hitherto reported in emmer wheat and perhaps also not in other species of the genus *Triticum*. In barley, however, chromosomal biotypes have been recently reported by Hagberg and Tjio[2].

Table 1

Characters	Biotype 1	Biotype 2
Length of ear	13·0 cm.	9 0 cm.
Pollen size	44·5–64·7 µ	48 0–68·0 µ
Pollen fertility	79·0 per cent	97·4 per cent
Grain-setting	67 5 per cent	90·0 per cent
Grain size	9 0 mm. long 2·5 mm. wide	8·0 mm. long 2·3 mm. wide

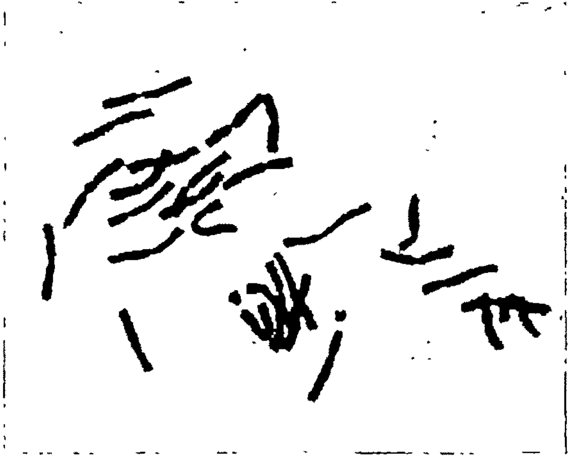

Fig. 1. *T. dicoccum* Schrank; $2n = 28$, with only one pair of *SAT*-chromosomes

Fertility and grain-setting in interspecific crosses between khapli (*T. dicoccum*) and bread wheat (*T. aestivum*) have been variously reported by different workers. Haynes[3] succeeded in getting fertile F_1 plants in reciprocal crosses between "Federation" and khapli. In crosses between "Garra", "Steinwedel" and khapli, Waterhouse[4] obtained as high as 65 per cent of grain-setting. Pal[5] has reported the F_1 hybrids between khapli and bread wheat to be "fairly highly fertile", while Bhatia[6] has recorded some seed-setting in similar crosses, but his F_1 plants did not grow to maturity. Recent observations at this Institute, however, have given almost the opposite results. Crosses made between khapli and bread wheat have given consistently highly sterile F_1 plants. This confirms the observations made earlier by Hayes and Stakman[7]. In view of the occurrence in Nature of two chromosomal biotypes of khapli, differing in their relative fertility, such variation in the fertility of F_1 hybrids, as observed by previous workers, is not only possible but also significant. Further studies on the behaviour of the hybrids of the two biotypes of khapli and types of *Triticum aestivum* in various combinations are likely to throw much light on: (i) the problem of relative fertility of the hybrids; and (ii) the relative resistance of the hybrids to the different races of black-rust.

We thank Dr. B. P. Pal, director, and Dr. R. D. Asana, head of the Division of Botany, Indian Agricultural Research Institute, New Delhi, for giving the material and facilities to conduct the present investigation.

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A Supernumerary Pelvic Fin in the Powan (*Coregonus clupeoides* Lacépède)

An abnormal pelvic structure in the form of an additional median fin (Fig. 1) was first observed in the powan during field studies on the population of this species of whitefish in Loch Lomond in 1951. Between 1951 and 1953 eighteen fish, representing 1·5 per cent of the total number examined, were found to have this abnormality; its occurrence is independent of sex of the fish or of their regional location in the lake. All these fish were two or more years old, but one specimen reared in the laboratory showed that the structure first appears at the age of about six months.

The additional fin occupied the same position in all specimens, lying in a median vertical plane with its base set symmetrically between and slightly in front of the bases of the paired pelvic fins. Externally, it projected from the ventral surface to an extent which varied widely without relation to size of fish. In its smallest form it appeared as a mere knob 2 mm. in length, in better developed forms as a translucent and rigid spike or blade and in the most highly developed example it was three-quarters of the length of the pelvic fin, flexible and with dark pigmentation towards the free edge.

The skeletal features of the abnormal specimens were examined initially by radiography and some visually after staining with alizarin red for bone or victoria blue for cartilage and clearing. The skeleton of a well-developed additional fin consisted of a pair of small anterior bones, presumably the elements of a fin ray, behind which there were nine separate rays, long and halved, with their bases enlarged. The stems of the rays were jointed and branched distally into tapering filaments as in normal lepidotrichia. The ray bases were hinged to an elongate structure of bone and cartilage consisting of an anterior and a posterior element closely apposed. The anterior and larger element possessed lateral cartilages with which the inner surfaces of the half-rays articulated, and the hind end of the posterior element lay just in front, and quite independent of, the median symphysis of the broad posterior part of the normal pelvic bones. As there were no other bones in the abnormal structure, these two elements may correspond to radial bones. They had a shallow seating on the median ventral tendon connecting the protractor and retractor ischial muscles to the pelvic arch but appeared to have no connexion with this tendon, being held in position by connective tissue only. No muscles appeared to be associated with the abnormal fin, and the muscles serving the paired pelvic fins were similar to those in normal powan.

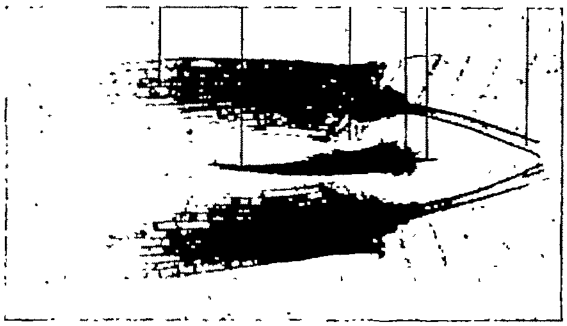

Fig. 1. X-ray positive of supernumerary fin, ventral view. *A*, Flexible rays; and *B*, their massive bases; *C*, bony projection of anterior element of supporting structure; *D*, normal pelvic fin (right); *E*, broad post-median part of pelvic bone (right); and *F*, its elongate anterior end

The average complement of rays and their pattern was the same in the paired fins of normal fish and those with the additional median fin. This fin therefore does not appear to have been derived from elements of the pelvics or to be connected in any way with them. It may be regarded as a true supernumerary fin the origin of which is uncertain. A more detailed description of its structure will be given elsewhere.

The occurrence of an additional fin in the pelvic region is now known to be present in two other members of the genus *Coregonus*. It has been reported (M. Dottrens, personal communication, 1953) to exist in approximately one per cent of the population of whitefish in Lac de Thoune, Switzerland, in a variety of *Coregonus wartmanni* known as the albock. In 1953 a similar abnormality was discovered in one of sixty specimens of the schelly (*Coregonus clupeoides stigmaticus*) from Ullswater in the English Lake District (G. J. Thompson, personal communication, 1953). The powan and schelly belong to the same British species and *C. wartmanni* is generally considered to be their closest relation among the numerous coregonid fishes in the continent of Europe. Since this abnormality has appeared in three isolated populations, further study may reveal whether it is attributable to a mutant genetic factor in this particular group of coregonids or in the genus as a whole. If it is restricted to the former, then it may provide a clue to their distribution in the Old World.

My thanks are due to Prof. C. M. Yonge and to Dr. H. D. Slack for their support and assistance, and to Dr. E. Trewavas, curator of fishes in the British Museum (Natural History), for technical advice.

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July 23.

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A Curious Ecological 'Niche' among the Fishes of Lake Tanganyika

Previous studies on certain Tanganyika Cichlids[1] have shown that, in species of the genus *Plecodus*, the stomach content is often composed of fish scales. It was not known if this was an indication of a very peculiar diet, and whether these scales had been taken from live or dead fish.

By collecting live and dead specimens of *Plecodus straeleni* Poll, *Plecodus paradoxus* Boulenger and a dead specimen of a *Pl. elaviae*, we are in a position to answer these questions. In one dead specimen of *Pl. straeleni* we have found the stomach full of ctenoid scales and in another one, of *Pl. paradoxus*, the stomach was full of Cichlid and Cyprinid scales, and did not contain any other food. In an aquarium we have been able to observe two *Pl. straeleni* feeding on the scales of a new species of *Lamprologus*, on those of *Lamprologus compressiceps* and of *Callochromis macrops*, all of which are bigger than the *Plecodus*.

It seems very difficult to feed *Pl. paradoxus* on earthworms, fish powder or insects. As for *Pl. straeleni*, we have been unable to feed them on any-

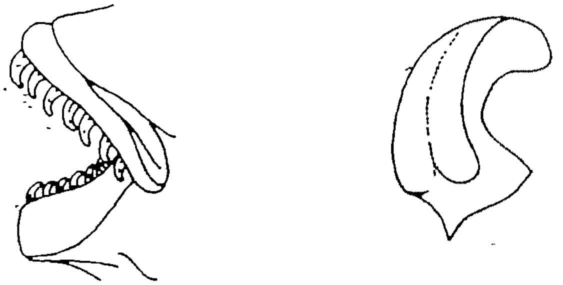

Fig. 1. *Plecodus paradoxus* Blgr. Dentition and isolated tooth (lateral view) after Poll (1948)

thing other than scales of live fish. When a *Plecodus* succeeds in attacking a fish, it pushes its mouth against the back of its victim for a short while. Then it swims away, leaving a denuded spot.

In the aquarium it seems that some species of fish know how to escape the attack of *Plecodus*, and they are able to drive them away from their shelter. For example, we have never seen a *Plecodus* 'scaling' a *Lamprologus savoryi* Poll, though a frequent fish in the *Plecodus*' environment, or a *Lobochilotes labiatus* or a *Simochromis curvifrons*. Some other fishes swim away from a *Plecodus* as soon as it appears (for example, *Lamprichthys tanganicanus*).

Of the four species of *Plecodus* (*Pl. paradoxus*, *straeleni*, *elaviae*, *multidentatus*) the first three were caught above a rocky bottom, the fourth one, above a muddy bottom, at considerable depth (90 m.). The first two are more littoral than *Pl. elaviae*. Sometimes, native fishermen catch *Pl. paradoxus* and *elaviae* with lines, baited with pieces of a small fish (*Stolothrissa tanganicae*). Thus it seems that adult *Plecodus* may secondarily turn to true carnivorous habits.

This peculiar way of feeding, so far as we know, has not been described in any marine fish, and the problem is how it has evolved from typical voracious habits. However, the dentition of *Plecodus*, with powerful band-like teeth, bending backwards (Fig. 1), seems, as Poll's figures show it, to be well adapted to that particular diet.

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July 2.

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[1] Poll, M., *Bull. Inst. Sci. Nat. Belg.*, 24, 26 (1948); 25, 33 (1949).

Occurrence of a Species of *Ornithodoros* in Britain

WHILE visiting Puffin Island, at the north-east end of the Menai Straits (North Wales) on May 16, 1954, about a dozen specimens of an argasid tick consisting of late nymphal stages and adults of both sexes were collected from under a stone in a dry part of the cliff. They possessed the movable cheeks to the camerostome; the legs, which were micromammilate, lacked dorsal humps, and the disks on the dorsal surface of the body were large and conspicuous. They were identified as an *Ornithodoros* species of the *talaje* group. A critical examination of this group by comparison with specimens from the British Museum (Natural History) is now being made.

The presence of *Ornithodoros* in Britain is interesting for two reasons: (1) several species are well-known carriers of a number of important diseases; and (2) the genus has been regarded as confined to the tropics and sub-tropics. So far as we are aware, apart from this occurrence in Britain, the most northerly records of the species of the *O. talaje* group are from the Central and Eastern Mediterranean countries.

A second visit on June 9 to Puffin Island showed the incidence of *Ornithodoros* was much greater than we had hitherto imagined. The ticks were found under stones some twenty feet above high-water mark in a well-defined zone of soft fossiliferous calcareous shale which has been more extensively weathered and therefore recessed a foot or two between harder layers of Lower Carboniferous limestone. They occurred in this dry region in company with the beetle *Harpalus latus* (L.), the bristle tail *Petrobius maritimus* Ouds., the earwig *Forficula auricularia* L., and the mite *Molgus littoralis* (L.).

The rest of this small island was examined with the view of determining the distribution, and it was found that the ticks were present along the whole of the north-west cliff and around the north-east tip of the island, but only in places where this particular stratum was exposed. Numerous limestone outcrops, old limestone walls and a large number of nests of herring and lesser black-backed gulls over the top of the island were examined without success.

The numbers present on the island must amount to many thousands, for under small stones not more than six inches in diameter there were 10–100 ticks. The majority of these were in the adult stage, and a rough count showed that 1 per cent were engorged. Large numbers of egg clusters were also noted alongside adults during this second visit.

Although rabbits occur on the island, the main hosts were thought to be birds, and this was substantiated by the presence of avian blood in the engorged ticks. Curiously enough, the main concentrations of these ectoparasites were some way removed from any bird colonies, and in one or two instances the nearest nests on the same ledge were 70 ft. away, although nests up the cliff face were probably no farther than 40 ft. Nesting sites near the tick areas were examined, and one or two *Ornithodoros* were present in some nests of cormorant, shag, razorbill and herring gull. Many chicks of the last species occur on the rock ledges near the ticks and these are possibly the main hosts.

It is clear that this tick is well established as a breeding species in this locality. Whether it occurs in similar situations around the British Isles remains to be seen. We have taken the opportunity of examining the sea-bird colony on Bardsey Island, off the tip of Caernarvonshire, but no *Ornithodoros* were found. However, it is of interest to note that the ixodid tick, *Haemaphysalis punctata* (Can. et Fanz., 1877), which has hitherto been recorded in the British Isles only from south-east England, was common here in rough pastures.

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July 30.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 15

University of London (at Guy's Hospital Medical School, St. Thomas' Street, London, S.E.1), at 5.15 p.m.—Dr. Christian Hamburger (Copenhagen): "The Excretion of 17-Ketosteroids in Human Urine".*

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. E. C. Cherry: "Information Theory".

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Has Nuclear Fission a Future as a Source of Industrial Power?".

Society of Chemical Industry, Pesticides Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. C. Tanner: "The Statistical Approach to Crop Protection Research".

Aslib (at the Royal Society of Arts, 8 John Adam Street, Strand, London, W.C.2), at 6 p.m.—Dr. Alexander King: "The Work of International Organizations and Foreign Documentation Centres".

Tuesday, November 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. C. W. Allen: "Activity in the Sun's Atmosphere".*

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 2.30 p.m.—Celebration of the Jubilee of the Thermionic Valve. The Most Honourable the Marquess of Salisbury, K.G., P.C.: Opening Address; Prof. G. W. O. Howe: "The Genesis of the Thermionic Valve"; Sir Edward Appleton, F.R.S.: "Thermionic Devices from the Development of the Triode up to 1939"; Dr. J. Thompson: "Developments in Thermionic Devices since 1939".

Physical Society, Low Temperature Group (joint meeting with the Institution of Chemical Engineers, in the Science Museum Lecture Theatre, Exhibition Road, London, S.W.7), at 4.30 p.m.—Dr J. W. L. Kohler (Eindhoven): "Gas Refrigerating Machines".

Institute of Physics, Electronics Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. V. Jelley: "Čerenkov Radiation".

Physical Society, Acoustics Group (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5.30 p.m.—Mr. A. Tumarkin: "On the Function of the Middle Ear—Evolution and Degradation".

Society of Chemical Industry, Plastics and Polymer Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. N. A. Hawthorn: "The Electrical Properties of Plastics".

Institution of Mechanical Engineers, Hydraulics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Measurement of Flow".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. H. T. Goodwin: "Uses of the 'Ace' Computer".

Wednesday, November 17

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. F. L. Warren: "Electrophoresis of Plasma Proteins".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Leslie H. Lampitt: "Science and Food Production" (H. Frankland Armstrong Memorial Lecture).

Institute of Petroleum (at the Royal Institution, Albemarle Street, London, W.1), at 4.30 p.m.—Mr. C. A. P. Southwell: "Winning Petroleum—a Story of British-American Co-operation" (Cadman Memorial Lecture).

Royal Meteorological Society (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.45 p.m.—Discussion on "Water Supply".

Royal Statistical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Lord Piercy of Burford, C.B.E.: "The Macmillan Gap and the Shortage of Risk Capital" (Inaugural Address of the President).

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Christopher Ounsted: "Genetic and Social Aspects of the Epilepsies of Childhood".*

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. H. Heywood: "The Microscopes of John Marshall".

Royal Institute of Chemistry, London Section (at the Institute of Metals, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Annual General Meeting. Sir Harry Jephcott: "Professional Status".

Royal Aeronautical Society (at 4 Hamilton Place, London, S.W.1), at 7.30 p.m.—Captain J. L. Pritchard, O.B.E.: "Bird Flight and the Aeroplane" (Graduates' and Students' Section Lecture).

Wednesday, November 17—Thursday, November 18

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1)—Autumn General Meeting.

Wednesday, November 17—Saturday, November 20

National Physical Laboratory (at Teddington, Middlesex)—Symposium on "Precision Electrical Measurements".

Thursday, November 18

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Special General Meeting. Mr. W. A. Sexton: "Chemotherapeutic Research at the Laboratories of Imperial Chemical (Pharmaceuticals), Ltd., at Manchester".

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. H. Jeffers: "The Collected Correspondence of Richard Pulteney, M.D., F.R.S. (1730–1801)"; Mrs. P. D. Wilson: "Mrs. A. W. Griffiths of Torquay and the Early History of Marine Botany in Britain".

Institution of Electrical Engineers, Utilization Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. J. Beavis: "The Use of Electricity in the Production of Calcium Carbide".

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Kramers (Delft): "Heat and Mass Transfer. 1: Unsteady States".*

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. A. G. Everson Pearse: "Histochemistry and its Applications to the Basic Sciences"*. (From a series of lectures on "The Scientific Basis of Medicine".)

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Dr. L. J. Wood: "The Constitution and Structure of Coal Tar Pitch".

Chemical Society (in the Large Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.30 p.m.—Prof. M. J. S. Dewar: "Molecular Rearrangements" (Tilden Lecture).

Friday, November 19

Royal Society of Medicine, Epidemiology and Preventive Medicine Section (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "The ABO Blood Groups and Disease". Opening speakers: Prof. Ian Aird, Miss A. M. Dickins and Dr. J. A. Fraser Roberts.

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Captain F. J. Wylie, R.N.: "The Cause of 'Radar-assisted Collisions'".

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. G. W. H. Gardner: "Guided Missiles" (James Clayton Lecture).

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. Kramers (Delft): "Heat and Mass Transfer. 2: Gas Absorption".*

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. G. B Foster: "The Analyst in the Fine Chemicals and Pharmaceutical Industries".

British Glaciological Society (in the Geology Department, The University, Oxford), at 8.15 p.m.—Discussion meeting on "Recent Trends of Glacier Fluctuations in the North Atlantic Area". Speakers: Mr. M. M. Sweeting, Mr. C. W. M Swithinbank and others.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Models of Metal Structure".

Saturday, November 20

Nutrition Society (in the Clinical Lecture Theatre, Middlesex Hospital Medical School, Mortimer Street, London, W.1), at 10.15 a.m.—Symposium on "The National Food Survey of Great Britain".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Harry Luke: "Easter Island".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Analytical Chemist (with an appropriate university degree or Associate of the Royal Institute of Chemistry, and preferably with some experience in an industrial laboratory) in the Central Laboratory—The Chief Personnel Officer, North Western Gas Board (Liverpool Group), Radiant House, Bold Street, Liverpool 1 (November 17).

Lecturer (with a university degree in engineering, some industrial experience, and preferably some teaching experience) in Mechanical Engineering—The Principal, Dudley and Staffordshire Technical College, Dudley (November 19).

Assistant Lecturer or Lecturer in the Department of Inorganic and Physical Chemistry—The Registrar, The University, Liverpool (November 20).

Senior Lecturer (with high academic qualifications and able to teach to special (honours) degree standard) in the Mathematics Department—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (November 20).

Junior Assistant Physicist (with a good honours degree and preferably some postgraduate experience) in the Department of Physics Applied to Medicine, Middlesex Hospital Medical School—The Secretary, Barnato Joel Laboratories, The Middlesex Hospital, London, W.1 (November 22).

Lecturer (with a good honours degree) in Geography, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (November 22).

Scientific Officer (with an honours degree in bacteriology, or an honours degree in science with a diploma in bacteriology, and preferably with a good knowledge of chemistry) in the Bacteriology Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (November 22).

Assistant (with a degree or equivalent in mathematics or statistics) for numerical and computational work arising from mathematical and statistical research on animal and plant populations—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (November 27).

Principal Scientific Officer (with a first- or second-class honours degree or equivalent in mechanical engineering or physics, with appropriate experimental experience and some knowledge of thermodynamics) in the Naval Air Department of the Royal Aircraft Establishment, Bedford, to take charge of a section responsible for research, development and testing of catapults for launching aircraft from carriers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.728/54A (November 27).

Assistant Lecturer in Pure Mathematics—The Registrar, University College of North Staffordshire, Keele, Staffs (November 30)

Lecturer, Grade II (preferably with industrial experience in the development of electrical machinery) in Electrical Engineering—The Registrar, The University, Birmingham 15 (November 30).

Senior Lecturer (graduate of a British university, with appropriate qualifications and experience) in Physics, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, November 30)

Technical Advisory Officers (with a degree in botany or agriculture or a recognized diploma in agriculture or horticulture, and preferably with a leaning towards, and experience in, grassland work), for work which involves the giving of advice to affiliated clubs and subscribing organizations on all matters concerning the establishment and maintenance of turf—The Director, Sports Turf Research Institute, St. Ives Research Station, Bingley, Yorkshire (November 30).

Research Assistant (preferably with experience of electronics) in the Department of Physics—The Registrar, University College Singleton Park, Swansea (December 1).

Research Officer (with a university honours degree in science or in veterinary science with physiology as a major subject, or equivalent qualifications) at the Sheep Biology Laboratory, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Great Western Highway, Prospect, New South Wales, Australia, to undertake investigations on the endocrinology of wool growth—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 205/55 (December 4)

Senior Research Officer or Research Officer (with a university degree in veterinary science or equivalent qualification and postgraduate research experience) at the MacMaster Animal Health Laboratory, Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, Parramatta Road, Glebe, New South Wales, to undertake investigations on parasitological problems of sheep, with particular reference to the control of liver fluke and to the development of and use of new anthelmintics—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 202/98 (December 4).

Chair of History and Philosophy of Science tenable at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 6)

Chair of Philosophy—The Secretary, The University, College Gate, St. Andrews (December 6).

Associate Professor (with a degree in science, engineering or metallurgy, with postgraduate research experience, and preferably some industrial experience) of Metallurgy, at Newcastle University College, New South Wales, Australia—The Agent General for New South Wales, 56–57 Strand, London, W.C.2 (December 21).

Assistant Experimental Officer (with at least H.S.C. or equivalent, and preferably conversant with radioactive measuring instruments) to assist in the development of prototype nucleonic instruments (Ref. 244/WGB/2); an Experimental Officer and an Assistant Experimental Officer (with at least H.S.C. in physics or equivalent) for research into the physical and mechanical properties of radioactive metals and alloys (Ref. 273/WGB/2); and an Experimental Officer (with at least H.S.C. and a knowledge of physical chemistry and some experience in chemical engineering) to assist in development work on high explosives on the plant scale and in the laboratory—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

Assistant Lecturer (graduate, with experience in teaching or in industry) in the School of Physics—The Registrar, College of Technology and Commerce, Leicester

Engineers and Physicists (with an appropriate first- or second-class honours degree or equivalent high professional attainments), in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A.

Honours Graduate for work involving a study of continuous fermentation on laboratory scale, and operation of small continuous culture plant—The Director, Antibiotics Research Station, 4 Hilton Road, Clevedon, Somerset.

Lecturer (with a good honours degree) in Electrical Engineering—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

Mathematical Physicists (with a first- or second-class honours degree in mathematics or physics, together with some years appropriate postgraduate experience) for work in one of the following fields: astrophysics, fluid dynamics, nuclear physics or statistics—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 283/WGB/34.

Principal Scientific Officer (with a first- or second-class honours degree or equivalent in physics or engineering, and with considerable research and development experience in the instrument-electronics field or related system of engineering in the aircraft industry) at the Royal Aircraft Establishment, Farnborough, Hants, to take charge of a project group responsible for the development in industry of a guided weapon—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.306/54A.

Technical Assistant (graduate chemist) in the Patents Division—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Colonial Office. Malnutrition in African Mothers, Infants and Young Children. (Report of the Second Inter-African Conference on Nutrition held under the auspices of the Commission for Technical Co-operation in Africa South of the Sahara (C.C.T.A.), at Fajara, Gambia, 19th–27th November, 1952.) Pp. 398 (56 plates). (London: H.M. Stationery Office, 1954.) 25s. net. [19

Shift Work. By F. P. Cook. Pp. 36. (London: Institute of Personnel Management, 1954.) 4s. [19

Science Museum, London. Book Exhibition Number Three: Historic Astronomical Books—Catalogue. Pp. 29. (London: H.M. Stationery Office, 1954.) 2s. net [19

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1952–53. Queensland. By R. W. Peters. Pp. 10. 9d. Tanganyika Territory, Eastern Province. By H. W. Valentine. Pp. 9. 9d. Survey of Reports. By J. B. Hutchinson. Pp. 14. 9d. (London: Empire Cotton Growing Corporation, 1954.) [19

Department of Scientific and Industrial Research. Report of the Food Investigation Board, with the Report of the Director of Food Investigation, for the year 1953. Pp. iv+56+4 plates. (London: H.M. Stationery Office, 1954.) 3s. 6d. net. [19

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (The National Fruit and Cider Institute), Long Ashton, Bristol, 1953. Pp. 218+18 plates. (Long Ashton, Bristol: University of Bristol, Department of Agriculture and Horticulture, 1954.) 15s. [19

Other Countries

Department of the Army—Corps of Engineers. Beach Erosion Board—Office of the Chief of Engineers. Technical Memorandum No. 44: Coast Erosion and the Development of Beach Profiles. By P. Bruun. Pp. vi+79+2. (Washington, D.C.: Department of the Army, Corps of Engineers, 1954.) [278

Southern Rhodesia: Federal Ministry of Agriculture. Annual Report of the Grasslands Agricultural Research Station, Marandellas, S. Rhodesia, for the year ending 30th September, 1953. Pp. iv+69. (Marandellas, S. Rhodesia: Grasslands Agricultural Research Station, 1954.) [19

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THE UNIVERSITY OF UTOPIA

ALTHOUGH the discussion on the adaptation of a university to the changing needs of the community, arranged on September 2 by Section L (Education) at the British Association meeting at Oxford, was somewhat circumscribed, the Section was well advised to raise a topic which has such general interest. The shortage of science teachers is only one particularly acute aspect of that general question. The expansion of technical and of technological education, and the supply of scientists and technologists as well as of administrators for industry and elsewhere, are other aspects of the adaptation of a university to the needs of the community. The means we adopt for meeting these changing needs, and the distribution of the nation's resources at the various levels of educational activity, depend in turn on our view of the true functions of a university and the stage at which and the means by which admitted defects are best corrected.

The British Association discussion was unrepresentative. Of its two papers, one, by Mr. J. T. Christie, principal of Jesus College, Oxford, was concerned with Oxford itself, as representing the two ancient universities. The other paper, read by Prof. F. A. Vick, in Prof. W. A. C. Stewart's absence, although concerned with what Sir Richard Livingstone characterized as the most interesting experiment in university education in Britain, could not claim, by itself, to be representative of the modern university. It was limited to a factual account of the University College of North Staffordshire, and an appreciation of the experience of its first four years, particularly with the fundamental idea of the exploratory foundation year. This is, of course, an attempt to broaden the range of academic courses, to meet the plea for more breadth which the Duke of Edinburgh, for example, voiced with such eloquence on his installation as chancellor of the University of Edinburgh. The important argument is, however, how and where the foundation for a broader education should be laid. The Duke of Edinburgh argued soundly that if narrowness begins in school it cannot be cured at the university or anywhere else. It is in school, he suggested, and not at the university, that the budding scientist should be helped, for example, to develop a taste for music and the arts, and the young historian an understanding and reverence for science. Clearly Sir Edward Appleton does not stand alone in deploring as a retrograde step the removal of two such broadening subjects as history and geography as higher subjects from the entrance examination to Scottish universities.

Even if, however, we accept it as a proper responsibility for the university to encourage general study, apart from providing a rich diversity of all the activities which make up civilized life, it should still be remembered that, as the title alone of a broadsheet, "The Keele Experiment" (No. 372 ; October 18, 1954), issued by Political and Economic Planning reminds us, the University College of North Staffordshire is only an experiment. For all the interest taken in this experiment in the Dominions and in the United States, as well as in Britain itself, it is far too early to form any opinion on the new type of university education provided at Keele. In ten or so years time, when there will have been more than a thousand graduates, it will be easier to see how the experiment is working. Meanwhile, this experimental basis makes a university college of no more than four hundred students completely unrepresentative of the 30,000 students in other modern English universities and university colleges, excluding London; moreover, there was no contribution to the British Association discussion from the University of London or the universities of Wales and Scotland.

Mr. Christie, however, not only fairly represented the nearly 15,000 students at Oxford and Cambridge, but also raised some significant points. His paper left no doubt that both universities are changing under the impact of social as well as of economic conditions, and that their growing dependence on State aid and the wider range of society from which their students are drawn involve problems and even threats to the performance of their functions. Mr. Christie is satisfied that there is at Oxford still the right balance of arts and sciences to provide a background for that wider informal education which is conducted by discussion and by living together in college. He indicated, however, that the university is increasingly concerned to meet the needs here of those students who come from homes with few books or cultural amenities, and that in these days an ancient university has perhaps a special responsibility for the preservation of the habits of civilized intercourse, and the ideas of knowledge for its own sake and education for leisure.

Such ideas are liable to come under pressure both from the demands of the State and from those of the individual who looks upon a university as being purely a means of training for a career. A university, Mr. Christie agreed, in a sense is always vocational; but once we admit that its essential task is to train men and women for the community and in the numbers the community requires for particular purposes, we are exposed to a danger of directed education which threatens the whole idea of the pursuit of knowledge for its own sake. Mr. Christie firmly maintained that something more than the vocational idea is an essential element in the university ideal; but although he indicated clearly enough the danger that the social climate may debase the idea of a university, he did not in this paper attempt to formulate any clear conception of the function and purpose of a university.

A valuable contribution to that end is to be found in Dr. R. M. Hutchins's "The University of Utopia"[*], and in the Sir George Watson Lectures on "The Idea of an American University" which he has since delivered in Britain. Although Dr. Hutchins's criticism is directed at the university as it exists in the United States, much that he writes about the dangers of specialization, of State control and of social and political conformity has its bearing on problems confronting universities in Britain to-day. The conception of the university and its functions in the world to-day which he embodies in the description of the ideal university of Utopia is no less stimulating and provocative in the British context than in that of the United States. Dr. Hutchins asks the right questions, and although we may not always in Britain give the same answers as are given in the United States, they are questions to which answers must be found before we can wisely decide how far the expansion of university or technological education should proceed, the right balance of studies in the universities, the distribution of resources between university, technological and technical education, the function of the universities in adult education and whether the attempt to secure greater breadth should be pursued in the schools or afterwards.

What stands out most clearly from the discussion at Oxford, and also in the pictures which Dr. Hutchins gives both of the American university and of the University of Utopia, is the dependence of the university on the character of the society it serves. The greatest weaknesses of the American university stem, in Dr. Hutchins's view, from weaknesses in American society. Mr. Christie similarly pointed to weaknesses in the ancient universities of Britain which arise fundamentally from social conditions in the homes from which their students are drawn. It is not primarily a matter of financial dependence, though that can also play a part—and on it Dr. Hutchins makes some caustic comments. The real case for university autonomy lies, in his view, on the proposition that societies require centres of independent thought and criticism if they are to progress or even to survive.

The conception of a university as a centre of independent thought is, of course, not new; nor is it inconsistent with the conception of the university as a place of vocational training, at least in so far as sovereign place is given to the educational rather than to the professional end. The conception of the university as a centre of independent thought, dedicated to the pursuit of truth by untrammelled thinking, by following the argument wherever it may lead, and meeting the critical encounter of other judgments, is implicit in the view of the functions of a university as expressed by the University Grants Committee nearly twenty years ago. Unless the universities are so dedicated and independent, they cannot stimulate and train their students "at least to think, and to think strenuously about the great issues of right and wrong, of liberty and government, on which, both for the individual and for the community, a balanced judgment is essential to a rational life".

Discussions on industry and the universities in recent years have made it unmistakable that such qualities of independent thinking are among those which industry looks for in recruiting university graduates, and the need for them in the Departments of State from Ministerial rank downwards has been forcibly demonstrated of late. The question of the true purpose of a university bears closely both on the extent and the character of the vocational or professional education which a university should give. Dr. Hutchins, in depicting the University of Utopia, seems to over-stress one aspect; but it should be remembered that he puts the right question first and also that in his Utopia much education or professional training of university status, in the sense in which the word is commonly used, is carried out in other institutions.

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[*] The University of Utopia. By Robert M. Hutchins. (Charles R. Walgreen Foundation Lectures.) Pp. ix+103. (Chicago: Univ. of Chicago Press; London: Camb. Univ. Press, 1953.) 19s. net.

If vocational education deflects the university from its primary function as a centre of independent thought, the imaginative pursuit of learning and the quality of its vocational education will soon suffer. The University of Utopia rests on the assumption that there should be somewhere in the State an organization the purpose of which is to produce men who can think most profoundly about the most important intellectual issues; and Dr. Hutchins, pointing out that this implies that unpopular opinions are likely to be heard in the university from time to time, insists that such a university can only function if its nature and purpose are clearly understood by the community. No one who has followed the post-war discussions on university development or the expansion of higher technological education in Britain can fail to appreciate the soundness of this argument.

Dr. Hutchins goes on to suggest that the first step towards clarifying the popular conception of the purpose and functions of a university is to exclude from the university those activities which are not proper to it, which prevent understanding of the function of the universities, and which create confusion in regard to it. There may be little danger in Great Britain of eccentricities in regard to degree subjects, of which Dr. Hutchins gives fresh examples; but some of the proposals in regard to technological education go far enough in that direction to prevent any self-righteousness. What is important to remember is that, as Mr. N. G. Fisher pointed out at a recent conference of the British Association for Commercial and Industrial Education, the universities are already subjected to pressures from students and the parents of students towards vocational education, or even training, which could easily divert them from their true function. Unless that task of educating public opinion as to the true function of the university is undertaken vigorously and continuously, there is real danger, not so much that insufficient public funds will be forthcoming for the universities, as that the universities will find their teaching so circumscribed by vocational demands that it is conceived solely in terms of qualification for a career.

Fortunately, in Great Britain the universities are still in a key position to influence the social pressures that shape them, and Dr. Hutchins's book is primarily of value as a reminder of the urgency and importance of that responsibility. The task is indeed being undertaken. Sir Hector Hetherington's Essex Hall Lecture last year on "The Social Function of the University", like the reports of the University Grants Committee, are important contributions to that end, and it is worth noting that Sir Hector essentially endorses Dr. Hutchins's criteria as to the fitness of a subject for university study, or indeed for study at any level in an educational system: it must have intellectual content in its own right.

The point is worth emphasizing again, because it bears closely on the expansion of technological education also and on the balance between that and technical education. Clear ideas as to the proper content of university and technological education are essential if standards are to be maintained and our limited resources of teachers of science and technology deployed to provide for the output of scientists and technologists which the interests of Britain manifestly demand. The recent conferences on industry and the universities arranged by the Federation of British Industries have fully endorsed the view set forth in the last quinquennial report from the University Grants Committee, namely, that a university has not fully discharged its obligations unless its teaching is so designed as to ensure for all of its students who use their opportunities the chance to become, in Mill's words, "capable and cultivated human beings". Nevertheless, much more could be done by both parties to those conferences, and probably also by the Parliamentary and Scientific Committee, to put such ideas before Parliament and the public in general.

MICHAEL SERVETUS, 1511–53

Michael Servetus

Humanist and Martyr. By John F. Fulton. (With a bibliography of his works and census of known copies, by Madeline E. Stanton.) Pp. 98+9 plates. (New York: Herbert Reichner, 1953.) 8.50 dollars.

Michael Servetus

A Translation of his Geographical, Medical and Astrological Writings, with Introductions and Notes. By Charles Donald O'Malley. (Memoirs of the American Philosophical Society, Vol. 34.) Pp. 208+5 plates. (Philadelphia: American Philosophical Society, 1953.) 3 dollars.

JUST over four hundred years ago, Michael Servetus, condemned by Calvin, was burned at the stake in Geneva because he had dared to regard the historical interpretation of Jesus as infinitely superior to the complex subtleties of the Trinity. But this original definition of the Unitarian belief is not the chief reason for the high place of Servetus in history. He is remembered to-day mainly as the discoverer of the pulmonary circulation. His anatomical knowledge was sound, and he not only discovered that the blood circulates through the lungs in passing from the right to the left side of the heart, but also he came very near to the anticipation of Harvey's discovery made in the following century, when he explained that "vital spirit is then transferred from the left ventricle of the heart into the arteries of the whole body". Those remarkable statements attracted little notice at the time, because they were buried in the pages of the famous theological work, "Christianismi Restitutio", of which only three copies escaped destruction, and which, as Dr. C. D. O'Malley states, is the book which helped to bring about its author's death but has also helped to keep his name alive.

This mixture of theology and physiology in a single work may appear strange to us in our own time of extreme specialism. We must recall the fact that the medieval mind was at least versatile, and that Servetus was more interested in the blood-stream as a vehicle for the soul or *spiritus*, rather than as a physiological phenomenon. The fact that an Arabic writer of the thirteenth century, Ibn an-Nafis, whose manuscript was discovered only in 1924, had grasped the idea of the lesser circulation, does not detract from the achievement of Servetus, who was probably unaware of this work. The question of priority is further complicated by the accounts of the pulmonary circulation, by another Spaniard, Valverde, in 1556, and by a successor of Vesalius at Padua, Realdo Colombo, in his "De re anatomica", 1559. Those descriptions may well have been based upon the work of Servetus. Remembering his fate, the writers would hesitate to acknowledge the source of their information. At all events, the discovery remained obscure for long, and Harvey, seventy-five years later, appears to have had no knowledge of Servetus.

All these questions are concisely discussed by Prof. J. F. Fulton in his admirable biography of Servetus. After due reference to the investigations of Galen and of Vesalius, as a background, Prof. Fulton discusses the career of Michael Servetus, on the basis of the comparatively slender evidence available. Studying at the universities of Saragossa and Toulouse, he led a wandering life, and we find him at Bologna and Basle, at Lyons and Paris, and lastly, to his undoing, at Geneva. His first two tracts on the errors of the Trinity, "De Trinitatis Erroribus" (1532) and "Dialogorum de Trinitate" (1533), shocked Catholic and reformer alike; so much so that for the next twenty-five years Servetus assumed the name Michael Villanovanus, after the town of Villanueva in Spain where he had spent his early years.

In Lyons, Servetus translated Ptolemy's "Geography", which had been a standard work since the second century, and added original material of his own. His estimate of the Scots is worth quoting: "They are brave in war, very enduring of hunger and lack of sleep, of pleasing manners, but very lacking in sophistication. They rejoice in falsehood, nor do they cultivate peace as the English". Dr. O'Malley has given us excellent translations of this and other works of Servetus. Among them is "In Leonardum Fuchsium Apologia" (1536), in which Servetus champions Symphorien Champier of Lyons against the equally eminent physician Leonard Fuchs of Tubingen: their quarrel relating to the differing views of the Greeks and the Arabists, whether the new disease of syphilis was the *lichen* of Greek times, and sundry other matters.

Servetus's work on the syrups (a generic term for many of the remedies of his time), "Syruporum Universa Ratio", dated 1537, accounts for more than half the pages of Dr. O'Malley's book. It deals extensively with Galen's views on digestion, or concoction, as he called it, and on the routine use of purgatives as an aid to health—a procedure followed for centuries and not altogether extinct to-day. The Discourse in Favour of Astrology, "Disceptatio pro Astrologia" (1538), shows that Servetus retained the medieval outlook. His translation of the Bible, issued in 1542, probably led Servetus to restate more strongly than ever his heretical views regarding the Trinity, in his "Christianismi Restitutio" of 1553, which led so swiftly to his death as a martyr.

The original editions of the works of Servetus are extremely rare, and the preparation of translations, and of a bibliography, must surely have been very hard tasks. Those tasks have been well performed, and Miss Stanton deserves special praise for a bibliography which presented such unusual problems. These two books, which have been reviewed together, do not conflict in any sense, but each is the complement of the other. Together, they form a worthy memorial to a gallant and tragic spirit who deserves to be remembered four hundred years after his untimely death.

Douglas Guthrie

THE RIGHT TO DISSENT

Freedom, Loyalty, Dissent

By Prof. Henry Steele Commager. Pp. x+99. (London: Oxford University Press, 1954.) 8s. 6d. net.

LIKE Prof. A. Macbeath's plea for heretics at the British Association meeting in Belfast, the five essays collected in this volume develop the pragmatic argument that the right to dissent, even to be wrong, is an imperative necessity for a society in which science or any other creative activity is to flourish. The several themes—the necessity of freedom and of experimentation, free enterprise in ideas, guilt by association, who is loyal to America ?—are linked by this argument, that to preserve and encourage the exercise of freedom of inquiry, investigation, dissent and association, whether in education, science, literature or politics, is not an abstraction or luxury but a first condition of the survival of a democratic society as it is understood in Great Britain or the United States.

Prof. H. S. Commager's essays are addressed to an American audience, but quite apart from the evidence they afford that there are those in the United States itself who have a national audience and are not afraid to attack McCarthyism, his refreshing defence of intellectual freedom will appeal to all scientists who welcomed Prof. Macbeath's forthright words. In the accents of Mill rather than of Burke, he argues for the encouragement of the experimental attitude in science, because "if we create a climate of opinion in which scientists fear to be bold and original or if we require that they work only on projects that appear to be of immediate importance to us, we shall end up with scientists and scientific knowledge inadequate to the tasks that we impose upon them". Similarly, he argues that without freedom to experiment in politics, the political system will prove inadequate to the demands now made upon it. Without freedom for the scientist, the scholar, the critic, without the open mind in politics, in economics, in international relations, even in the realm of morals we forfeit alike security and the ability to adapt ourselves to new demands or new situations.

Prof. Commager, no more than Prof. Macbeath, is not advocating license. He recognizes that there must be limits on liberty, as there are limits on authority. Here again, the appeal is to the practical, not to the constitutional or to natural rights. To draw the line between the exercise of freedom and the limitations on freedom is one of the most delicate tasks of statesmanship and philosophy, and the governing factor he suggests is that no society can afford the cumulative costs of the intimidation of thoughtful and critical men and women. Security and progress are most likely to be achieved by a government which scrupulously protects and encourages complete freedom of thought, expression, communication, investigation and criticism. "A society that attempts to put education and science and scholarship in strait jackets will find that in strait jackets there can be no movement and that the result will be intellectual atrophy."

But Prof. Commager does not merely attack. When he touches, for example, on the questions of loyalty and the right of association, he raises issues that run far wider than the activities of McCarthy and which call for examination in a British context. The divorce or gap between membership and responsibility is already embarrassing scientific societies in Britain, and the implications of Prof. Commager's comment here merit examination. What he writes further about the way in which a blow at the principle and practice of voluntary association endangers the working machinery of democracy is supported by the whole argument of such a book as C. D. McIver's "The Ramparts We Defend", or the late Lord Lindsay of Birker's writings on democracy. Once the notion that joining an organization may be dangerous is firmly established, all organizations or institutions will be affected, whether of science, the professions, education, the arts or government itself, and a fatal blow may well be dealt to the functioning of those communal groups in which, in the complexities of to-day, individual men and women increasingly find opportunity for self-expression and for influencing events. Gratitude for a lucid restatement of the case for freedom of thought and a courageous attack on illiberalism should not be allowed to lead to the challenge of this book being ignored, or prevent an examination of exactly why the pragmatic tradition proved too weak to inhibit the growth of McCarthyism. Why this retreat from reason ? R. BRIGHTMAN

DETERMINATION OF CRYSTAL STRUCTURES

The Determination of Crystal Structures

By Dr. H. Lipson and Dr. W. Cochran. (The Crystalline State—Vol. 3.) Pp. ix+345+9 plates. (London: G. Bell and Sons, Ltd., 1953.) 50s. net.

SOME crystals seem most reluctant to give up their secrets. Though they are easily persuaded to yield more than enough data for their structures to be found, yet with a perversity inherent in their very nature, they scramble it first. The problem thus presented to the X-ray crystallographer resembles a jig-saw puzzle of several hundred pieces each bearing the same pattern on both its sides, and he must decide where each piece belongs in the picture and which way up it should go—often indeed without any clear idea of what the picture will prove to be. This ambiguity, which conceals such valuable prizes, has called forth great ingenuity, especially during the past few years. The attack has been systematized, and this book is a manual of both strategy and tactics, the first, in fact, to be devoted so fully and exclusively to that end.

The authors presuppose that a set of intensities has been measured on some arbitrary scale, and address themselves to the interpretation, or the finding of a structure which not only makes chemical sense, but is also capable of refinement. This occupies four chapters. The refinement and the precision ultimately achieved are discussed in another chapter, while the first four are devoted to a detailed discussion of all the principles and computational routines which comprise the main tools of the structure analyst.

The volume lacks nothing of the high standards of scholarship and presentation that distinguished its predecessors, but its compilation has presented the authors with problems peculiar to this volume. Like painters busy on the portrait of an active child, they found their subject just would not sit still. Of the 309 references, 143 relate to the years 1948 and onward (three of them in 1953), which are the years in which the book was prepared. This does not imply a neglect of earlier publications, but is a fair indication of the spate of work with which the authors had to contend. One would have been satisfied if they had only harvested this prolific crop. They have, however, done much more. The crop has been threshed and assessed, and at every turn valuable comments are given from their own experience on the best ways of handling each different method: these are the tactics which so rarely find their way into the original literature.

Both the authors are well known to crystallographers as pioneers who have contributed substantially to this subject, and as writers with a clear and easy style. Their practical outlook has not prevented them from including results which, although of no practical utility, have thrown valuable light on the subject. They have effected valuable economies by referring freely to Vols. 1 and 2 of the series and to the "International Tables". In only one place (in the early part of Chapter 2) do they seem a little undecided about the level of experience expected from the reader, for though on one hand the symbols (graphic and Hermann–Mauguin) for screws and glides are introduced without explanation, yet it was apparently deemed necessary to deduce *ab initio* the systematic absences they produce. Very great care has obviously been taken in the proof-reading, for very few misprints have been found and, of these, only one, a tangle of signs in the last equation on p. 80 and the first on p. 81, involve more than a momentary interruption of the reading.

The publishers, too, share in the credit for this book in two ways especially. First, it was decided to make the book comprehensive up to the end of 1952, but the rapid and continued development of the subject could have made the book largely out of date at the time of its appearance had the publishers not co-operated so well. Secondly, the authors use some innovations in the numbering of figures and equations and in their combined author-index and bibliography. These are, as the authors hoped, a great help to all who will wish frequently to consult the book, but it is evident that it involved both the authors and the publishers in considerable extra work. They must be congratulated that the experiment was made and was not allowed to delay the appearance of the book.

The volume is freely illustrated and will stand up to all the hard wear it is sure to get. Its price is reasonable if judged by modern standards of size and quality, but is very reasonable if judged by its usefulness and the wealth of material that has been packed into it. It is certain that this book will stimulate yet more work, so that it will require considerable expansion in its second edition. It is at present small enough to permit of such expansion, and the foundation already laid should be ample to carry it. Anyway, by the time the second edition appears, these copies will be due for honourable retirement; they are not likely to get much peace until then.

D. ROGERS

THE SYNCHRONOUS INDUCTION MOTOR

The Synchronous Induction Motor
By J. Griffin. Pp. 136. (London: Macdonald and Co. (Publishers), Ltd., 1954.) 18s. net.

ROTATING electromagnetic machines form a family of machines in which a field-producing element and a current-carrying element react in such a way as either to convert electrical into mechanical energy or vice versa. The different methods used to activate the elements give rise to the various types of machines and include the use of direct or of alternating current and, in the latter case, of supply by direct connexion or by induction. Most types maintain the same methods during running as during starting, and their behaviour under both conditions of operation can be understood from consideration of the basic characteristics of their individual types. But the synchronous induction motor embodies the characteristics of two fundamentally different types: one, the induction motor, actuates both elements from a single source; the other, the synchronous motor, uses two different sources to energize the elements. One difficulty presented to the student of this machine is in understanding how the transition from induction motor to synchronous motor occurs, and how it will affect the machine in its ability to pull into synchronism; and another is in appreciating the effect of direct current flowing in a polyphase winding and producing a magnetic field.

The author of this book treats these problems in a practical manner, and his review is materially helped by the co-operation of manufacturers, who have provided the material for the many plates with which the book is illustrated. Mr. L. H. A. Carr, in a foreword, points out the value of a book which explains to utilization engineers the properties of a machine permitting power-factor control and to teachers the theory of the cylindrical rotor type of synchronous machine.

In the introduction the author pays tribute to the Swedish inventor Danielson, who brought out the motor in 1900, and gives in an appendix a translation of an article in *Elektrotechnische Zeitschrift* (December 26, 1901) by Danielson. A chapter is given to methods of starting, and some important points are made such as the necessity on the grounds of temperature rise to limit horse-power output demands when over-exciting the machine for power-factor correction. There are useful chapters on synchronous motor theory and on the economics of power-factor correction, and the effect of first cost is well discussed. Overload capacity, automatic control and electrodynamic braking are adequately and simply described. The merits of making the rotor carry the primary winding are well brought out, and general limits of the method as to voltage and output are stated.

Secondary windings are described generally and include double three-phase star, open delta, unsymmetrical three-phase star, two-phase with single-phase excited; and the general theory concludes with a comprehensive treatment of the problem of the exciting current and its calculation. A brief chapter on the salient-pole synchronous induction motor is interpolated, presumably for purposes of comparison of performance, and the book concludes with details and examples of general construction. There are a useful bibliography and a good index.

H. M. CLARKE

A MODERN VIEW OF INORGANIC CHEMISTRY

Comprehensive Inorganic Chemistry
Edited by Prof. M. Cannon Sneed, Prof. J. Lewis Maynard, and Prof. Robert C. Brasted. Vol. 1: Principles of Atomic and Molecular Structure. By W. N. Lipscomb. Theoretical and Applied Nuclear Chemistry. By P. R. O'Connor. The Actinide Series. By G. T. Seaborg. Pp. xi+232. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 35s. net.

THERE can be many plans for the writing of books. In this case different authors have contributed separate sections, each of which is, in its own way, complete within itself and relatively independent of the others. In such circumstances, one might ask whether the choice of articles is the best and whether any given topic has been developed in the most suitable manner.

The introductory section to the first volume of this series, by William N. Lipscomb, deals with principles of atomic and molecular structure. Discussion is restricted to extra-nuclear properties such as electronic structure, chemical bonds and structures of molecules and crystals. The material is very well presented in a space of eighty pages, an impression of completeness having been achieved by strict adherence to the main theme. The second chapter, on theoretical and applied nuclear chemistry, by P. R. O'Connor, also eighty pages in length, includes a useful account of elementary particles, nuclear structure and radioactivity, followed by a discussion of methods of radioisotope production and applications to chemical problems. The last chapter, on the actinide series, has been written by Prof. G. T. Seaborg. It is, of course, authoritative, and extremely well presented, although perhaps written with rather more bias towards the radiochemical point of view than is necessary in a volume on inorganic chemistry.

This criticism is one which might be levelled at the volume as a whole. The development of atomic energy has undoubtedly led to a great development in radiochemistry, and it is a good thing that this aspect of inorganic chemistry should be well to the fore in a modern treatise. If it seems to have been overdone in this instance, it is probably because the volume has the character of a collection of independent review articles rather than that of a really cohesive treatise. On the other hand, it must not be denied that the system has its merits, particularly when the standard of the individual articles is as good as in the present instance. The book should, therefore, be well received by students and research workers alike.

R. SPENCE

Infrared Absorption Spectra of Steroids

An Atlas. By Konrad Dobriner, E. R. Katzenellenbogen and R. Norman Jones. Pp. xlv+299. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953.) 11.50 dollars.

USUALLY infra-red spectra are duplicated or printed separately as in the American Petroleum Institute spectra of hydrocarbons, but occasional attempts have been made to provide collected spectra in book form. Nothing comparable with the present atlas in quality of spectra or wide range of comparatively inaccessible compounds has, however, previously appeared. At first sight, the atlas seems highly priced, but since 306 spectra are presented the cost only works out to about 3*d*. each, which compares favourably with, say, American Petroleum Institute spectra. It is obviously a great convenience to have spectra in book form, neatly classified, and it is probable that in years to come every department of organic chemistry will possess rows of volumes similar to this.

Each spectrum in the atlas has been obtained under the supervision of the authors with 1–5 mgm. of material dissolved in carbon disulphide, carbon tetrachloride or chloroform. By using a double-beam instrument with a variable-length cell in the comparison beam, the solvent absorption has been practically eliminated. The spectral regions covered are 1,800–1,580, 1,480–1,300, 1,400–650 and (in twelve cases) 3,700–2,800 cm.$^{-1}$. Even with steroids differing only in some minor point of structure, the spectra are distinct although the spectral differences may be quite small.

This work was started as an aid to cancer research by the late Dr. K. Dobriner. It is a matter of great regret that the death of this investigator has removed a distinguished pioneer from an important field, but this well-laid foundation will certainly be used to great advantage by others. A. E. MARTIN

Time Counts

The Story of the Calendar. By Harold Watkins. Pp. xi+274. (London: Neville Spearman, Ltd., 1954.) 15*s*. net.

THE first portion of this book gives a brief history of the calendar up to the time of the introduction of the Gregorian Calendar into Great Britain in 1752. If there is a second edition, the first chapter, which is based on the unacceptable theories of Hoerbiger and Bellamy, should be omitted.

The main part of the book is concerned with the various proposals that have been made for the reform of the Gregorian Calendar and, in particular, with the advantages of the scheme advocated by the World Calendar Association. A proposal in favour of the adoption of the World Calendar has recently been brought before the Economic and Social Council of the United Nations Organization by the Government of India, which is concerned with rectifying the complicated calendar situation in India, where many different calendars are in use; India would like, at the same time, to remove the illogicalities and inconveniences of the present calendar.

The Economic and Social Council at its meeting in Geneva at the end of July decided, by a unanimous vote, to refer the question of the reform of the calendar for study by the governments of the world, with the view of its discussion at the nineteenth session of the Council next year.

The fixing of the date of Easter is a separate question. The inconveniences of the date of Easter wandering over a period of thirty-five days are widely felt, and the adoption of the World Calendar would greatly facilitate the fixing of the date of Easter. H. S. J.

Lower Tertiary Foraminifera of the Qatar Peninsula

By Alan Hilder Smout. Pp. ix+96+15 plates. (London: British Museum (Natural History).) 45*s*.

THE title of this monograph obscures the fact that it is essentially a study of the Rotaliidea, almost half the contents being devoted to an account of the structure and evolution of the group, the remainder to systematics. Dr. A. H. Smout demonstrates that the rotaliid test is formed by "instars" of successive laminæ, each of which totally encloses the whole of the previously formed test, so that in *Nummulites*, for example, the test is constructed from a series of "chinese-box laminæ" and not, as previously thought, from a spiral chevron of shell material.

Evidence from physiology and fossil morphology, influenced by D'Arcy Thompson's "Growth and Form", is synthesized into a persuasive morphogenical argument. Conviction that direct adaptations are possible as a result of physical difficulties imposed on the sarcode by increase in size of the test leads to a limited Neo-Lamarckian interpretation, the author, however, being prepared to allow normal genetical factors to fix and translate the acquired character into the earlier stages of succeeding ontogenies. The systematics are concerned with a revised classification of the Rotaliidea; the erection of a new superfamily, the Discorbidea; and a description of rotaliids and a few associated forms from borings in north-east Arabia, including three new genera, *Dictyokathina*, *Kathina* and *Daviesina*, seventeen new species, and two new varieties.

The monograph, which is beautifully printed and illustrated, deserves to be much more widely read than might be expected from its generalized title, since the views expressed are fundamental to adequate appreciation of the structure and morphological evolution of the larger foraminifera.

The Geology of South Africa

By Dr. Alex. L. du Toit. Edited and prepared for publication by Dr. S. H. Haughton. Third edition, revised and enlarged. Pp. xiv+611+41 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 63*s*. net.

THE late Alexander du Toit's "Geology of South Africa" first appeared in 1926 (*Nature*, 119, 665; 1927) and was followed by a second edition in 1939. Du Toit himself had almost finished the text of this new revised and enlarged edition at the time of his death in February 1948. The task of completing the revision, with the aid of certain notes left among the author's papers, and the preparation of the manuscript for the press were placed in the capable hands of Dr. S. H. Haughton.

While the text has been left essentially in the state in which the author prepared it, attention has been directed, by means of footnotes, to later work by South African geologists in which views have been expressed, particularly on problems of correlation, that differ materially from those of the author. The coloured geological map that accompanies the volume has been completely revised and redrawn under Dr. Haughton's supervision. Geologists everywhere will welcome the new edition of this standard and authoritative work.

THE SPECIES SPECIFICITY OF MYOGLOBIN

By Dr. J. C. KENDREW and Dr. R. G. PARRISH*
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AND
Prof. J. R. MARRACK and Dr. E. S. ORLANS†
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Crystallographic Aspects

MYOGLOBIN is in many ways a very suitable protein for X-ray crystallographic studies, but has hitherto been scarcely a convenient one, since it is difficult to crystallize when obtained from the more common domestic animals. During a survey of less easily available animals—in particular the whales—we have found a number of new crystal forms of myoglobin, some of them very readily prepared. The main purpose of this survey was to discover crystals suitable for detailed study by X-ray diffraction, and accounts of such studies will be published elsewhere; however, the distribution of these forms among the species we have examined is also of interest from the point of view of species specificity and zoological relationship, and in the light of immunological studies described in the second part of this paper.

In searching for promising sources of myoglobin, we have mainly investigated aquatic mammals, and birds which spend a good deal of time under water; the skeletal muscles of such animals often contain so much myoglobin that they are almost black in colour. We have found that whales (especially the sperm whale, *Physeter catodon*), seals and penguins are particularly rich sources; on the other hand, a specimen of dugong meat (kindly sent to us from Ceylon by Mr. J. W. S. Pringle) was very pale and contained little myoglobin.

The procedure used for extracting and purifying the myoglobin was a modification of that described by Morgan[1], Theorell and de Duve[2], and Schmid[3]; it consists in essence of extracting the myoglobin from minced tissue with ice-cold water, and removing other proteins by treatment with lead acetate and by repeated recrystallization from ammonium sulphate and from concentrated phosphate buffer. Crystallization may be effected by salting-out from either of the latter media.

By methods of this kind, varying in detail from species to species, we have found some dozen crystal forms of myoglobin, all of which have been studied by X-ray methods. Of these (see Table 1) only the following have been previously described: horse myoglobin (type *C*), see Kendrew[4] and Kendrew and Trotter[5]; finback whale myoglobin (type *F*), see Schmid[3] and Kendrew[6]. Blue whale crystals of type *E* were first prepared by Dr. J. Keilin in 1951 and examined crystallographically by one of us[7]. The crystals of tortoise and carp myoglobins were first prepared by Hamoir[8] and Renard[9], and those used by us for X-ray analysis were made from material supplied by them. Besides all these, the myoglobins of a number of species, including cow, man, ass, mule and pig, have been crystallized by Rossi-Fanelli, Theorell, Roche, Vieil, Drabkin and their associates; we have omitted these from present consideration since in no case have they been studied by X-ray methods.

We find that several different types of crystal may sometimes be derived from the same species of animal (see Table 2); often different forms are obtained according to the salt used for precipitation (for example, sperm whale gives type *A* in ammonium sulphate, type *B* in phosphate), while sometimes different derivatives of the protein crystallize in different forms (for example, myoglobin of gentoo penguin; as metmyoglobin in phosphate this gives type *G*, as imidazole-myoglobin it gives type *H*. In ammonium sulphate the met-compound refused to crystallize, while the imidazole derivative gave

Table 1. Types of Myoglobin Crystal

Type	Principal source	Symmetry	Space group	Mol./cell	Cell dimensions (wet) a	b	c	β
A	Sperm whale* (from ammon. sulph.)	Monoclinic	$P2_1$	2	64·6 A.	31·1 A.	34·8 A.	105·5°
B	Sperm whale (from phosphate)	Orthorhombic	$P2_12_12_1$	4	48·9	40·2	79·3	
C i	Horse†	Monoclinic	$P2_1$	2	57·3	30·8	57·0	112°
	Seal‡	Monoclinic	$P2_1$	2	57·7	29·6	57·1	112°
ii	Seal§	Monoclinic face-cent.	$A2$	4	57·7	29·6	106·2	102°
iii	Horse	Monoclinic ψ-orthorh.	$P2_1$	4	57·0	30·8	106·0	91°
D	Blue whale	Orthorhombic	$P2_12_12_1$	4	33·9	60·4	76·6	
E	Blue whale	Orthorhombic	$P2_12_12_1$	12–16	144·5	37·7	107·5	
F	Finback whale	Orthorhombic	$P2_12_12$	4	97·4	39·8	42·5	
G	Gentoo penguin	Face-cent. orthorhombic	$C222_1$	8	48·3	80·2	78·5	
H	Gentoo penguin (imidazole deriv., phosphate)	Orthorhombic	$P2_12_12_1$	4	106·4	39·1	45·3	
I	Gentoo penguin (imidazole deriv., ammon. sulph.)	Orthorhombic	$P2_12_12_1$ (?)	4	94·5	38·3	43·5	
J	Carp	Orthorhombic	$P2_12_12_1$	4	55·0	46·5	51·7	

* A related lattice was obtained from tortoise (*Testudo graeca*), with space group $P2_1$ and lattice dimensions a = 64·3, b = 30·2, c = 36·4 A., β = 105°; the distribution of intensities is fairly similar to that of type *A*. A shrinkage stage of this lattice was observed.
† In addition, one shrinkage stage.
‡ In addition, one swelling stage.
§ In addition, three shrinkage stages.

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* Merck Post-Doctoral Fellow of the U.S. National Research Council at the Cavendish Laboratory, Cambridge, 1952–54.

† Holder of a Post-Doctoral Fellowship of the U.S. Public Health Service.

Table 2 DISTRIBUTION OF TYPES OF MYOGLOBIN CRYSTAL

	Types of crystal observed	Cross-reaction with anti-sperm-whale myoglobin *a*	*b*
CETACEA			
Odontoceti (toothed whales)			
Physeter catodon (sperm whale)	*A* *B*	+++	100
Phocaena phocaena (common porpoise)	*A* *B*	+++	33
Tursiops truncatus (bottle-nosed dolphin)		++	
Mysticeti (whalebone whales)			
Balaenoptera musculus (blue whale)	(*A*)† *D, E*	+++	(66)
Balaenoptera physalus (finback whale)	(*A*)† *F*	+	(35)
Balaenoptera borealis (sei whale)	*A*	+++	36 (90)
Balaenoptera acutorostrata (lesser rorqual)	*A*	+++	
Megaptera nodosa (humpback whale)	*D*	+++	33
PINNIPEDIA			
Phoca vitulina (common seal)	*C*	+	
Zalophus californianus (Californian sea-lion)*		+	
OTHER ORDERS			
Equus caballus (horse)	*C*	0	
Testudo graeca (tortoise)	*A* (?)	0	
Pygoscelis papua (gentoo penguin)	*G, H, I*	0	
Cyprinus carpio (carp)	*J*	0	

* Crystals obtained, but too small for X-ray analysis.
† Crystals of this form rarely obtained.

crystals of type *I*). On the other hand, we sometimes obtained virtually the same crystal form from two or more different species; by this we mean that the lattice dimensions were nearly identical, and the intensities of corresponding X-ray reflexions difficult to distinguish. In some cases (for example, type *A*) the resemblance is very close indeed; in others there may be appreciable changes in cell dimensions (for example, in type *C*, where horse myoglobin crystals have $b = 30 \cdot 8$ A. and seal crystals have $b = 29 \cdot 6$ A.), though the general resemblance is unmistakable. Tortoise myoglobin provides an example of a more distant relationship, its crystals showing a definite resemblance to crystals of type *A* but nothing approaching an identity; tortoise myoglobin crystals stand in the same sort of relationship to type *A* as would a shrinkage stage, if one were known. Crystals of type *C* form a most interesting group; as has been indicated in a recent paper[4], horse myoglobin generally forms pseudo-orthorhombic crystals having four molecules in the unit cell, this arrangement being derived by inversion of alternate sheets of molecules from a rare monoclinic form (two molecules/cell) obtained on one occasion only[4]. In the common seal as well we obtained two related forms: by crystallization from phosphate a monoclinic 2-molecule form closely resembling monoclinic horse myoglobin, and from ammonium sulphate a new face-centred 4-molecule monoclinic form derived from this by simple translation of alternate sheets of molecules in the *b*-direction instead of by inversion. The Patterson projections of these forms confirm these relationships, which will be discussed in detail elsewhere.

The close resemblances between certain crystal forms of myoglobins from different species provide justification for a comparative study of myoglobin structure using different types of crystal. The myoglobin molecules in sperm whale, in porpoise, and in four *Balaenoptera* species, all of them crystallizing in type *A*, must resemble one another extremely closely; indeed, from the still rather crude point of view of the X-ray analyst, one can certainly regard them as identical. These facts, taken together with the polymorphism of myoglobin from sperm whale and porpoise (types *A* and *B*), of blue whale (types *A*, *D* and *E*), and of finback whale (types *A* and *F*), mean that from this point of view we are entitled to assume the virtual identity of the myoglobin molecules present in types *A*, *B*, *D*, *E* and *F*, and to make comparative studies of these forms. Type *C* (horse and seal), types *G*, *H*, *I* (gentoo penguin) and type *J* (carp) still lie outside this system. In the absence of complete chemical analyses we cannot do more than guess at reasons for the slight but observable intensity differences between the diffraction patterns of, for example, type *A* crystals from different species; they are, however, of a magnitude which would be accounted for by differences of one or a few side-chains in the molecule. In monoclinic sperm whale myoglobin, differences of the same order of magnitude have been produced artificially by attaching an imidazole molecule to the hæm group prior to crystallization; but even so small an alteration in the molecule can sometimes produce a more extensive change in crystal habit. Thus in orthorhombic sperm whale myoglobin the imidazole derivative gives intensities so much changed from normal that one must assume an appreciable change in crystal packing, although the lattice constants are very slightly affected, if at all: in the gentoo penguin, as has already been pointed out, a complete change in crystal form is induced by the attachment of imidazole.

Immunological Aspects

The cross-reactions of the myoglobins of various species with antisera against sperm whale and seal (*Phoca vitulina*) myoglobins were studied by three methods:

(*a*) *Ouchterlony's method*[14]. Cup *A* (Fig. 1), which was cut out of a layer of agar in a Petri dish, was filled with antiserum; cup *B* with a solution of the homologous myoglobin (*M*) and cup *C* with a solution of another myoglobin (*M'*); the concentrations of the myoglobin solutions were about 0·02 per cent. Antigen and antibody diffuse into the agar and form a precipitate where they meet; the precipitate is soluble in excess of antigen, so that the band of

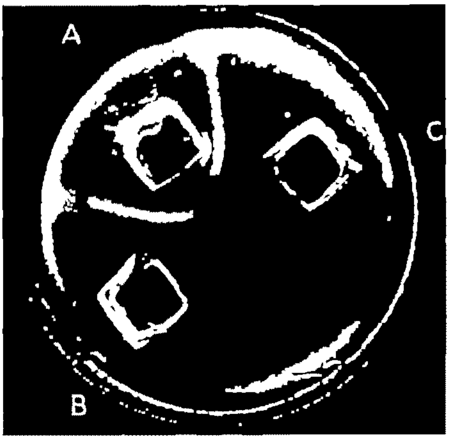

Fig. 1. Reactions of sperm whale and finback whale myoglobins with a solution of γ-globulin prepared from a pool of antisera against sperm whale myoglobin, demonstrated by Ouchterlony's method: *A*, γ-globulin solution; *B*, sperm whale myoglobin; *C*, finback whale myoglobin

precipitate is limited on the antigen side. If M and M' are identical, excess of antigen sufficient to inhibit precipitation is reached at the same place by antigen diffusing from B and from C: the left- and right-hand bands are continuous. If M' is similar to M and will precipitate some, but not all, of the antibody in the antiserum, excess with respect to the M'-antibody reaction will be reached before excess with respect to the M-antibody reaction: the bands will not be continuous (as in Fig. 1). The more similar M' is to M the more nearly will the right-hand and left-hand bands be continuous. If M' is so unlike M that it forms no precipitate with the anti-M serum, no band of precipitate will form on the right. Estimates of the degree of similarity of myoglobins of other species to sperm whale myoglobin, assessed in this way, are given in column *a* of Table 2.

(*b*) The maximum amount of precipitate formed by M' with anti-M serum can be used as another criterion of the immunological similarity of M' to M. The amounts of precipitates formed by various myoglobins with anti-sera against sperm whale myoglobin (expressed as percentages of the maximum precipitate formed by sperm whale myoglobin with the antisera) are given in column *b* of Table 2. The antisera used were from the same rabbit, bled on October 8 (1953) and March 12 (1954), after a further course of injections. The figures in brackets were obtained with the second sample of antiserum: it appears that, as is usual after more prolonged immunization, the second antiserum cross-reacted with heterologous antigens more strongly than the first.

(*c*) The antisera, particularly those against seal myoglobin, were rather weak. Concentrated solutions of γ-globulin were therefore prepared from the antisera, and rough visual estimates were made of the amounts of precipitate formed by the various myoglobins with these solutions; and the rates of flocculation of the anti-sperm whale myoglobin γ-globulin with various myoglobins (at optimum proportions) were compared.

As judged by these three criteria, the myoglobins may be classified into five groups, ranging from those in group (1) which cross-react very strongly with sperm whale myoglobin, to those in group (5) which do not cross-react at all: (1) porpoise, sei whale, and lesser rorqual; (2) humpback and blue whale; (3) dolphin and finback whale; (4) seal; (5) tortoise, horse, penguin and carp. (There is little distinction between groups (1) and (2).)

When sei whale or porpoise myoglobin was used in cup C in Ouchterlony's method, with certain samples of sperm whale antiserum in cup A, two distinct bands appeared on the right-hand side; on the left the separation of the bands are less definite. This is evidence that these antisera contain antibodies against two antigens in the sperm whale myoglobin and in the sei whale and porpoise myoglobins. The ratios of the two antigens in the sperm whale myoglobin to the two antibodies in the antisera were such that the points at which excesses of both antigens were reached almost coincided, whereas the ratio of the two antigens in the sei whale and in the porpoise myoglobins was slightly different. When the γ-globulin solution prepared from pooled antisera was used in cup A and a solution of finback whale myoglobin in cup C, three distinct bands were formed on the right-hand side (Fig. 1)—evidence of the presence in the γ-globulin of antibodies against three antigens. These results suggest that myoglobin as prepared from tissues by rigorous methods (which include repeated recrystallizations—in the case of the sperm whale antigen five times from ammonium sulphate and twice from phosphate) consists of more than one component: the same conclusion has previously been reached from electrophoretic studies[3].

The antiserum against seal (*Phoca vitulina*) myoglobin cross-reacted with myoglobins of other members of the same order (*Zalophus californianus*, *Mirounga peonina*, and another seal of unknown species), but not with horse myoglobin.

Kesztyus and Várterész[11] obtained antisera against horse, ox, dog, pig and cat myoglobins; each formed a precipitate with myoglobin of the homologous species and not with the heterologous antigens. None of these species is as closely related as the members of the Cetacea. Comparable studies are those of Heidelberger and Landsteiner[12] and of Hektoen and his colleagues[13–15] on hæmoglobins; cross-reactions were found between horse, donkey and mule hæmoglobins, between human and rhesus hæmoglobins and between ox, sheep, goat and yak hæmoglobins.

Relationships of the Myoglobins

The range of purified myoglobins available from various animal species is now wide, and this protein would probably lend itself well to detailed investigations of species specificity. It is unfortunate that at present complete amino-acid composition data are available only for horse[16] and finback whale[17] myoglobins, and the molecular weight has been determined only for horse (there is, however, reason for supposing that the molecular weight of blue whale myoglobin is also about 17,000[18]; furthermore, all the X-ray data are consistent with this being the value in every species so far examined). But even without other data, the distribution of crystal forms shows features of interest. Thus type *A* crystals are widespread among whale myoglobins, and indeed they have been made from almost every species of whale the myoglobin of which has so far been crystallized; but it is remarkable that although the form is predominant in both the main groups—the toothed and the whalebone whales—there are two members of the whalebone genus *Balaenoptera* in which type *A* has been encountered only very rarely (myoglobin from *B. musculus* and *B. physalus* almost always crystallizes in type *D*, *E* or *F*), although these species are morphologically much more closely related to *B. borealis* and *B. acutorostrata* than are the toothed whales *Physeter catodon* and *Phocaena phocaena*—in all four of which type *A* is the predominant form.

This distribution of crystal forms is in accord with the immunological results which, as we have seen, also suggest a relatively closer resemblance between the myoglobins of certain whalebone whales and of the toothed whales, and a relatively greater dissimilarity between that of *B. physalus* and those of other members of the genus *Balaenoptera*, than would have been anticipated from the conventional morphological classification. On the other hand, myoglobins which have similar crystal forms are not necessarily similar immunologically; horse myoglobin did not form a precipitate with antiserum against the myoglobin of the seal *Phoca vitulina*, although both myoglobins give type *C* crystals.

Such chemical information as is available is not inconsistent with the findings of the present investigation. Terminal amino-groups have been shown (by the fluoro-dinitrobenzene method) to be present to the extent of one per 17,000 molecular weight units in each of the four species of myoglobin so far investigated. In finback whale[17] and sperm whale[19] the terminal residue is valine; in horse[20] it is glycine, and one of us (E. S. O.) has recently found that it is also glycine in the seal *Phoca vitulina*. So far as it goes, the correlation is satisfactory; but it is clear that at present the relationships can only be incompletely grasped. One might, for example, have anticipated a cross-reaction between horse and seal myoglobins, and between those of sperm whale and tortoise, in conformity with the chemical and crystallographic relations. There is evidently a need for wider studies using chemical as well as immunological and crystallographic techniques, if a deeper insight is to be gained into the molecular basis of species specificity and morphological classification.

It appears from the ratio of antibody to antigen in the precipitates that one molecule of myoglobin can combine with three of antibody; thus there must be three combining groups on the myoglobin molecule. Some indication of the nature of these groups might be gained by comparative chemical studies; these could be directed in the first instance towards pairs of species such as, on one hand, the horse and the common grey seal, the myoglobins of which crystallize in closely related forms giving very similar diffraction patterns but do not cross-react; and, on the other hand, sperm and sei whale myoglobins, the crystals of which stand in a similarly close relation to one another, but which cross-react very strongly. As has been indicated, the chemical differences required to account for the differences in diffraction pattern might amount to one or two amino-acid residues; but they could as well be differences of sequence as differences of overall composition, so the chemical procedures required to detect them might be very laborious.

We are grateful to many individuals and institutions for assistance in obtaining samples of meat; among them are the Low Temperature Research Station at Cambridge (especially Dr. R. G. Sharp), Zoological Society (London), Dr. F. C. Fraser, of the British Museum (Natural History), Royal Scottish Museum, Hector Whaling, Ltd. (especially Mr. H. W. Symons), Pacific Steam Navigation Co., National Institute of Oceanography (especially Mr. R. Clarke), Prof. C. Monge, of the University of Lima (Peru), Prof. G. Hamoir, of the University of Liège (Belgium), Prof. R. J. Harrison, of the London Hospital Medical School. One of us (J. R. M.) gratefully acknowledges financial assistance from the Nuffield Foundation.

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ELECTRONIC BAND STRUCTURE OF SOLIDS

THE growing importance which government scientific establishments now attach to the theory of the electronic band structure of solids is shown by the holding of a conference on this subject at the Radar Research Establishment in Malvern during September 27–28. Besides members of the Establishment, there were representatives present from Harwell and Baldock, as well as from most of the universities in Great Britain.

It is now about twenty-five years since the idea of a band structure for the energy-levels of electrons in a crystal lattice was put forward by Bloch and others; and during this period, apart from certain stimulating but controversial ideas of Linus Pauling in the United States, this concept has dominated all theoretical discussions of metals, particularly of electrical conductivity and related effects. According to this approximation, the valence, or conduction, electrons are treated as moving, more-or-less independently of each other, in the electrostatic field produced by the positive nuclei and the average Coulomb potential of the various electrons. These electrons are allotted to energy-levels, which lie in bands, often—but not always—separated from each other, having forbidden energies between them. The density distribution $N(E)$ of these energies is fundamental for almost all later applications.

One of the earliest calculations of these energy-levels is the so-called cell model. In this model, we divide the space around each atom into cells, and within each cell (sometimes replaced by an effective sphere for convenience in manipulation) we solve the Schrodinger wave equation, using the potential field for an isolated atom, but replacing atomic boundary conditions by appropriate boundary conditions for the cell. But recently certain serious difficulties have become apparent. Thus, we have good reason for believing that over the greater part of the atomic cell —or polyhedron—the absolute magnitude of the wave function ψ is nearly constant, showing fluctuations only in the immediate vicinity of the nuclei. Now, the representation of an almost constant function within a polyhedron in terms of atom-like s,p,d, functions with correct boundary conditions is not easy; and it has been found necessary to use high-energy atomic orbitals. A further difficulty was pointed out by N. H. March (Sheffield), who showed, from a Thomas–Fermi statistical approximation in a diamond-type structure, that it is not adequate to use the spherically symmetrical atomic potential. Instead, the perturbations due to incipient chemical bonds affect the symmetry both of the potential and the wave functions by introducing higher-order angular terms.

More recently, the cell model has been replaced by an alternative, in which the potential is taken as constant over the metal, excluding a suitable spherical region around each nucleus. In this latter region it has the atomic value. Where the potential is constant, the wave function is that of a plane wave. But near the nuclei, ψ deviates considerably from this form. This method is referred to as the augmented plane-wave method. Dr. D. J. Howarth (Malvern) has extended this treatment, and, particularly for the important case of copper, has shown how, by combining two or more plane waves (equivalent to each other in the reciprocal lattice space), a rapid convergence is obtained. It was previously supposed that too many terms would be needed to make this method usable. A further variant of this treatment has been introduced by R. S. Leigh (Harwell), who found that it is possible to work with wave functions within and without the nuclear spheres, which are not continuous at the boundary and the gradients of which are also discontinuous. This 'shocking' disregard of conventional usage seems to work much better than might have been expected.

Another alternative to the cell-model type of approach is the tight-binding method, familiar to chemists as the molecular orbital approximation. Dr. G. C. Fletcher (Exeter) described the application of this method to the 3*d* electrons in nickel, and the possibility of inferring ferromagnetic anisotropy factors. Dr. E. P. Wohlfarth (Imperial College of Science and Technology, London) showed how, if we accept the idea of an energy band, we may use experimental ferromagnetic curves to infer the shape of these bands. Dr. R. Barrie (Services Electronics Research Laboratory, Baldock) showed similar uses of thermoelectric power data, particularly in relation to semiconductors such as gallium–arsenic or indium–antimony, where the energy gap between bands is relatively small. Lattice scattering was discussed by J. M. Radcliffe (Malvern), and Dr. S. L. Altmann (Oxford) gave a general discussion of the way in which the non-localized orbitals may be replaced by an equivalent set of localized, or Wannier, functions.

So far we have accepted the fundamental concept of an energy band; but this is now under serious scrutiny. For the electrons affect each other, and there are large exchange forces between electrons of similar spin, which are different from those between electrons of opposite spin. If this is a significant difference, the basis on which calculations are made is entirely changed. It is believed that just this situation does arise in antiferromagnetism, where electrons of one type of spin tend to collect on certain sites, whereas electrons of the other type congregate around the alternate sites. Clearly the form of the effective one-electron potential is crucial. Dr. G. G. Hall (Cambridge) discussed this on the basis of the Hartree–Fock type of wave function, showing among other things that the presence of an exchange force should lead to a different potential for occupied and unoccupied states. The relevance of this for all discussion of X-ray absorption spectra, in which an electron is lifted from a lower (atomic) level to one of the previously unoccupied conduction levels, is obvious.

A second criticism of the simple band theory came from R. J. Elliott (Harwell), who showed that the spin-orbit coupling of the conduction electrons, almost always neglected in calculations of this kind, is not really negligible, and can easily amount to 0·4 eV. in particular cases. In addition, Dr. S. Raimes (Imperial College, London) indicated that the recent theory of Bohm and Pines, in which long-range correlation of electrons is taken account of in terms of so-called plasma oscillations, also affects the shape of the $N(E)$ curve. Not only does it give a far more satisfactory shape than the Hartree–Fock approximation, but it also reduces the calculated band-width, as seems to be required to agree with experiment, and also leads to the possibility of a 'tail' in the soft X-ray emission curve. Such tails exist, and have been a source of considerable perplexity to the experimentalist who tries to interpret them in terms of a conventional band concept. This explanation may easily provide a way out of the difficulty.

A final criticism of the one-electron picture came from J. Hawgood (Newcastle), who showed how to apply the molecular theories of configurational interaction to a simplified 'linear' metal. The number of configurations to be considered is enormous, reminiscent of the number of canonical structures in organic chemistry. But sufficient progress has been achieved to suggest that this is a hopeful line of approach.

The foregoing account should make it clear that no strikingly new theories have been put forward. But at long last, it looks as if we are beginning to understand both the limitations of any band theory of the electrons in a metal, and also the type of numerical and algebraic technique that is likely to prove most effective in handling the problem on the assumption that a band model is legitimate.

C. A. COULSON

ABRAHAM DE MOIVRE (1667–1754)

TWO hundred years ago, on November 27, 1754, the death occurred in London of the Huguenot refugee, Abraham de Moivre, whose name is best known from his theorem in analytical trigonometry. But perhaps more important were his contributions to the theory of probability, which, according to Todhunter, owes more to him than to any other mathematician, with the sole exception of Laplace.

The son of a surgeon, de Moivre was born on May 26, 1667, in Vitry, France. He was at first educated by the Christian Brothers, but at the age of eleven entered the Protestant University of Sedan. His studies were continued at Saumur and Paris, but were suddenly interrupted in 1685 by the revocation of the Edict of Nantes and his seclusion in a priory. On his release in 1688 he went to London, with a letter of recommendation to the Earl of Devonshire, at whose house he heard of Newton's "Principia". In 1692 he met Halley and soon afterwards Newton, who esteemed him very highly, and in his later years used to reply to inquiries about mathematics and the "Principia": "Go to Mr. de Moivre; he knows these things better than I do". De Moivre contributed a paper on fluxions to the Royal Society in 1695 and was elected a Fellow in 1697. In 1712 the Royal Society appointed him to the committee to report on the Newton–Leibniz controversy.

De Moivre's first publication on probability was "De Mensura Sortis" (1711), which extended de Montmort's essay on games of chance. The more important "Doctrine of Chances" (1718) dealt with the probability of a compound event and with many particular problems. De Moivre was second only to Halley as a founder of the theory of life contingencies, and his "Annuities on Lives" (1725), which was much used by actuaries, ran into several editions. The "Miscellanea Analytica" (1730) included analytical trigonometry, recurring series, problems of chance, and analysis applied to astronomy. It contained something equivalent to 'De Moivre's theorem', though the usual form of this theorem was not explicitly stated, and there was also 'De Moivre's property of the circle'. These trigonometrical results were the development of the work of R. Cotes. Many copies of the "Miscellanea Analytica" contain a supplement which ends with a table of fourteen-place logarithms of factorials. But a second supplement, dated 1733, is so rare that it was unknown to most authorities until described by Karl Pearson[1]; this contained the first treatment of the probability integral and essentially of the normal curve, long before the discussions by Laplace and Gauss. De Moivre also discovered what is usually known as Stirling's theorem, an approximate formula for the factorial of a large number; he communicated the result to Stirling, who then obtained an alternative proof and a slightly improved form. What is now known as Bernoulli's theorem was only partially due to Bernoulli, for it was completed by de Moivre.

The "Miscellanea Analytica" brought fame to its author and his election as a member of the Berlin Academy. Unfortunately, in spite of de Moivre's many influential admirers, the fact that he was of French birth prevented him from attaining any satisfactory appointment, either in Britain or Germany. He supported himself by private tuition and lectures, and in his old age earned a precarious living at Slaughter's Coffee House by solving problems on games of chance for its aristocratic frequenters. A few months before he died he was elected an associate of the Paris Academy of Sciences.

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USE OF RADIOACTIVE ISOTOPES IN SMALL-MAMMAL ECOLOGY

By GILLIAN K. GODFREY
(Mrs. Crowcroft)
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MANY problems in animal population studies require for their solution knowledge of the range of movement of individuals. Repeated live-trapping of marked animals is the usual technique employed, though with birds and the larger mammals visual observation is often possible. The availability of a wide range of radioactive isotopes has enabled certain animals, especially insects, to be marked in a novel and efficient manner. Radioactive isotopes also promise to be of great value for obtaining direct information about the movements of a single individual.

The first recorded use of radioactive material in tracing the movements of an animal is by Tomes and Brian[1,2]. Female click beetles (*Agriotes*) were labelled with radium sulphate which was sandwiched between aluminium disks and fastened beneath the elytra. The beetles, which could be detected through three inches of soil, were located periodically with a Geiger–Muller counter. Daily movements were of the order of twelve inches. Certain other insect studies have involved the actual incorporation of the radioactive isotope into the tissues[3,4].

It is difficult to obtain information about the movements of small mammals as they are relatively mobile and carry out most of their activities in dense cover or below ground. It is known that live-trapping may produce both physiological and psychological effects, the former being seen in abnormal movements after release, and the latter in changed behaviour towards traps. By trapping a small mammal once only, attaching a radioactive source and following it about with a portable Geiger–Muller counter, it is possible to make a large number of observations without disturbing it further. Clearly, the size and habits of the species will determine whether or not this method is practicable: for example, it will not be applicable to the study of a large, highly mobile mammal like the fox.

The method was applied in 1949, however, to a study of the movements of the field vole (*Microtus agrestis*)[5]. A high-energy gamma source was required as the animals had to be detected through tall, dense grass (*Brachypodium*) and at times within shallow burrows. Cobalt-60 was chosen as it was available in a convenient form and had a long half-life (5·3 yr.). Each vole was labelled with 80–100 microcuries enclosed in a brass capsule which was soldered to a nickel leg-ring. The Geiger–Müller tube was mounted at the end of a 6-ft. rod, and as the source could be detected (through headphones) 3–4 ft. from the tube, the animal could be located at a distance of up to 12 ft. from the observer. By locating an individual at frequent intervals, a clear picture of its range of movement could be obtained. Labelling pregnant females with radioactive rings also proved a useful means of locating nests containing young[6]. Similar work has been attempted in America using meadow voles (*Microtus pennsylvanicus*) injected with beta-emitting radioactive phosphorus (L. Miller, personal communication). This method depends upon locating radioactive faeces, and appears to be of limited use for work on small mammals.

Radioactive labelling is currently being utilized in an ecological study of the mole (*Talpa europaea*), financed by the Nature Conservancy. A larger version of the ring used for *Microtus* is fitted around the base of the mole's tail, where it does not interfere with movements or digging. A source of 80 microcuries has proved sufficient in spite of soil absorption, for in the absence of tall vegetation the probe can be held immediately above the soil surface. Because of the mole's reputed sensitivity to vibration, a longer handle was fitted to the probe to enable the animal to be located at a greater distance.

The determination of the range of movement is only the first step in investigating the animal's relationship with its environment. The next step is clearly an attempt to find out how the individual obtains and expends its energy within its range. Live-trapping has proved an inadequate means of showing how the various parts of the range are used, and which areas within the perimeter are, in fact, not used at all. The way in which the animal distributes its activities in time must also be investigated. The ability to keep in almost continuous contact with a mole labelled with radioactive material means that, in this species at least, a start can be made on the simpler aspects of these problems. The animal's confinement within a discrete tunnel-system, much of which is visible on the surface, greatly simplifies the procedure of following it about. In practice, the actual paths taken as it moves about are marked with numbered pegs and afterwards recorded in detail. In this way a fairly accurate estimate of the linear distances moved in successive periods can be obtained. In addition to providing information about movements, long periods of continuous observation have revealed the nature of the mole's activity rhythm.

Before using radioactive labelling on a large scale, much thought must be given to possible immediate or long-term effects on the health and consequently the behaviour of the animals. Some of the theoretical considerations involved in estimating permissible dosages have been discussed by Griffin[7]. Where there is any danger of substantial loss of rings through predation, isotopes with a short half-life are obviously preferable. It is extremely unlikely, however, that predators will be affected when metal rings are used, as these are either rejected, regurgitated, or passed with the fæces. Nevertheless, the choice of a study area should take into account not only the range of the species being labelled, but also that of any possible predator. In the present work on moles, most of the rings have now been removed from the animals, which have shown no signs of ill-health.

A drawback of the technique is that it is impossible to distinguish between labelled individuals with overlapping ranges. Although this limits its use, there are many important population problems, which by their nature can only be studied at the individual level, and for these it promises to be of valuable application.

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OBITUARIES

Dr. Philip Eggleton

By the death of Dr. Philip Eggleton on October 7 at the early age of fifty-two, medical science has lost one of its most versatile and original minds and the University of Edinburgh one of its most stimulating and popular teachers.

Eggleton received his undergraduate and post-graduate education at University College, London. After graduating with honours in chemistry in 1922, he joined the Department of Physiology and Biochemistry, where he studied for two years under Prof. E. H. Starling, Sir William Bayliss and Sir (then Prof.) Jack Drummond. In 1925, following a brief experience in industry, Eggleton returned to University College with a grant from the Medical Research Council to work on certain of the chemical aspects of muscular contraction under the direction of Prof. A. V. Hill. The following year he was awarded a Beit Memorial Fellowship to continue his work in this field.

During this period, Eggleton (with Grace P. Eggleton) carried out his now classical work on the phosphorus compounds in muscle, which culminated in the almost simultaneous discovery by Fiske and SubbaRow and by himself of creatine phosphate (phosphagen) and in the recognition of the importance of the latter in the chemistry of the contractile process. The part played by Eggleton in what has been termed "The Revolution in Muscle Physiology" (A. V. Hill) was a most distinguished one, and it was fitting that in 1931 he was awarded the Julius Mickle Fellowship by the University of London for the most outstanding research in medical science carried out in the University during the preceding five years.

In 1930 Eggleton went to Edinburgh as lecturer in biochemistry in the Department of Physiology, and in this capacity and as senior lecturer and reader served the University under no fewer than four professors of physiology. On three separate occasions he was acting-head of the Physiology Department for long periods. At Edinburgh, Eggleton developed his great potentialities as a teacher to the full, and soon became one of the most lucid and stimulating lecturers in the University. He also developed a remarkable facility for explaining scientific matters to the layman in vivid and readily understandable language; and, since he was convinced of the value of some knowledge of the aims and methods of science in the general education of everyone, it was natural for him to become actively interested in the popularization of science. In collaboration with Prof. W. O. Kermack, he wrote an excellent popular book, "The Stuff We Are Made Of", and for many years he acted as adviser to the B.B.C. in Scotland on scientific broadcasts. His own broadcast talks were models of what such talks should be.

An important part of Eggleton's duties at Edinburgh consisted in giving help and advice on many different chemical matters to his colleagues in the Physiology Department. Because of this, and also possibly because of his own inclinations, his interests in biochemistry and in science generally broadened very considerably. He extended his knowledge of mathematics, and latterly became interested in rheological problems in biology. Possibly his own career as a creative scientist might have been more spectacularly successful had he been less catholic in his interests and had he been less unselfish in his attitude to his colleagues. However, those who were closest to him know that he was always happiest when helping others.

During the Second World War, Eggleton collaborated in research in the Physiology Department under the direction of Prof. I. de B. Daly on phosgene poisoning on behalf of the Ministry of Supply, and on decompression problems on behalf of the Air Ministry. He joined the Edinburgh Gas Identification Service (Civil Defence) and became deputy district gas adviser for South-East Scotland.

Eggleton was a member of the Physiological Society, the Biochemical Society and the Society for Experimental Biology. He served on the committees of all three bodies. He was also a member of the Joint Committee on Rheology of the International Council of Scientific Unions, and he organized the First International Colloquium on Physiological Problems in Biology, which was held in Sweden in 1950.

G. F. Marrian

Dr. G. P. Douglas, O.B.E.

The death of Dr. G. P. Douglas on October 16 at his home at Camberley will be regretted by a wide circle of friends.

Born in 1892, he was educated at George Watson's College, Edinburgh, and graduated in 1914 from the University of Edinburgh with distinction in engineering. He served in the First World War and was awarded the M.C.; in July 1916 he was wounded, suffering the loss of his leg. In December of that year he joined the Royal Aircraft Factory (now Establishment), where he was concerned in the building and running of the 7-ft. wind tunnels which were to supplement the single 4-ft. tunnel that was then the sole equipment. In 1918 he became engineer in charge of the wind tunnels, and played a formative part in the development of model work at the Establishment. He had a genius for using simple means, lucidity as to the range of validity of these means, and a keen appreciation of the need for flexibility in method. During this period the 5-ft. and 24-ft. tunnels came into use.

In 1934 he became head of the Aerodynamics Department, of which the model work was one section. He played a big part in building up a strong department, more elaborate equipment, and enlarged field of work called for by the Second World War.

Dr. Douglas served on the council of the Royal Aeronautical Society during 1946–51, and for many years on the Aerodynamics Committee of the Aeronautical Research Council. He extended his contacts by attending the main international congresses on aerodynamics. He retired in March 1953. Though he would never allow the handicap of his lameness to keep him from clambering about aircraft, balloon shed roofs, ships, or anywhere else where his work lay, he had to pay for the effort involved by sacrificing many other activities. By the time of his retirement, he was over-strained by his unremitting devotion to duty.

To many of us, Dr. Douglas's greatest achievement lay in his personal influence in shaping the Department. He was honest to the core, humble as to his own attainments, and whole-heartedly pleased at the advance and achievement of the many distinguished people who served under him for various periods as young men. Under three ministries, he maintained to a very high measure the Aerodynamics Department as a place where scientists could grow up and develop their own type of ability, with the minimum of restrictive organization. F. B. BRADFIELD

Mr. Fred Lincoln

FRED LINCOLN, who has just died at the age of seventy-seven, must have been by far the most widely known laboratory assistant in the world. Almost all the leading physicists in the Commonwealth and many in other countries have worked in the Cavendish Laboratory at one time or another, and to all of them Lincoln was one of its main institutions. He joined the staff as a laboratory boy in 1893, and when I was a student Lincoln had already been the head assistant for many years. When I returned to Cambridge thirty years later as Cavendish professor, there was Lincoln in the same position and quite unchanged in appearance and energy. His fierce eye and even fiercer moustache still induced a very proper respect in the young research worker applying to him for apparatus or stores, and the kindness, humour and loyalty to the Laboratory, which had earned our admiration and affection, were the same as ever. When a presentation was made to him on the occasion of his retirement, contributions came from physicists all over the world, who will now be sad at the passing of a great figure and a warm friend. W. L. BRAGG

NEWS and VIEWS

Royal Society: Award of Royal Medals

H.M. THE QUEEN has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell, for his distinguished work on nuclear and atomic physics; Prof. H. A. Krebs, Whitley professor of biochemistry in the University of Oxford, for his distinguished contributions to biochemistry.

Chemistry at Aberdeen: Dr. G. M. Burnett

DR. G. M. BURNETT, at present lecturer in chemistry in the University of Birmingham, has been appointed to the chair of chemistry in the University of Aberdeen at the early age of thirty-three. Dr. Burnett succeeds Prof. R. M. Barrer, who has gone to the Imperial College of Science and Technology, London (see *Nature*, July 31, p. 205). Educated at Robert Gordon's College, Aberdeen, he graduated with first-class honours in chemistry at Aberdeen in 1943. Owing to war-time requirements, he became an assistant in the Physics Department at Aberdeen, with special responsibility for dealing with the supplies of radium for the hospitals in the north-east of Scotland. In his meagre spare time at that period, he started research on the problem of determining the absolute rate constants and radical concentration in liquid-phase free-radical polymerization reactions. He very quickly succeeded in obtaining an exact solution to this problem, and was in fact the first to do so. The extension and exploitation of this work have been his main preoccupation during his stay in Aberdeen and, since 1948, in Birmingham. Dr. Burnett has written many papers covering all aspects of this field, and these have culminated in the publication of a book on polymer reactions, which forms a landmark in describing and reviewing critically this important branch of polymer chemistry and reaction kinetics.

Pure Mathematics at Birmingham: Prof. C. A. Rogers

DR. C. A. ROGERS has been elected to the Mason professorship of pure mathematics in the University of Birmingham in succession to Prof. R. A. Rankin, who has gone to Glasgow (see *Nature*, April 3, p. 615). Dr. Rogers, who is thirty-three, graduated at University College, London, in 1941, and after war service in the Applied Ballistics Department (Ministry of Supply) returned to that College as a research student in 1945. He was appointed assistant lecturer in 1946 and lecturer in 1949. The title of reader in mathematics was conferred on him in 1953. Dr. Rogers was awarded a Commonwealth Fund Fellowship in 1949 and spent the session 1949–50 at the Institute for Advanced Study, Princeton. Dr. Rogers has published some forty papers, many of which are substantial memoirs. Most of his work has been on the theory of numbers, and in particular on the geometry of numbers. In 1947 he gave a new and simple proof (*Ann. Math.*, 48, 367; 1947) of the theorem of Minkowski and Hlawka, and this has proved to be the starting-point for much later work by himself and others. In a memoir published in *Acta Math.*, 82, 185 (1950), he applied to the geometry of numbers a new inequality obtained by solving an integral equation. Jointly with A. Dvoretzky he has solved an outstanding problem in the theory of Banach spaces (*Proc. U.S. Nat. Acad. Sci.*, 36, 192; 1950). Dr. Rogers's work has given him an international reputation as a pure mathematician, and he is also well known to many for his work in statistics and for his wide interests in science generally.

Veterinary Research in Mexico by the University of Pennsylvania

A CO-OPERATIVE research affiliation has been established between the School of Veterinary Medicine of the University of Pennsylvania and the Institute of Livestock Research (Institute de Investigaciones) at Palo Alto, near Mexico City, of the Mexican Government, and 18,000 dollars is being supplied by the United States Foreign Operations Administration to support the project. E. R. Squibb and Sons of Mexico, a subsidiary of the Olin Mathieson Chemical Corporation, New York, and E. R. Squibb and Sons, New York, are also participating and will assist in financing the undertaking. Prof. G. W. Rake, research professor of microbiology in the University of Pennsylvania, will direct the research work for the University at Palo Alto; before going to Philadelphia a year ago, he was director of the Squibb Medical Division for four years, and for twelve years previously headed the Microbiology Division of the Squibb Institute for Medical Research. Among the research workers from the Veterinary School in Philadelphia who are to be sent to Palo Alto will be Dr. Carlos Espana, who was born in Mexico and is a graduate of the University of Mexico. The Institute at Palo Alto, which was established in the 1940's mainly for combating foot-and-mouth disease, has four laboratory buildings, one large combination laboratory–administration building and thirty-six isolation units suitable for handling large farm animals; a main laboratory has been set aside for the Pennsylvanian workers and will be known as the Squibb–Mathieson Laboratory for Veterinary Research of the Ministry of Agriculture and Husbandry in Mexico and of the University of Pennsylvania. The first investigations to be made at this Laboratory will be one of the blood disease anaplasmosis, which is an infectious condition of the red corpuscles, and, later, studies will probably be made of shipping fever and brucellosis. The University of Pennsylvania plans to increase greatly the number of fellowships it offers for postgraduate training and, in particular, in return for the facilities at Palo Alto it will offer places for the training of Mexican veterinary workers and other scientists interested in infectious diseases affecting animals, with especial emphasis on those diseases transmissible to man. In conjunction with these new developments in Mexico, a dedicatory meeting was arranged in Palo Alto on November 17, and at the same time the annual conference of the Associated University of Pennsylvania Clubs was held in Mexico City.

Long Ashton Research Station: Report for 1953

THE annual report of the Agricultural and Horticultural Research Station, Long Ashton, for 1953 (from the Station at Long Ashton, Bristol; pp. 218+13 plates; 1954; 15s.) is of particular interest as it records the jubilee celebrations held in July of that year, and includes speeches made by Sir Thomas Dugdale, Lord Bledisloe, Mr. Christopher Norbury and Prof. T. Wallace on that occasion. The special jubilee lecture delivered by Lord Rothschild has already been published in the commemorative volume "Science and Fruit". The research work carried out during the year falls into five main categories: pomology, plant nutrition (including that under the Agricultural Research Council Unit for Micronutrients), plant pathology, cider and fruit juices, and domestic food preservation. Among the numerous subjects under investigation, mention may be made of a survey of perry pears in the West Midlands, carried out in view of the increased interest in this beverage. A number of varieties are described and illustrated, and an attempt has been made to sort out the confusion of synonyms. Spray application problems form the subject of a group of papers. A method is described for use in estimating the penetration of DDT into plant tissues, and the times, strengths and formulations for DDT and BHC given for control of apple and plum aphids and of BHC for apple sawfly. A combined DDT–BHC emulsion has also been prepared. Field trials have been carried out with airflow mist spraying, a technique aimed at reducing both costs and risk of crop damage. Though the method was successful with DDT and BHC emulsion against plum and apple aphid and apple sawfly, similar applications of lime sulphur failed to control red spider, woolly aphid or apple scab.

Geophysics in Canada during 1953

THE first volume of the series "Canadian Geophysical Bulletins", an annual review of activity in geophysical research and applied geophysics, published by the Associate Committee on Geodesy and Geophysics of the National Research Council of Canada, appeared in January 1947; the latest volume, Vol. 6, was published in December 1953, but has only comparatively recently been received here (pp. 73. Ottawa: National Research Council of Canada, 1953). It includes a bibliography of papers published during the year under review, either by Canadian workers in the field or by scientists from other countries, relating to Canadian problems. Short descriptions are given of nine papers on geodesy (including gravity), forty-two on seismology and the physics of the earth's interior, twelve on meteorology and hydrology, forty-nine on terrestrial magnetism and atmospheric electricity, and forty-two papers on oceanography. In December 1953, thirty-eight companies were known to be operating a total of about a hundred and fifty seismic prospecting parties in British Columbia, Alberta, Saskatchewan and Manitoba. Noteworthy is the publication by W. C. Gussow of the detailed geological, seismic and gravimetric studies of New Brunswick which were conducted for the Shell Oil Company (*Bull. Amer. Assoc. Pet. Geol.*, 37, 1713; 1953).

Catalogue of Polish Scientific Literature, 1945–49

VOL. 21 of the "Catalogue of Polish Scientific Literature" (pp. 441. Krakow: Polska Akademia Nauk) covers the years 1945–49 and bears the date of publication 1952, though it has only recently been received. It is the first to appear since that for the years 1931–34, but Vol. 20, covering the years 1935–39, will be published later. The entries are given alphabetically by authors in eleven main sections—mathematics, physics, astronomy, terrestrial sciences, botany, microbiology, zoology, archæology, geography, technology—with a miscellaneous section, and some sub-sections such as chemical technology. There is also an author index and a list of Polish periodicals from which entries are taken, with the abbreviations used, and which includes 254 items.

Science Masters' Association: Meeting in Newcastle upon Tyne

THE annual meeting of the Science Masters' Association will be held in King's College, Newcastle upon

Tyne, during December 28–31, the annual business meeting of the Association being on December 30 at 5.15 p.m. Dr. C. I. C. Bosanquet, rector of King's College, will deliver the presidential address to the Association on the evening of December 28, his subject being "In Praise of Natural Philosophy", and the Science and Citizenship Lecture will be given on the evening of the next day by Dr. Eric James, High Master of Manchester Grammar School. Besides the usual lectures in the morning on various scientific topics and informal visits to laboratories, there will be a discussion on the teaching of electricity, with special reference to M.K.S. units, on the morning of December 30, and another the next day on the teaching of science in secondary modern schools. As in the past, manufacturers and publishers who advertise in the *School Science Review* will be showing exhibits, and the usual members' exhibition of apparatus and teaching aids which members of the Association have found useful will also be held. The Northern Area Lighting Service Bureau of the Electric Lamp Manufacturers' Association has arranged to prepare an exhibition entitled "The Practical Aspects of Light and its Production", and the British Iron and Steel Federation will be showing some of its educational material. In the afternoons a number of excursions will be made to various works. Tickets are necessary for these visits and can be obtained from A. Hill, Hookergate Grammar School, Rowlands Gill, Co. Durham; they must be claimed by December 11. All other correspondence should be sent to the Annual Meeting Secretary, W. H. Dowland, 93 Westbourne Road, West Hartlepool, Co. Durham.

Physical Society : Annual Exhibition

The Physical Society's annual exhibition of scientific instruments and apparatus will be held in the New Hall of the Royal Horticultural Society, Westminster, during April 25–28, 1955. About a hundred and forty exhibitors are expected to take part, including the usual number of university departments and government establishments, and the exhibition will also include scientific books and journals. The handbook of the exhibition will be on the same lines as those of previous years, with a large advertisement section which is open to all firms with scientific interests, whether taking part in the exhibition or not. The change of venue from the Imperial College of Science and Technology, London, to the Royal Horticultural Society's New Hall will in no way change the character and purpose of the exhibition; the space in the New Hall is by its nature more compact than that which has hitherto been available, and it is hoped that this will help visitors to see the exhibits more advantageously in a shorter time. Further information can be obtained from the Honorary Exhibition Secretary, Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Swedish Academy of Engineering Sciences : Awards

The Swedish Academy of Engineering Sciences has awarded four Gold Medals and its Brinell Medal for contributions in various scientific and technical fields. The Gold Medals have been awarded to the following: Mr. Erik Stemme, the principal scientific worker in a team that in three years has built the binary electronic computing machine BESK, the dielectric punched ribbon reader and certain details in its magnetic memory being the results of personal inventions by Mr. Stemme; Mr. Gunnar Jancke, for his role as a leading engineer in the designing and carrying out of a new network of high-tension electric cables which transmit current at 380,000 V. from the Lapland waterfalls to the central and southern parts of Sweden; Dr. Erik Bergstrand, for designing the geodimeter, an instrument for measuring geographical distances in terms of the time taken by light to traverse the distance, and which, incidentally, has been used in reverse to obtain an accurate measure of the velocity of light; and Mr. Olle Wernholm, for his work in perfecting electron accelerators. The Brinell Medal of the Academy goes, for the first time to a non-Swede, to Prof. John Chipman, of the Massachusetts Institute of Technology, for his achievements in the fields of metallurgy and metallography.

Announcements

Dr. H. J. Eysenck, reader in psychology with special reference to psychiatry in the Institute of Psychiatry, University of London, has been appointed to the University chair of psychology tenable at the Institute.

Applications are invited for the Drummond fellowship for research in nutrition, which will be awarded about March next year. The fellowship is worth £900 a year, normally tenable for two years, with up to £50 a year research expenses and £90 superannuation. Application forms, to be returned by January 15, and further information can be obtained from the Honorary Secretary, Drummond Trust, University College, Gower Street, London, W.C.1.

The Royal Society of New Zealand is offering a T. K. Sidey Summer-time Award, consisting of a bronze medal and prize of £100 (New Zealand currency), for scientific research on any kind of electromagnetic radiation (visible or invisible), including its relation to human welfare. Applications must be submitted by February 28, 1955. Further information can be obtained from the Secretary, Royal Society of New Zealand, Victoria University College, Wellington, W.1.

The Sabena International Prize, which was established in 1953 to mark the thirtieth anniversary of Sabena Belgian Airlines, is awarded in alternate years to an artist or research worker, less than thirty years of age and of either sex, who wishes to extend his or her general knowledge by travel-study in the Belgian Congo or the United States. The subject of this year's competition is "Aviation and Social Geography", and entries must be submitted by March 31. The prize is worth 75,000 Belgian francs (just over £500). The conditions of the competition and further information can be obtained from Sabena Belgian Airlines, Air Terminus, Brussels.

In an article discussing agricultural research in *Nature* of October 9, on p. 664 it is stated that "the Department of Scientific and Industrial Research . . . draws its revenue largely from industrial concerns". This is, of course, incorrect; the Department supports the research associations, and it is these associations which receive a major proportion of their revenues from industry.

In the advertisement supplement in *Nature* of November 13, p. ix, the telephone number of Teleonics (Communications), Ltd., is incorrect; we are asked to state that the correct number is Fulham 1534.

ARCHÆOLOGY IN THE LABORATORY

A CONFERENCE convened by the Council for British Archæology under the title "Archæology in the Laboratory" was held on April 9 in the rooms of the Society of Antiquaries of London, at Burlington House. The proceedings of the conference have only recently become available.

Dr. C. B. M. McBurney (University of Cambridge), in his introduction for the Council, explained that, since its formation in 1944 as the co-ordinating body for archæological research, the Council has been anxious to explore the various possible applications to archæology of the methods and results produced in other scientific fields. A Natural Sciences Panel was accordingly set up and had prepared the "Notes for the Guidance of Archæologists in regard to Expert Evidence" published in 1947. Not only are the "Notes" now out of date, but also the rapid acceleration of developments in science and technology has made it necessary to re-examine the whole matter with regard to both scope and organization. There is also the reverse aspect, not hitherto considered systematically, where the archæologist could provide the scientific research worker with valuable material in a context that could be precisely defined and is independently datable.

The Council had been considering a proposal, made earlier in the year by Mr. L. Biek (Ministry of Works), to establish a permanent Scientific Research Committee for Archæology. This was, in particular, to facilitate the flow of material sent from archæological excavations for expert examination and to collate the results, and generally to provide a clearing house for information and ideas of mutual value to archæologists and other scientists. The scheme was welcomed by archæologists and, at the suggestion of Sir Mortimer Wheeler (University of London), the Council had decided to invite scientists to give their views on the proposal. Dr. McBurney said he was asking if they considered it to be desirable and practicable, and what they felt about the reciprocal value, to themselves, of this type of work. He was further asking for details of recent advances, and for suggestions about improving and extending investigations as at present carried out, in the principal fields which had been selected for discussion, namely, petrology of stone implements and ceramics, building research, soil science, pollen analysis and other botanical examination, ecology, conchology, animal and human osteology, physical and chemical tests, and metallurgical and corrosion studies.

The following then gave their views: Mr. E. M. Jope (The Queen's University, Belfast), Prof. F. W. Shotton (University of Birmingham), Dr. F. S. Wallis (Bristol Museum), Mr. M. Davies (British Iron and Steel Research Association), Mr. H. Barker, Dr. F. C. Fraser and Dr. K. P. Oakley (British Museum), Dr. N. Davey and Dr. H. G. Midgley (Building Research Station, Department of Scientific and Industrial Research), Mr. R. M. Cook (Cambridge Museum of Classical Archæology), Dr. H. Godwin, Dr. S. K. Runcorn and Dr. J. O. Trevor (University of Cambridge), Mr. T. W. Farrer (Chemical Research Laboratory, Department of Scientific and Industrial Research), Dr. W. H. J. Vernon (recently of the Chemical Research Laboratory), Dr. F. Y. Henderson (Forest Products Research Laboratory, Department of Scientific and Industrial Research), Dr. P. A. Sabine (Geological Survey), Mr. C. F. M. Fryd (Department of the Government Chemist), Prof. R. D. Preston (University of Leeds), Dr. I. W. Cornwall, Prof. F. W. Jane and Prof. F. E. Zeuner (University of London), Mr. H. H. Coghlan (Newbury Museum), Dr. E. T. Hall (University of Oxford), and Dr. J. S. Weiner (Oxford University Museum).

With certain notable exceptions in the fields of metallurgical and palæomagnetic analysis, where more or less specific schemes are operating to less than capacity and samples are indeed welcome, it seems that there is a general lack of man-power if not, in most cases, of equipment. Nevertheless, work in all the other fields is proceeding well. Important advances have been made in applying the use of 'white' X-rays to the study of unknown materials. Pollen analysis has been expanded to include herbaceous plants and to give information about methods of husbandry. Full details were given about a 'general service' in carbon-14 dating, due to begin shortly. The possibility of typifying certain pottery on a physical basis (that is, by making thin sections, etc.) is being examined, and a tentative suggestion was made about relating changes in the submicroscopic structure of wooden remains to the duration of burial under certain conditions.

Although the principles are in most cases fairly well understood, methods of preparing specimens (for example, for charcoal analysis) are sometimes imperfect, or there may be a lack of suitable comparative material in certain specific respects (for example, for matching rocks or bones); both here and in fields not so limited (for example, in counting pollen grains), the work is extremely tedious and time-consuming.

The majority of speakers thus reluctantly, but firmly, refused to accept investigations which were unlikely to help in solving some major problem. Even in the relatively simpler work of chemical analysis, identifying wood, and analysing mortars, isolated queries are discouraged unless submitted through some recognized institution. In the case of mortar analysis, as also with samples for carbon-14 and palæomagnetic examination, correct and careful sampling is essential. Where, as in the majority of cases, this aspect is less important, it is at least necessary to know the context accurately and reliably, because results can only be interpreted in relation to 'neutral' associated material. On the other hand, with problems involving soil and pollen analysis, or the corrosion of metals, it is absolutely vital for the investigator to be present during excavation in order to evaluate all aspects of the site from his point of view and to take his own samples. Archæological evidence is of great importance to research in botany, geophysics and metallic corrosion, and can be of great value to building research, soil science, human osteology, and the submicroscopic study of wood.

The suggestions made for improvement fall into four general groups. First, more workers and more (suitably selected) material for analysis and reference constitute major requirements. Several speakers stressed that such work, in general, is not appropriately recognized or paid, and consequently the number of, say, geologists interested in archæological problems will always be very small. It would help if such small groups could meet regularly to discuss problems and progress. It was suggested that museum staff, in particular, should be approached with the view of interesting them more in this type of work. In Denmark, pollen analysts, petrologists and archæologists are successfully collaborating at the National Museum, and it was felt that the volume of such work in Britain would remain small until some similar scheme were put into operation.

It was further stressed that definite instructions should be issued to prevent the destruction or loss of valuable material (particularly botanical and osteological) and records (for example, of the preservation of buildings), and that these should be centrally stored and suitably catalogued; so that even if there should be no facilities for immediate examination, the material would be available later. Other suggestions included the preparation of sets of slides of petrological specimens from archæological finds, and organic-carbon assays (perhaps at university centres) to determine whether a sample is suitable for carbon-14 analysis. It is—as so very frequently in scientific work—most important to develop a battery of techniques for any one type of problem in order to obtain reliable results; thus no fewer than six methods were used in the recent investigation of the Piltdown mandible.

Secondly, it is important that archæologists should frame specific questions to accompany their material; this would considerably ease the investigators' burden, and serve to prevent friction and loss of time. In certain cases (for example, bones) excessive cleaning prior to dispatch from the site is undesirable.

Thirdly, it was obvious from all that had been said that the closest co-operation between archæologists and scientists at all stages is essential, not forgetting regular contact between, for example, the petrologists themselves who are engaged on archæological work.

Finally, this aspect becomes vital when (as in most cases) the problem has to be considered statistically. The examination of human bones can take on a wider significance only when its results can be related geographically. Only the archæologist can tell, in the last instance, which copper implements form a homogeneous series suitable for metallurgical analysis in attempting to trace the ores that have provided the metal; sometimes museum specimens of ores, selected on a different basis, may not include inferior material that might well have been used by early metal-workers.

In carbon-14 determinations, quite apart from the statistical errors due to equipment and method, structural differences between young and mature wood, and contamination both during and after burial may be expected to affect the results. A number of such 'rogues' have in fact been encountered, and single or even duplicate estimations may well be more misleading than helpful unless considered on a wider statistical basis. This calls for full and accurate publication of results, and the Council was urged to oppose firmly any unilateral 'editing' of scientific appendixes in archæological journals. It further points clearly to the need for planned research and, ultimately, for an Archæological Research Institute embracing all aspects and capable of both research and routine work. Concrete proposals for such a body, it was felt, should be worked out and submitted through the Council to the appropriate quarters as soon as possible.

In one of the concluding remarks the hope was expressed that, as a result of the conference which had thrown this aspect into relief, something might be done to make it easier for archæologists and scientists to understand one another; so that the archæologist could come to know the limitations of scientific techniques, and the scientist in his turn would be able to appreciate archæological requirements. The president, Dr. D. B. Harden, in thanking members of the conference on behalf of the Council, had no doubt that the latter would be glad to do what it could, particularly about 'vetting' material sent for expert examination, in order not to strain the limited resources available. He said that he and other archæologists present had been most encouraged by the support given to the conference; if an Archæological Research Institute still seemed a long way off, it was well worth while working towards it in the best possible way.

As reported in *Nature* of October 9, p. 677, a Scientific Research Committee for Archæology has now been formed by the Council. Further details may be obtained from the Assistant Secretary, Council for British Archæology, 10 Bolton Gardens, London, S.W.5.

L. Biek

PHYSICS OF CLOUDS AND PRECIPITATION

An international symposium was held at the Federal Institute of Technology, Zurich, during October 4–6, under the auspices of the Swiss Federal Commission for the Study of Hail Formation and Prevention, to discuss recent developments in the physics of clouds and precipitation and in the artificial modification of clouds. After the delegates had been welcomed by Prof. R. Sänger, president of the Commission, opening addresses were given by H. Dessens (France) on some theories of cloud nucleation submitted to experimental test, and by B. J. Mason (Great Britain) on the physics of natural precipitation processes.

M. Dessens described studies at the Pûy de Dome of the freezing of water droplets and the growth of ice crystals in the laboratory. The droplets, supported on spiders' threads, were suspended in a cold chamber on the stage of a microscope. Although large drops generally froze at higher temperatures than small ones, he obtained no clear-cut relation between drop size and freezing temperature because the freezing mechanism appeared to be propagated along the thread. However, large drops could be maintained at temperatures above −12° C. for many minutes without freezing.

The seeding of natural supercooled stratus clouds with silver iodide produced ice crystals if the temperature was below −4° C. and was often followed by precipitation and partial dissipation of the cloud. The seeding of similar clouds with 'dry ice' generally resulted in overseeding in the neighbourhood of the source, but precipitation and dissipation of the cloud did not follow. Large-scale seeding with silver iodide was carried out in the Pyrenees during 1951–53, but the effect on the rainfall was inconclusive. Clouds in this region tended to glaciate naturally if their summits were colder than −15° C.

Mr. Mason reviewed the present state of knowledge concerning the physical mechanisms which are responsible for the release of precipitation from both shower- and layer-type clouds. Having traced recent theoretical developments, he analysed the information which has resulted from the exploration of clouds by aircraft and radar to illustrate the conditions under which rain might be produced either by the growth of ice crystals or by the coalescence of water droplets, and to point out how the cloud behaviour might be influenced by geographical and climatic conditions. The conclusion was that in middle latitudes the majority of rain from stratiform clouds is produced by the ice-crystal process and that the coalescence process is normally responsible for only drizzle or light rain. The radar echo from precipitating warm frontal clouds can be satisfactorily interpreted in terms of the growth and multiplication by splintering of ice crystals, their aggregation to form snowflakes, and the aggregation during melting of the latter to form raindrops. In the case of showers, however, it is considerably more difficult to decide which of the possible mechanisms may be dominant.

Calculations on the growth of precipitation elements in model clouds indicate the conditions under which showers may be released by coalescence (initiated, for example, by large hygroscopic nuclei), by the growth of ice particles, by the shedding of water drops from wet hailstones and by a process of raindrop multiplication due to disruption of large drops (raindrop chain reaction). In middle latitudes during the summer, and particularly over the sea, the coalescence process may forestall the ice particles in releasing precipitation even though the tops of the clouds may afterwards show glaciation. This may account for the fact that hail falls from only a small fraction of these clouds. The coalescence mechanism will be even more favoured in the deep, warm clouds of tropical regions where the conditions may often be suitable for the rapid multiplication of raindrops by a chain reaction.

In a session devoted to atmospheric aerosols, E. M. Fournier d'Albe described how the concentration and size distribution of large hygroscopic nuclei were measured at five ground-level stations in Pakistan. Near the coast the concentrations of particles with mass greater than 10^{-9} gm. were of order 100/m.^{3} but fell off rapidly inland. Although these particles were depleted during heavy rain, there was some evidence that hygroscopic nuclei were left behind when raindrops evaporated before reaching the ground. Dr. Fournier d'Albe thought that the main source of these particles was the sea and that they were responsible for releasing showers by initiating a chain reaction in the warm cumulus clouds of Pakistan.

O. Vittori (Italy) described microchemical tests for identifying microscopic and submicroscopic particles. The particles when caught on gelatine containing dissolved salts produce coloured rings of precipitate; particles of mass down to 10^{-15} gm. may be detected. This technique has been used to identify sulphate and chloride particles in the atmosphere and also various artificial aerosols such as silver nitrate. Some preliminary experiments for the physico-chemical detection of minute silver iodide particles were also described. It is not yet possible to determine accurately the masses of the particles by these methods.

Prof. C. G. Rossby (Stockholm) showed some results which had emerged from the chemical analysis of rainwater in Sweden, in particular the geographical distribution of various elements as measured over a two-year period. The total deposits of sodium and chlorine fell off very rapidly from west to east, much more rapidly than does the rainfall. The ratio chlorine/sodium by weight in the deposit showed a definite geographical pattern with values of 1·2 near the coast falling off to 0·6 well inland; these values have to be compared with a ratio of 1·8 for sea water. The distribution of calcium was fairly uniform over the country, but the ratios of calcium/sodium and potassium/sodium were generally much higher than those found in sea water.

In studying the supercooling of water drops supported on a metal plate, W. Rau (Germany) has found some evidence for the spectrum of freezing nuclei having maxima at −4° C., −11° C. and −19° C. Aqueous solutions show the same general spectrum of freezing nuclei but displaced to lower temperatures. Dr. Rau believes that precipitation from natural clouds tends to occur at rather well-defined temperatures and that this can be explained in terms of his spectra of freezing nuclei. He has measured the ice nucleus contents of air samples of different origin and has found polar air masses to contain many very efficient ice nuclei which are absent from subtropical air; he concludes that these nuclei were of maritime origin. He believes that the freezing of supercooled cloud droplets at −40° C. is brought about by freezing nuclei and that spontaneous nucleation occurs only at temperatures below −70° C. when cubic ice crystals are formed. He said that he had repeated his earlier experiments in view of criticisms that his apparatus may have been contaminated by alcohol, and he now reported that he can confirm his earlier results.

G. Soulage (France), having grown ice crystals in the atmosphere and allowed them to evaporate, found that their residues could act as centres for the formation of ice crystals at temperatures between −12° and −15° C. The particles had no particular crystalline shape, were partly insoluble and partly hygroscopic and acted as ice nuclei only after liquid water had condensed on them.

In a discussion on cloud physics, H. Byers (Chicago) described recent studies of cumulus clouds in Puerto Rico and in the middle of the United States with radar-equipped aircraft. The tropical clouds forming over the sea were relatively slow-growing and gave radar echoes when little more than 6,000 ft. deep, so that they were entirely below the 0° C. isotherm. Those forming over the island, however, showed much more rapid development, but did not precipitate until they attained considerably greater depths. The cloud droplets of tropical cumulus had a bimodal size distribution with maxima diameters of 10–15 μ and 30–50 μ, the latter no doubt being responsible for starting the coalescence process. In order to illustrate further the geographical differences of cloud populations, Prof. Byers also reviewed radar studies made of summer cumulus in New Mexico, which often reaches great heights without precipitating, and of thunderstorms in Ohio where the initial radar echo, in the majority of cases, is entirely below the 0° C. level, suggesting that the precipitation is initiated by coalescence.

F. H. Ludlam (London) described the observations made in central Sweden this summer as a part of a field-programme organized jointly by the Imperial College of Science and Technology, London, and the Institute of Meteorology, University of Stockholm. The behaviour of cumulus was studied with the aid of small aircraft, double theodolites, time-lapse photography and radar. Particular attention was paid to the growth-rates of the clouds, their development during the day and the onset of precipitation. Careful studies of the glaciation of cloud summits indicated that this sometimes occurred at temperatures as high as −4° C. Showers sometimes fell from clouds little more than 1 km. deep.

The instrumentation of the aircraft of the British Meteorological Research Flight was described by R. J. Murgatroyd. A very rapid hot-wire thermometer was used to determine the thermal structure of the air below the bases of cumulus, while the airflow around the sides of the cloud was studied by following the relative motions of packets of 'window' with radar. Vertical currents inside clouds were measured with an integrating accelerometer and the liquid-water content with both a hot-wire instrument and a refrigerated icing disk. With the latter instrument, full adiabatic values of the water content were found in cold clouds. Measurements of the drop-size distribution in clouds by means of slides coated with either magnesium oxide or oil showed drops of radius 20–25 μ near the bases of stratocumulus clouds which were occasionally observed to produce rain if more than 4,000 ft. thick. Mr. Murgatroyd has evidence that in southern England summer showers are often released by coalescence and that even small cumulus often contains many drops of diameter 50 μ. Ice crystals appeared in detectable numbers only at temperatures below −12° C.

V. J. Schaefer (United States) outlined the cloud physics programme of the Munitalp Foundation, in particular the attempts to make a survey of cloud development at various sites in the United States with the help of voluntary observers using ciné cameras. He showed a number of colour films of clouds taken by members of the United States Forestry Service and of cloud systems which were associated with jet streams. M. Bossolasco (Milan) described some observations of precipitating clouds made at a mountain observatory and attempted to correlate the onset of precipitation with the temperature at screen level. G. Fea (Rome) reported on methods which were used to measure liquid-water content of clouds on Monte Cimone. G. Yamamoto (Japan), in his studies of the initial growth stage of ice crystal on nuclei of silver chloride and silver nitrate, has found crystals which are square rather than hexagonal prisms.

The main contribution on cloud seeding came from E. Bollay, who has conducted large-scale commercial trials in the United States, mainly with the object of increasing the snowpack in the lee of the Sierras. Silver iodide smoke was released on all occasions when clouds in the target area surpassed the −5° C. evel. The results were evaluated using a regression method in which past rainfall data were used to obtain a regression curve between the rainfall of the target and a control area, this being used to predict the rainfall to be expected naturally in the target area during the seeding period. Mr. Bollay estimates that in four successive years of operations in the Central Sierras they increased the snowpack by 27, 21, 7 and 22 per cent respectively. An independent assessment of three other operations by the Statistical Laboratory of the University of California suggests that in one case the rainfall showed a decrease, in another there was a considerable increase, the third being inconclusive.

In recognizing that there are certain factors which militate against commercial undertakings being able to carry out seeding experiments in the most scientifically acceptable form, Mr. Mason said that it is important for those interested in the purely scientific aspects of the problem to give considerable thought to the design and execution of a large-scale experiment. The results can be evaluated only on a statistical basis, and he indicated how an experiment might be designed using control and target areas, the decision to seed being made on the basis of a random choice. Such an experiment would probably take at least five years if rainfall increases of order 15 per cent were to be detected with reasonable confidence. Dr. Fournier d'Albe showed a film to illustrate how warm cumulus clouds were inoculated with salt particles dispersed from the ground in two areas in Pakistan. Particles of mass greater than 10^{-9} gm. were dispersed at a rate of 10 gm./sec., about half being carried aloft by the air. Although there was some preliminary indication that the rainfall was higher in the target regions than outside, a complete analysis of the results has not yet been made.

After three days of lectures and discussions, visits were arranged to the Institute for Snow and Avalanche Research on the Weissfluhjoch, Davos, and to the observatory of the Meteorologische Zentralanstalt at Locarno. These gave delegates an opportunity of seeing something of this beautiful country in which they were received with such friendliness and hospitality.

B. J. Mason

MARIE CURIE CELEBRATIONS IN WARSAW

The twentieth anniversary of the death of Marie Sklodowska-Curie was celebrated at a special session of the Polish Academy of Sciences at Warsaw during October 6–8. This session was attended by Mrs. Irene Joliot-Curie, Madame Curie's daughter, and by specialists on various aspects of radioactivity from China, Czechoslovakia, France, Great Britain, Hungary, Norway and the U.S.S.R., as well as by a large number of Polish scientists who had gathered there from all parts of the country. Madame Curie's elder sister was a guest of honour, and in spite of her great age she was present at all the numerous functions of the session.

The first two days of the session were partly devoted to official speeches and surveys of the various physical and medical applications of radioactivity. Noteworthy was the speech by Mrs. Irene Joliot-Curie, in which she analysed her mother's work in a most vivid and personal way. Moreover, the participants attended the inauguration of a museum devoted to Madame Curie and installed in the newly rebuilt house where she was born in the so-called "New City" (which is actually an eighteenth-century extension of the Old Town). In this museum an extensive collection of documents and apparatus pertaining to Madame Curie is displayed in a most effective manner. The successive rooms are devoted to Madame Curie's childhood and family circle, her years of study in Paris, her great work in collaboration with her husband, her activities in promoting the medical use of radioactivity and her leadership of the Institut du Radium at Paris. The last rooms evoke the development of nuclear physics, which had its origin in the discovery of radioactivity, and lead the visitor to an impressive display of photographs illustrating on one hand the devastating use of nuclear energy in destroying cities and their inhabitants, and on the other the applications of nuclear energy for medical and industrial purposes (including a photograph of the first nuclear power station recently put into operation in the Soviet Union).

The last day of the session was entirely devoted to a more technical discussion of physical problems, and was held in the main lecture room of the Physical Institute. Among others, Prof. J. Rayski, of the University of Toruń (who is well known to nuclear physicists in Great Britain), presented a new interpretation of the various kinds of particles recently discovered in cosmic radiation. The Academy of Sciences and the State authorities also organized official receptions of the participants, who enjoyed, during the whole duration of their stay, the most cordial hospitality.

For the occasion the Academy of Sciences, which displays considerable activity in publishing scientific periodicals and excellent journals aiming at the popularizing of science, had issued a series of valuable books. These comprise Polish translations of Madame Curie's "Traité de Radioactivité", of Mrs. Irène Joliot-Curie's shorter text-book on nuclear physics, and also of Madame Curie's delightful short biography of her husband which originally appeared in French in 1924. Another book contains a collection of articles by various Polish scientists surveying Madame Curie's work and its implications, as well as a reprint of two articles written in Polish by Madame Curie. Last, but not least, a magnificent volume has been prepared containing a reprint in the original language (mostly French or Polish) of the complete works of Madame Curie. It is interesting to see to what extent Madame Curie was anxious to write popular articles or more technical surveys on the development of radioactivity in her native language. A bronze medal bearing the figure of Madame Curie was struck to commemorate the celebration.

The present writer had the opportunity of visiting in detail the Warsaw Physical Institute and of discussing questions of common interest with Polish physicists there. He was much impressed by the activity with which the newly reorganized Institute was teeming, and with the results already achieved in a surprisingly short time in trying circumstances. The Experimental Department of the Institute, under the direction of Prof. L. Sosnowski, pursues no less than four lines of investigation. Prof. Sosnowski himself is interested in problems of semiconductors; there is a section on nuclear physics (Prof. A. Soltan), a section on the study of cosmic rays by the emulsion technique (Prof. M. Danysz), and a section on optical and X-ray spectroscopy, which was set up by the late Prof. S. Pieńkowski, the creator of the Institute after the First World War. The Theoretical Physics Department occupies a new wing which was recently built in the space of a few months and which offers a group of very keen and active young theoreticians ideal conditions of work under the leadership of the two well-known theoretical physicists, Prof. L. Infeld and Prof. W. Rubinowicz. There are flourishing centres of research in physics at the other universities, which the writer had, however, no time to visit. The general impression from his brief contact with Polish physicists is that of a remarkably vigorous activity and growth, worthily upholding the brilliant traditions of Polish science.

L. Rosenfeld

SOCIAL IMPLICATIONS OF THE GENETICS OF MAN

In his presidential address to the Pacific Division of the American Association for the Advancement of Science, Prof. A. H. Sturtevant, of the California Institute of Technology, dealt with two matters. First, he emphasized the peculiar difficulties in the way of building up a sound body of knowledge on the formal genetics of man. These account for our gross ignorance of the part played by heredity, for example, in mental differences. Secondly, he considered the problems set by the genetical consequences of atom and hydrogen bombs.

Stressing that, for their effects on heredity, there is no lower level at which high-energy radiations are harmless, Dr. Sturtevant deprecated the statement by the Chairman of the Atomic Energy Commission that "... after every test ... there is a small increase in natural background radiation in some localities within the U.S.A. ... far below the levels which could be harmful in any way to human beings ...".

Dr. Sturtevant made the point that the risk is one to which the whole of mankind is already being subjected, and, if mankind survives for many generations, the bombs already exploded will ultimately and inevitably result in an increase in the harvest of defective individuals.

Few biologists will disagree with Dr. Sturtevant's criticism of the attitude exemplified above. The genetical consequences of a world atomic war would, clearly, be trivial compared with the immediate results. If mankind cannot avoid such a war there is not much point in speculating on the genetical consequences. But if it should be avoided, then a permanent increase, no matter how small, in radioactivity, be it due to industrial waste products or to the tests mentioned by Dr. Sturtevant, might become of tremendous importance. With present knowledge we are not even in a position to make a few intelligent guesses. It is to be regretted that Dr. Sturtevant, besides deprecating the light-hearted attitude towards biological problems mentioned above, did not also consider the consequences of the development of atomic energy for peaceful purposes. It seems to the reviewer that we are taking incalculable risks by building the factories without concentrating as much energy and money on the study of the long-term biological consequences of the atomic age.

G. Pontecorvo

UNITED NATIONS TECHNICAL ASSISTANCE BOARD

REPORT FOR 1953

The sixth report on the United Nations Expanded Programme of Technical Assistance for Economic Development*, submitted by the Technical Assistance Board to the Technical Assistance Committee of the Economic and Social Council, describes the progress of the programme during 1953, the third financial period. It also includes information on the approved programme for 1954 and some details on that proposed for 1955. Almost 200 out of the 267 pages of the report are occupied by the statements of the participating organizations and an analytical summary of the programmes for 1953–55 taken country by country. The general features of the Expanded Programme are discussed in an introduction which is illustrated by a series of diagrams and charts; and, in view of what has already been recently published in *Nature* (173, 50 and 174, 1; 1954), it is unnecessary here to refer to more than a few points.

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* United Nations Technical Assistance Committee. Sixth Report of the Technical Assistance Board. Economic and Social Council—Eighteenth Session—Supplement No. 4. Pp. vii+267. (New York: United Nations; London: H.M.S.O., 1954.) 2.50 dollars; 17s. 6d.; 10 Swiss francs.

In the four years since the Programme began, the less-developed countries have re-examined their economic and social problems and have invited many thousands of experts from many lands to work with and for them. The technical skill and experience of many countries have been drawn upon to accelerate progress where it has lagged, and the report claims that in some measure the energies and initiative, the hopes and capacity for self-help of many peoples have been quickened. Nevertheless, the volume of technical assistance fell slightly, from 22,968,129 dollars in 1952 to 22,810,000 dollars, partly in consequence of a thorough review of the Programme, when pledges for 1953, totalling 22·4 million dollars, fell far below the cost of the technical assistance requested. The number of countries and territories receiving experts, however, increased from sixty-two to sixty-five, although fellowships were awarded to nationals of only eighty-two countries, compared with ninety-two in 1952, and sixty-seven, as compared with seventy-six, countries or territories acted as hosts to Fellows.

Attempting to distinguish features of the Programme on the basis of five years of operation, the report points out that only a small proportion of the funds is required to meet urgent priority requests: most technical assistance is designed to assist the less-developed countries in themselves solving chronic and age-long problems and represents only a fraction of sustained national effort required for appreciable and enduring results. The approved programme for 1954, for example, includes some eight hundred projects in each of which the average number of experts is about two throughout the year, and a hundred and fifteen projects which include only one fellowship each and no experts. Secondly, relatively little equipment is provided with the expert assistance: in 1953 only 10 per cent of obligations was for equipment and only about 6 per cent is planned for 1954. Thirdly, the Expanded Programme is not related directly to any source of capital supply.

Experience seems to show that a large proportion of the Programme in widely different fields must be devoted to training national personnel in the less-developed countries. Often these training facilities are linked with, or followed by, the award of fellowships to candidates recommended by the government concerned to enable them to follow a specified course at teaching institutions abroad. In many countries international experts have assisted governments in developing the institutional framework required for experimental work, pilot projects and development. It is also emphasized that the degree of under-development and the requirements of various countries differ widely, and in most fields specific instruction and demonstration as to how to do things are taking the place of general advice as to what needs to be done.

During the year attempts were made for the first time to work out comprehensive technical assistance programmes at the country-level, and special attention to the possibilities of economy in the Board's field establishments led to a 24·5 per cent reduction in the estimated costs of these establishments for 1954. The holding of the Pledging Conference before the beginning of the Programme year also eased financial management in 1953, and the approval by the Technical Assistance Committee and the Economic and Social Council of proposals for the establishment of a reserve which might be utilized as a working capital and reserve fund should enable the Board to make advances to tide over time-lags between pledges and payment and to satisfy special currency requirements. Financial ceilings are now being imposed on obligations in order to regulate the rate of expenditure in relation to the rate of estimated collection. The Board is also re-examining the criteria and techniques to be used in judging the results of individual projects and the effectiveness of country programmes as a whole. In spite, however, of the improvement in financial management, the determined attack on administrative costs, the stronger co-operation between governments, agencies and the Board's representatives at the country-level and the improved co-ordination with other technical assistance programmes, much remains to be done to improve the operation of the Programme, to make more effective use of limited resources and to come to terms with the dimensions of the task for which the Expanded Programme was created. Once again it is clear that educational and economic advance should go side by side. Neither should dominate the other. This report should assist in formulating a clear conception of the principles involved in technical aid and what they require; and to overcome the difficulties encountered in obtaining a sufficient supply of experts and retaining their services, it may well prove necessary to form an international cadre with continuous and guaranteed agreed terms of service operating for something in the nature of a World Development Authority.

FISH CULTURE IN INDONESIA

THERE has recently been published by the Food and Agriculture Organization (F.A.O.) a highly important report* on fish culture in Indonesia. This report comprises a selection of the papers delivered and discussed at a seminar on brackish- and fresh-water fish culture, held at Djakarta during April 11–May 23, 1951, under the ægis of the Indo-Pacific Fisheries Council.

It is now generally recognized that the fish resources of the sea, vast though they be, are not limitless, nor are they uniformly distributed throughout the seas and oceans of the world. In many highly populated regions of the earth, especially within the tropics, the marine fisheries are as yet poorly developed and their yields make inadequate contributions to the needs of the inhabitants. In consequence, great effort is being made in many such regions—much of it under the inspiration and guidance of the Food and Agriculture Organization—to increase the yield of sea foods.

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* Fish Culture in Indonesia. G. L. Kesteven, General Editor. Indo-Pacific Fisheries Council (F.A.O.) Special Publication No. 2. I.P.F.C. Secretariat, F.A.O. (Regional Office for Asia and the Far East, Bangkok, 1953.) n.p.

This can be done only by streamlining and improving fishing methods and intensifying fishing effort. It is already clear, however, that in many places the ultimate yields from the sea's natural resources can never fully meet the unsatisfied demands for animal proteins; and no means have yet been found of adding appreciably to the sea's productivity by culture methods. Fish farming is not feasible in the sea; but in brackish lagoons and fresh inland waters it is both possible and profitable and has long been practised in various parts of the world.

Great effort to improve and extend the practice of fish culture in fresh and brackish waters is therefore now being made, especially in the Indo-Pacific region. This volume on fish culture in Indonesia is thus a most valuable document. It opens with a general description of the inland fisheries of Indonesia followed by reports on: (1) the anatomy and physiology of the milkfish or bandeng, *Chanos chanos*; (2) the capture and transportation of its fry for stocking purposes; (3) the breeding of carp, *Cyprinus carpio*; (4) the plankton populations of brackish-water ponds; (5) the occurrences of *Anopheles* larvæ in rice fields during combined cultivation of rice and fish. There are also brief notes on many other allied problems.

Practical fish culturists and all others interested in improving and extending the science and art of fish culture will be grateful to the Food and Agriculture Organization for providing in this publication such a rich fund of useful information.

The Organization has also published a second (revised) edition of its valuable List of Scientific and other Periodicals published in the Indo-Pacific Area*.

G. A. Steven

* List of Scientific and other Periodicals published in the Indo-Pacific Area. 2nd edition (revised) Indo-Pacific Fisheries Council, I.P.F.C. Secretariat, F.A.O. (Regional Office for Asia and the Far East, Bangkok, 1953.) n.p

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PARTICIPATION OF COENZYME A IN THE OXIDATION OF FAT*

By Prof. F. LYNEN

Biochemical Department, University Chemical Laboratory, Munich

RESEARCH in recent years has greatly increased our understanding of the pathways involved in fat metabolism and has confirmed the classical β-oxidation theory of Knoop[1] as the chief process by which fatty acids are oxidized. Fatty acid chains undergoing this process are cleaved into C_2-fragments, until recently known as 'active acetate', as their true nature was a mystery. The discovery of coenzyme A by Lipmann[2] was followed by that of the 'energy-rich' acylmercaptans or thioesters[3]. This led to the identification, three years ago, of 'active acetate' as the thioester formed from coenzyme A and acetic acid (acetyl-coenzyme A)[4]. Knowing this, it was possible to formulate a provisional scheme for the oxidation and synthesis of fatty acids[4-6]. The essentials of this scheme were soon confirmed, owing to the rapidity with which the enzyme systems involved were isolated and studied by several laboratories[7-10], including my own in Munich[11].

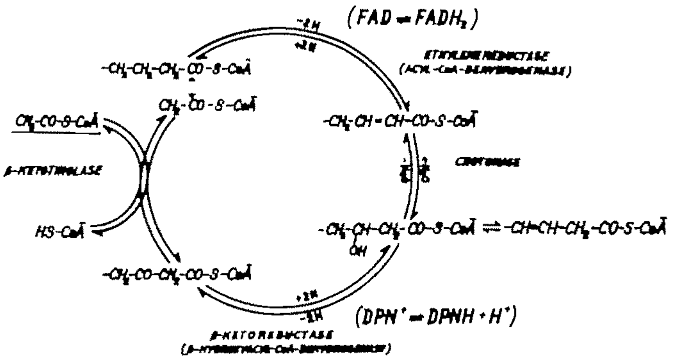

Fig. 1. Fatty acid cycle

This scheme (Fig. 1) represents a 'fatty acid cycle'. The synthesis of fatty acids is achieved by a repetition of four consecutive steps, catalysed by four new enzymes, which hand to each other substrates of different chain-length. (Recent experiments show that there exist two ketothiolases[7] and two ethylene reductases[8], each specific to substrates with certain chain-lengths.) I have named these enzymes according to the direction of their equilibria under physiological conditions. The four steps are as follows: (1) one molecule of acetyl-coenzyme A condenses with another, giving acetoacetyl-coenzyme A; (2) acetoacetyl-coenzyme A is reduced to β-hydroxybutyryl-coenzyme A in the presence of reduced diphosphopyridine nucleotide; (3) β-hydroxybutyryl-coenzyme A undergoes dehydration to crotonyl-coenzyme A; (4) crotonyl-coenzyme A is reduced to butyryl-coenzyme A in the presence of reduced flavine.

In these four steps the carbon chain of the original acetyl-coenzyme A is extended by two carbon atoms. An additional acetyl-coenzyme A and four additional hydrogen atoms are required. The butyryl-coenzyme A so formed can re-enter the cycle through condensation with another molecule of acetyl-coenzyme A to give ketocaproyl-coenzyme A, afterwards undergoing reduction to caproyl-coenzyme A. The repetition of the cycle eight times in a spiralwise manner will produce stearyl-coenzyme A (C_{18}). Fatty acid coenzyme A derivatives formed in the 'spiral' can transfer their acyl groups to α-glycerophosphate, forming diacyl phosphatidic acids[12], possible precursors of the phosphatides and true fats. The transferring enzyme concerned is highly specific for fatty acid chains of 16, 17 or 18 carbon atoms, which may account for

Table 1. $R—CO—S—CH_2—CH_2—NH—CO—CH_3$

Acyl (R—CO)	Melting point	Investigator
$CH_3—CO—$	80°	R. Kuhn and G. Quadbeck (ref. 15a), G. Vogelmann
$CH_3—CH_2—CH_2—CO—$	28°	W. Seubert
$CH_3—CH=CH—CO—$	62–63°	W. Seubert
$CH_3—\underset{\underset{OH}{\mid}}{CH}—CH_2—CO—$	fl.	T. Wieland and A. Bernhard, K. Decker
$CH_3—\underset{\underset{O}{\Vert}}{C}—CH_2—CO—$	60°	G. Vogelmann and L. Wessely
CH_3—(CH_2)[illegible]—CO—	22°	W. Seubert
CH_3—(CH_2)[illegible]—CO—	45–46°	W. Seubert
CH_3—(CH_2)[illegible]—CO—	60°	W. Seubert

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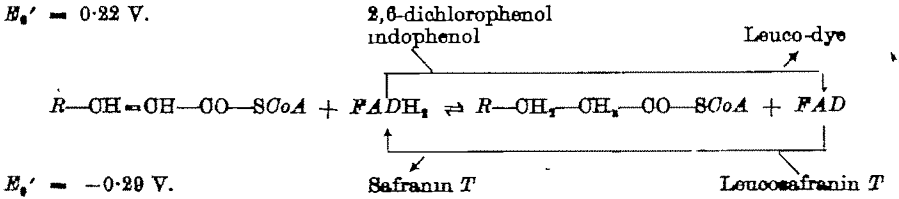
* Summary of a lecture given on March 8 at University College, London. The experimental work reported was aided by grants from the Deutsche Forschungsgemeinschaft, Bad Godesberg, and the Rockefeller Foundation, New York.

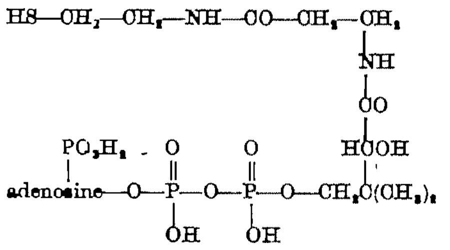
the preponderance of palmityl and stearyl glycerides in Nature. By reversing the 'spiral' the complete degradation of a fatty acid chain into C_2-fragments can occur, provided that the fatty acid is first activated by combination with coenzyme A.



$$R\text{—CH=CH—CO—}SCoA + FADH_2 \rightleftharpoons R\text{—CH}_2\text{—CH}_2\text{—CO—}SCoA + FAD$$

(*FAD* = flavine adenine dinucleotide, *FADH*$_2$ = reduced *FAD*)

The study of these four new enzymes in our laboratory in Munich has been based on the application of the elegant optical methods of Warburg[12], and on the wide use of model derivatives of coenzyme A—the derivatives of N-acetyl cysteamine, an analogue of coenzyme A.



Coenzyme A

HS—CH_2—CH_2—NH—CO—CH_2—H

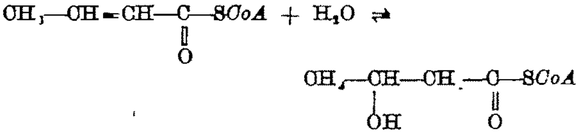
N-Acetyl cysteamine

These model compounds were first prepared by us with the object of obtaining information about the chemical properties of the predicted intermediaries of the fatty acid cycle (Table 1). They also proved to be of great value in the study of enzyme reactions. Not only are they inexpensive and readily available (unlike coenzyme A and its derivatives), but they can also be prepared in the laboratory as analytically pure compounds. Some of them possess, in common with the coenzyme A derivatives, strong absorption bands in the ultra-violet. The S-crotonyl and S-acetoacetyl derivatives possess absorption bands at 263 mμ and 303 mμ ($pH > 8$, enolic form) respectively, and the thioesters of the saturated fatty acids and the β-hydroxyacids have a band at 233 mμ [14]. The model compounds must be used at higher concentrations than the corresponding coenzyme A derivatives, as the enzymes concerned have a lower affinity for them. The models possess the correct configuration of atoms next to the active group but lack the anchor, perhaps provided by the phosphate groups of coenzyme A, for their firm attachment to the enzyme. In this respect the enzymes of the fatty acid cycle may resemble the triose phosphate dehydrogenase[13,15].

Ethylene reductase is a flavoprotein enzyme with flavadenine dinucleotide as prosthetic group, an observation made independently in Munich[16] and in Madison[17,17a]. It catalyses the oxido-reduction between saturated fatty acid derivatives of coenzyme A and flavine, and can also react with the model compounds. This reaction may be followed spectrophotometrically by observing either the bleaching of 2,6-dichlorophenol indophenol by the saturated fatty acid derivatives, or the regeneration of colour from leucosafranin *T* by the S-crotonyl derivatives.

The enzyme was purified four hundred times from sheep liver extract, using the second reaction for the assay system[16]. The enzyme has the same affinity for model as for natural compounds, but, in order to achieve the same velocity at identical substrate concentrations, three times more enzyme is needed with the model compound than is needed with the natural one. This suggests that the transfer of hydrogen from the natural substrate to flavine is three times more rapid than the transfer from the model compound. The rate of oxidation of the model fatty acid derivatives increases with chain-length. We have evidence that our purified ethylene reductase is different from the 'acyl-coenzyme A dehydrogenase', isolated in Madison[17].

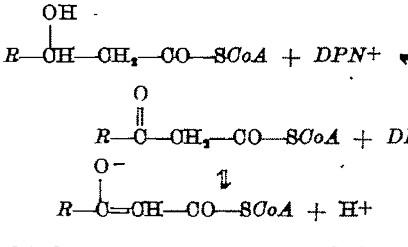
Crotonase catalyses the reversible hydration of the thioesters of the unsaturated acids to the corresponding β-hydroxyacids[18,19].



$$CH_3\text{—CH=CH—}\underset{\underset{\displaystyle O}{\|}}{C}\text{—}SCoA + H_2O \rightleftharpoons CH_3\text{—}\underset{\underset{\displaystyle OH}{|}}{CH}\text{—CH}_2\text{—}\underset{\underset{\displaystyle O}{\|}}{C}\text{—}SCoA$$

This reaction may be followed by measuring changes in the absorption band of S-crotonyl derivatives at 263 mμ[7]. The extinction coefficient of this band is sufficiently high to prevent significant interference by the adenine band of coenzyme A at 260 mμ. Crotonase can remove water from β-hydroxybutyryl-coenzyme A to give vinyl-acetyl-coenzyme A[18,19], an unsaturated fatty acid with the double bond between carbons 3 and 4. The incorporation of such a fatty acid into a chain undergoing synthesis in the 'spiral' could explain the distribution of double bonds, in a number of naturally occurring unsaturated fatty acids (for example, linolenic, $C_{9:10}$, $C_{12:13}$, arachidonic, $C_{5:6}$, $C_{11:12}$).

β-*Ketoreductase* catalyses the reduction of the S-acetoacetyl derivatives of coenzyme A and N-acetyl cysteamine to the corresponding β-hydroxyacid derivatives, using reduced diphosphopyridine nucleotide (*DPN*H) as hydrogen donor[20,20a].



$$R\text{—}\overset{\overset{\displaystyle OH}{|}}{CH}\text{—CH}_2\text{—CO—}SCoA + DPN^+ \rightleftharpoons R\text{—}\overset{\overset{\displaystyle O}{\|}}{C}\text{—CH}_2\text{—CO—}SCoA + DPNH + H^+ \rightleftharpoons R\text{—}\overset{\overset{\displaystyle O^-}{|}}{C}\text{=CH—CO—}SCoA + H^+$$

Of the two enantiomorphs of the β-hydroxyacid, only the D-compound takes part in the reaction[19]. This may be followed by using S-acetoacetyl-N-acetyl cysteamine as the substrate, and measuring the disappearance of reduced diphosphopyridine nucleotide.

Considerable purification of the enzyme from sheep liver was obtained, using this assay system[18]. The affinity of the enzyme for its natural substrate is one hundred times greater than its affinity for the model compound. At physiological pH the equilibrium of the reaction lies towards oxidized diphosphopyridine nucleotide and β-hydroxyacyl-coenzyme A, but shifts towards the S-acetoacetyl compound with rising pH. Above pH 8·5 the acetoacetylmercaptan dissociates to give the enolate ion. The latter effect can be used in the preparation of S-acetoacetyl or higher β-ketoacyl derivatives of coenzyme A. This was first done in our laboratory in Munich[20] and later elaborated by Bemert in Madison[21]. Various tissues have been examined for the presence of the enzyme. Of all the organs tested, the brain was found to contain very little (Fig. 2), which agrees with the well-known fact that this organ can metabolize carbohydrate but not fat.

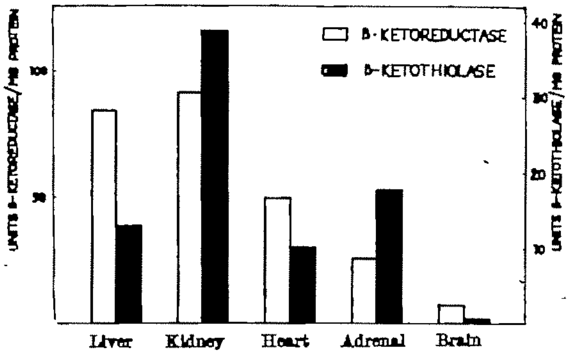
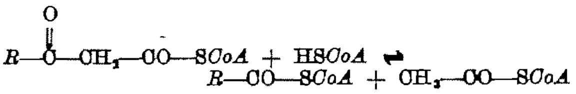


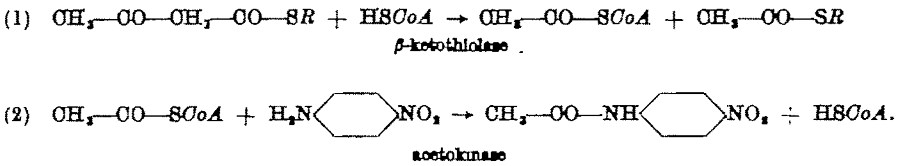
Fig. 2. Occurrence of β-keto reductase and β-keto thiolase in various sheep tissue-extracts

β-*Ketothiolase* catalyses the reversible cleavage of acetoacetyl-coenzyme A into two molecules of acetyl-coenzyme A[7,21]. The equilibrium of the reaction under physiological conditions lies towards the thiolytic cleavage, one thousand molecules of acetyl-coenzyme A being in equilibrium with about five molecules each of acetoacetyl- and free coenzyme A.



$$R-\overset{\substack{O\\ \|}}{C}-CH_2-CO-SCoA + HSCoA \rightleftharpoons R-CO-SCoA + CH_3-CO-SCoA$$

The reaction may be followed by observing changes in the absorption band of acetoacetyl-coenzyme A at 303 mμ[14]. The model compound, S-acetoacetyl-N-acetyl cysteamine, can replace the natural substrate, but at such high concentrations that the reaction cannot be followed at 303 mμ. This difficulty can be overcome by coupling the enzyme with the acetokinase for aromatic amines from pigeon liver. The acetyl-coenzyme A formed by the thiolytic cleavage acetylates p-nitroaniline, giving an almost colourless compound[22], and the overall reaction can be followed optically[23].



$$(1)\quad CH_3-CO-CH_2-CO-SR + HSCoA \underset{\beta\text{-ketothiolase}}{\rightarrow} CH_3-CO-SCoA + CH_3-CO-SR$$

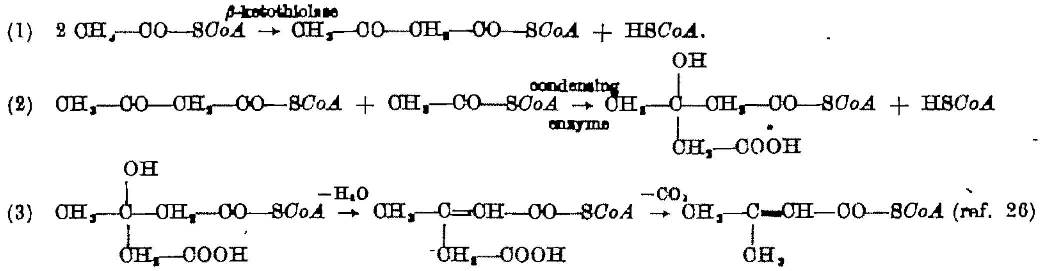
Acetoacetyl-coenzyme A and acetoacetyl-glutathione will also react in this system, showing the wide range of the β-ketothiolase, the only enzyme so far known which will react with the S-acyl derivatives of glutathione.

We have come to the conclusion that the enzyme participates in the reaction, in the following stoichiometric manner, by means of a thio group, which is essential to its activity[14].

$$(1)\quad \text{Enzyme } SH + CoAS-CO-CH_2-CO-CH_3 \rightleftharpoons \text{enzyme } S-CO-CH_3 + CoAS-CO-CH_3.$$

$$(2)\quad \text{Enzyme } S-CO-CH_3 + CoASH \rightleftharpoons \text{enzyme } SH + CoAS-CO-CH_3.$$

The distribution of the enzyme in certain tissues is shown in Fig. 2. The great accumulation of the enzyme in the suprarenal gland suggests that it might participate in the synthesis of steroids from acetyl groups, via squalene[24]. We suggested more than two years ago that a 'building block' suitable for such biosyntheses, and containing five carbon atoms in an isoprene structure, could be produced in a fashion analogous to the *in vivo* synthesis and transformation of citrate[25].



$$(1)\quad 2\,CH_3-CO-SCoA \xrightarrow{\beta\text{-ketothiolase}} CH_3-CO-CH_2-CO-SCoA + HSCoA.$$

$$(2)\quad CH_3-CO-CH_2-CO-SCoA + CH_3-CO-SCoA \xrightarrow[\text{enzyme}]{\text{condensing}} CH_3-\underset{\substack{|\\ CH_2-COOH}}{\overset{\substack{OH\\ |}}{C}}-CH_2-CO-SCoA + HSCoA$$

$$(3)\quad CH_3-\underset{\substack{|\\ CH_2-COOH}}{\overset{\substack{OH\\ |}}{C}}-CH_2-CO-SCoA \xrightarrow{-H_2O} CH_3-\underset{\substack{|\\ CH_2-COOH}}{C}=CH-CO-SCoA \xrightarrow{-CO_2} CH_3-\underset{\substack{|\\ CH_3}}{C}=CH-CO-SCoA \text{ (ref. 26)}$$

Activation of fatty acids. In the fatty acid cycle fatty acids are not metabolized in the free form, and prior to oxidation must undergo activation by combination with the thio group of coenzyme A[7,26a,26]. Three enzymes are known which catalyse this reaction. One, which has received the most intensive study, activates acetate and propionate[7,26a,26]; another activates fatty acids, unsaturated fatty acids and β-hydroxy-acids of chain-length C_4–C_{11} [27]; and a third activates higher fatty acids up to C_{22} [28]. The activation needs energy from adenosine triphosphate[29], which was shown by Lipmann and his co-workers to split into adenosine monophosphate and pyrophosphate during the activation of acetate[30]. The recent collaboration of our team with Lipmann's elucidated the mechanism of acetate activation[31]. This seems to require the stoichiometric participation of a group (X) on the enzyme in a three-step reaction:

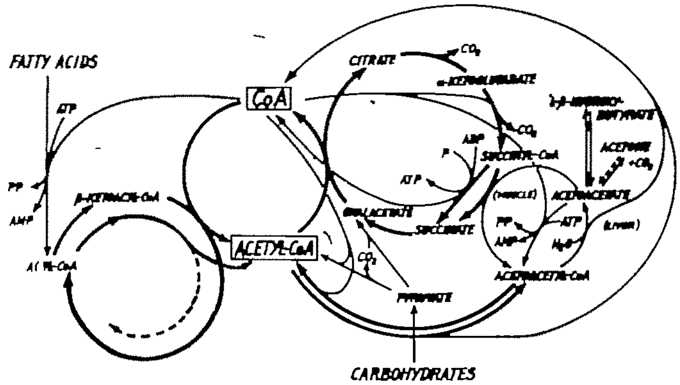


Fig. 3. Interaction of the fatty acid cycle and the citric acid cycle

(1) $\text{Enzyme } X + Ad{-}P{\sim}PP \rightleftharpoons \text{enzyme } X{\sim}P{-}Ad + PP.$

(2) $\text{Enzyme } X{\sim}P{-}Ad + HSCoA \rightleftharpoons \text{enzyme } X{\sim}SCoA + Ad{-}P.$

(3) $\text{Enzyme } X{\sim}SCoA + CH_3COOH \rightleftharpoons \text{enzyme } X + CH_3CO{\sim}SCoA.$

(Ad = adenosine, $Ad{-}P$ = adenosine monophosphate, PP = pyrophosphate).

It has been known for many years that the metabolism of fat is closely integrated with that of carbohydrate, but only now is it possible to have a clear picture of this integration at the enzymatic level (Fig. 3). For the synthesis of fat the fatty acid cycle is dependent upon the supply of acetyl-coenzyme A and reduced diphosphopyridine nucleotide, derived from the breakdown of carbohydrate. A high concentration of these substrates must be maintained, and the concentration of free coenzyme A kept low, if the equilibria of the β-ketothiolase and the β-ketoreductase are to be shifted in the direction of synthesis. In the living organism the supply of these two substrates is crucial in deciding if fat is to be synthesized or oxidized. In diabetes, where the metabolism of carbohydrate is depressed, the stationary concentration of reduced diphosphopyridine nucleotide in the liver is lowered[23] and the synthesis of fatty acids restricted.

The acetyl-coenzyme A derived from the oxidation of fatty acids passes into the citric acid cycle by condensation with oxaloacetate, to be oxidized to carbon dioxide and water. The level of fatty acid oxidation is therefore determined by the rate at which oxaloacetate becomes available. If this rate falls off, through the depression of carbohydrate metabolism, as in diabetes, then acetyl-coenzyme A cannot be metabolized completely. Acetoacetyl-coenzyme A accumulates and gives rise to the 'ketone bodies' of the blood by being hydrolysed by a deacylase, found only in liver, to give free acetoacetate. Acetoacetate may be reduced or decarboxylated to β-hydroxybutyrate or acetone. In normal animals acetoacetate can be used to provide energy[33], for once activated with coenzyme A it will give rise to acetyl-coenzyme A, which enters the citric acid cycle. Two such activating mechanisms are known. Stern[34] and Green[35] discovered independently an enzyme which exchanges acetoacetate with the succinate of succinyl-coenzyme A (arising from the citric acid cycle) to give acetoacetyl-coenzyme A and free succinate. There is also an enzyme, found mainly in kidney[36], which catalyses the direct activation of acetoacetate with coenzyme A and adenosine triphosphate. The level of the blood acetone bodies will be controlled by the inter-relationships of such systems producing and utilizing acetoacetate.

The smooth integration of fat and carbohydrate metabolism depends upon a steady turnover of coenzyme A. Free coenzyme A is acylated in the activating and thiolysing steps, and is liberated from the acylated form by condensation reactions involving acetyl-coenzyme A. This turnover explains why coenzyme A does not appear on the balance equation of β-oxidation, and provides a beautiful example of the catalytic functioning of coenzyme A in the living organism.

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LETTERS TO THE EDITORS

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Ion-Exchange Chromatography of Guanidino Amino-acids from Synthetically Modified Gelatin

Elution chromatography of amino-acids on columns of 'Dowex 50' by the method of Moore and Stein[1] has proved a versatile technique for the analysis of biological materials[2-4]. Application of the method to chemically modified proteins has received little attention. The present investigation, in which it has been used to separate two amino-acids, considered to be homoarginine[5] and hydroxyhomoarginine, from hydrolysates of a guanidated gelatin, illustrates its power in this connexion.

The parent gelatin (17·9 per cent nitrogen), prepared from cattle hide after prolonged treatment with lime[6], was guanidated[7] by treatment with O-methyl isourea at *p*H 10–12. The guanidino gelatin (18·7 per cent nitrogen) had an isoelectric point, determined by the method of Janus, Kenchington and Ward[8], at *p*H 4·91, identical with that of the original gelatin, whereas its titration curve showed almost complete removal of ε-amino-groups. This would suggest conversion of the ε-amino-groups to guanidino-groups which, if complete, would give rise to an increase in total nitrogen of 0·87 per cent.

The gelatin and the guanidated product were de-ionized[8] with mixed-bed ion-exchange resins to remove all small ions and hydrolysed in sealed tubes with 6 *N* hydrochloric acid at 100° for 24 hr. The hydrolysates were chromatographed on 15 cm. × 0·9 cm. columns of 'Dowex 50' and eluted with 0·1 *M* sodium citrate, *p*H 4·95 for the first 25 ml. The elution curve of the gelatin (Fig. 1,*a*), in which the actual optical density of the test solution from each fraction is plotted against eluant volume, showed peaks corresponding to hydroxylysine, histidine, ornithine, lysine, ammonia and arginine. The asymmetry of the hydroxylysine peak was attributed to partial separation of the diastereoisomers[9]. The small ornithine peak partially merged into the leading edge of the lysine peak. This gelatin contained an abnormally large proportion of ornithine, formed by alkaline decomposition of guanidino-groups during manufacture. Collagen and acid-process[6] gelatins have been shown to contain no ornithine[10], whereas gelatins prepared after short lime treatments have small amounts.

The chromatogram of the guanidino gelatin (Fig. 1,*b*) showed almost complete absence of hydroxylysine, ornithine and lysine, increased arginine and the appearance of two new peaks. The first of these peaks, emerging between ammonia and arginine, was attributed to hydroxyhomoarginine, formed by guanidation of hydroxylysine. The peak emerging after arginine was considered to be homoarginine derived from lysine. The high and variable blank, in the region of the ammonia peak, due to emergence of ammonia accumulated from the buffer solutions, necessitated the removal of ammonia from alternate fractions to permit accurate estimation of hydroxyhomoarginine. The 1-ml. fractions were brought to *p*H 11·5 by addition of 0·051 ml. of *N* sodium hydroxide and ammonia was removed by evacuation at 15 mm. pressure for 4 hr. The fractions were then brought to *p*H 5·0 by addition of 0·097 ml. of 2 *N* hydrochloric acid before addition of ninhydrin reagent[11].

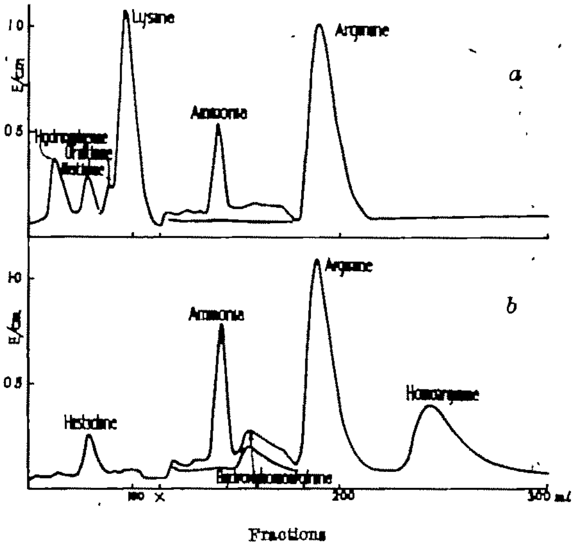

Fig. 1. Elution curve from 15 cm. × 0·9 cm. columns of 'Dowex 50' of hydrolysates of (*a*) 11·07 mgm. of gelatin, and (*b*) 11·07 mgm. of guanidated gelatin. The lower curve for fractions 120–180 indicates values obtained after removal of ammonia. The eluant buffer was changed from *p*H 6·75, 0·1 *M* sodium phosphate to *p*H 6·50, 0·2 *M* sodium citrate at the point marked *X* (115 ml.)

The contents of basic amino-acids of the gelatins are shown in Table 1. The 'colour yields'[11] of homoarginine and hydroxyhomoarginine were assumed to be the same as for arginine. The sum of the hydroxyhomoarginine and residual hydroxylysine of the guanidino gelatin is rather less than the original hydroxylysine content. This may be due to errors in the integration of the small hydroxylysine peak, arising from uncertainty in the position of the base line. Rather lower hydroxylysine values have been obtained with other gelatins[10]. The increase in the arginine content exceeds what would be expected from guanidation of ornithine. Errors in the estimation of ornithine are substantial, although these do not affect the combined figure for lysine and ornithine. The sum of the homoarginine, the increase in arginine and the residual lysine of the guanidated gelatin (35·0 residues per 10^5) agrees with the original total of ornithine and lysine (33·9 per 10^5), confirming that the discrepancies arose from the analysis of the overlapping peaks.

Arginine, homoarginine and hydroxyhomoarginine all give rise to asymmetrical peaks, each having a gradually falling trailing edge which appears to be

Table 1. Content of Basic Amino-acid Residues and Amide Nitrogen of a Limed Hide Gelatin, before and after Guanidation

	No. of residues per 10^5 molecular weight of parent gelatin* (that is, 1,105 total residues)	
	Gelatin	Guanidino gelatine
Hydroxylysine	7·7	0·3
Hydroxyhomoarginine	0·0	6·7
Ornithine	2·7	0·0
Lysine	31·2	1·4
Homoarginine	0·0	28·0
Arginine	47·6	53·2
Histidine	5·6	5·3
Amide groups†	6·0	11·4

* 1 gm. of gelatin gives rise to 1·017 gm. of fully guanidated gelatin.

† Corrected for ammonia formed by decomposition of serine and threonine during hydrolysis.

characteristic of the guanidino-group. The sharp separation of arginine and homoarginine, each of which contains the same three ionizable groups and which differ only by one carbon atom in chain-length, illustrates the high resolution of basic amino-acids on 15-cm. columns of 'Dowex 50', eluted with nearly neutral buffers. Substitution of a hydroxy-group in homoarginine has the effect of causing an earlier emergence of the hydroxy amino-acid, a result also shown by the pairs lysine and hydroxylysine and alanine and serine.

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Colour Reaction for Deoxyribose Compounds

THE two most commonly used methods for detecting deoxyribose compounds are the diphenylamine reaction[1] and the cysteine–sulphuric acid method[2,3], both originally discovered by Dische. Overend and Stacey[4] have made the most recent survey of the usefulness of these methods. Both methods suffer from the same fault, that neither measures pyrimidine-bound deoxyribose quantitatively. Brody[5] has used the cysteine–sulphuric acid method under conditions of precise temperature control for the quantitative determination of deoxyribose nucleic acid. It was not determined whether or not the pyrimidine-bound deoxyribose compounds were as chromogenic as the purine-bound sugars. The observations presented here show that the method can be employed for a variety of compounds containing deoxyribose.

The only change from the description by Brody was to decrease the final volume from 5·55 ml. to 3·33 ml., and the amounts of reagents used were reduced accordingly. The intensity of colour that developed was determined in the Beckman spectrophotometer at 474 mμ. Assuming that each mole of deoxyribose is quantitatively converted to the chromogen, Table 1 shows the apparent molar extinction coefficient of this chromogen as derived from tests with a variety of compounds containing deoxyribose. Within experimental error, the observed molar extinction coefficient is the same. It appears, therefore, that pyrimidine-bound deoxyribose reacts as well, quantitatively, as purine-bound deoxyribose. One can therefore use this method to determine the total deoxyribose content of a given sample. One can also determine the amount of purine-bound and pyrimidine-bound deoxyribose in any sample by a combination of the diphenylamine reaction and the cysteine–sulphuric acid method as described by Brody.

Table 1. REACTION OF DEOXYRIBOSE COMPOUNDS IN THE CYSTEINE–SULPHURIC ACID METHOD.

The test was carried out under the conditions described in the text. 50 μgm. of each substance was used, and the apparent molar extinction coefficient calculated from the value obtained

Substance	Apparent molar extinction coefficient of the chromogen (× 10⁴)
Adenine deoxyriboside	1·6
Thymidine	1·5
Cytosine deoxyriboside	1·3
Deoxyguanylic acid	1·4
Deoxyadenylic acid	1·3
Thymidylic acid	1·4
Thymidine diphosphate*	1·5
Deoxycytidylic acid	1·5
Thymus deoxyribonucleic acid†	1·4

* A commercial sample obtained from the California Foundation for Biochemical Research, Los Angeles, Calif.

† A commercial sample obtained from General Biochemicals, Inc., Chagrin Falls, Ohio. The apparent molar extinction coefficient was calculated on the basis of the composition of the deoxyribonucleic acid being a statistical tetranucleotide.

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Correlation between Endogenous Auxin and its Destruction *In vivo* by 2:4-Dichlorophenoxyacetic Acid in Plants

SEVERAL investigators have recently pointed out the accelerating effect of 2:4-dichlorophenoxyacetic acid (2,4-D) on the destruction of auxin in dicotyledonous plants[1–3]. In addition, one group[3] has revealed that the opposite effect prevails in oat coleoptile sections, that is, 2,4-D effects a prevention or 'sparing action' of the previously reported destruction of indolylacetic acid in oat coleoptiles[4].

Experiments *in vitro* using etiolated oat coleoptile, pea epicotyl and sunflower hypocotyl sections (3 mm.), have shown that these two phenomena do indeed occur under similarly controlled conditions. Table 1 indicates that 2,4-D in increasing concentrations causes a continuously retarded destruction of added indolylacetic acid (50 mgm./l.) with oat sections. The opposite is shown for the pea and sunflower sections.

Next, intact plants grown in 'Terralite' were sprayed *in vivo* in the greenhouse and in the *Avena* dark room with 1,000 p.p.m. (4 × 10^{-3} *M* of sodium salt) of 2,4-D and allowed to stand 12–48 hr. (or longer for beans). Plant parts, exclusive of leaves, were extracted in the cold room (0–2° C.) with two successive portions of wet, peroxide-free ether over a 16-hr. period. The extracts were then made up in the usual manner for use in the Went *Avena* assay.

The results, as shown in Table 2, indicate that there is fairly good correlation between the previously cited effect of 2,4-D on auxin destruction (Table 1)

Table 1. Time in hours to cause complete destruction of indolylacetic acid (50 mgm./l.) in 30 sections of 3 mm. length (total volume of medium 12 c.c.). Phosphate buffer, pH 6·5. Continuous shaking at 110 oscillations per minute at 30° C

Species	Concentration of 2,4-D (p.p.m.) 0	250	500	1,000
Oat	4·5	5·0	6·0	9·0
Pea	6·0	4·5	4·5	6·0*
Sunflower	4·0	3·5	3·25	4·0*

* Destruction possibly inhibited by disorganization of the tissues in the sections due to high concentration of 2,4-D.

Table 2. Endogenous auxin in plants treated with 2,4-D at 1,000 p.p.m. (after 48 hr.) Tested by *Avena* assay of Went

Species	Wet wt. (gm.)	Curvature of *Avena* coleoptiles Untreated	Treated	Standard IAA 25 γ/l.
Oat*	2·0	7·2	8·2	11·7
Sunflower	5·0	13·8†	7·8†	9·7
Pea	5·0	9·0	5·8	10·0
Bean	2·3	73·0	16·4‡	av. 10·5

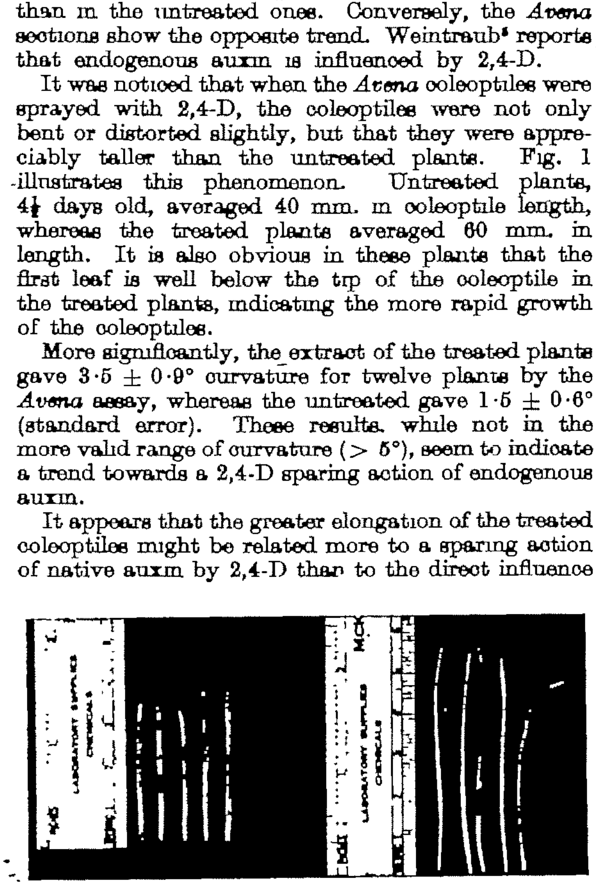
* Average of four separate runs made at widely different times
† One run out of three gave untreated, 13·5°; treated, 8·8°
‡ These plants were treated with 10, 100 and 1,000 p.p.m. 2,4-D; results: 52°, 18°, 16°, respectively.

and the amount of endogenous auxin remaining in the plant sections. It is obvious that the dicotyledons are definitely influenced by 2,4-D either in their auxin synthesis or in its destruction, since the levels of auxin in the treated plants are significantly lower than in the untreated ones. Conversely, the *Avena* sections show the opposite trend. Weintraub[5] reports that endogenous auxin is influenced by 2,4-D.

It was noticed that when the *Avena* coleoptiles were sprayed with 2,4-D, the coleoptiles were not only bent or distorted slightly, but that they were appreciably taller than the untreated plants. Fig. 1 illustrates this phenomenon. Untreated plants, 4½ days old, averaged 40 mm. in coleoptile length, whereas the treated plants averaged 60 mm. in length. It is also obvious in these plants that the first leaf is well below the tip of the coleoptile in the treated plants, indicating the more rapid growth of the coleoptiles.

More significantly, the extract of the treated plants gave 3·5 ± 0·9° curvature for twelve plants by the *Avena* assay, whereas the untreated gave 1·5 ± 0·6° (standard error). These results, while not in the more valid range of curvature (> 5°), seem to indicate a trend towards a 2,4-D sparing action of endogenous auxin.

It appears that the greater elongation of the treated coleoptiles might be related more to a sparing action of native auxin by 2,4-D than to the direct influence of the latter on cellular elongation. Sufficient evidence exists that this could be the possible explanation, just as it appears to be the cause for the continued acceleration of respiration in the coleoptile sections under the influence of added indolylacetic acid and 2,4-D[3]. Experiments are under way, using decapitated and non-decapitated coleoptiles, in an attempt to elucidate whether the increased growth is a result of the 2,4-D or native auxin.



Untreated

Treated with 1,000 p.p.m. 2,4-D

Fig. 1. *Avena* coleoptiles (sample of five out of c. 200) untreated and treated with 2,4-D, the latter after 36 hr. exposure to 1,000 p.p.m. All plants grown in *Avena* 'dark' room

Thus, it is possible that these observations might bring about a new interpretation of some of the previously unexplained results involving the use of 2,4-D on plants.

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Some Cytological Observations on the Delayed Effect of Mustard Gas

IN the course of a quantitative study of re-arrangements induced by mustard gas in *Drosophila melanogaster*[1], 757 progeny of treated males have so far been analysed by the salivary gland method. Among sixteen structural changes, one was a mosaic for two inversions involving separately the *X* and *3R* chromosomes. Mosaic glands have also been found in the progeny of X-irradiated males[2]; the special features of the present case are: (1) mosaicism for two independent changes and (2) the fact that in any one nucleus both changes were either present or absent. Of thirty-eight nuclei analysed, seventeen contained both inversions, twenty-one neither. Since in the preparation of the slides only one larva was used at a time, a mixture of two sets of glands on the same slide could not occur. The possibility that nuclei in unanalysed parts of the larva may have contained only one of the inversions cannot be ruled out; but the simplest interpretation is that both changes arose simultaneously either immediately after fertilization or through delayed effect at a later mitosis. The first alternative requires that in both *X* and *3R* only one of the broken sister chromatids formed an inversion, while the other was restituted in the old order, and that at anaphase the two inverted chromatids segregated to the same pole. The second alternative dispenses with these requirements and is therefore rather more probable. It suggests that conditions which affect the nucleus as a whole may result in the simultaneous opening up of latent breaks in several chromosomes.

Another structural change consisted of a reversed repeat involving regions 7 and 8 of the *X*-chromosome. Repeats, whether in reverse or normal order, which occur in the progeny of treated males, must have arisen as chromatid changes. The individuals containing them presumably are mosaics, carrying the duplication in part of their cells and the complementary deficiency in the remainder. With a favourable distribution of the two types of cells, this kind of mosaicism has indeed been observed after treatment with X-rays[2,3] and mustard gas[4]; in other cases the deficiency may not have been accessible to analysis, or it may not have given rise to viable tissue.

The origin of such a duplication-deficiency in the newly fertilized zygote need not involve a true delayed effect, but only differences in the way in which the broken sister chromatids undergo reunion. X-ray duplications presumably arise by this mechanism. Their frequency in Bauer's experiments[5] was seven duplications out of 688 structural changes; Kaufmann[6] found a similar frequency. After mustard gas treatment of males, Mehtab[7] obtained two reversed repeats among eleven structural changes. Added to the present sample, this gives a frequency of three reversed repeats among twenty-seven changes, a markedly higher value than that found for X-rays. It suggests that some special effect of chemical treatment, probably its after-effect, favours the occurrence of repeats. It should also be noted that reverse repeats cannot arise without previous breakage of the chromosomes; the frequent occurrence of this type of change after mustard gas treatment indicates that at least many of the structural changes induced by mustard gas cannot be explained by non-homologous crossing-over (see ref. 8).

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Inability of Acetylcholine Antagonists to protect Mice against the Toxicity of 'Tensilon'

The anticurare action of 'Tensilon' (3-hydroxy-*N*-dimethylethylanilinium bromide) was considered by Randall[1,2] not to depend upon cholinesterase inhibition. Hobbiger[3] and Hall and Parkes[4] showed, however, that 'Tensilon' does not reverse neuromuscular block after treatment of the preparation with tetraethyl pyrophosphate, implying the necessity of active cholinesterase for the effect.

We have recently described the protection afforded to mice against the toxicity of anticholinesterase drugs by antagonists of acetylcholine[5]. Animals were injected intravenously with atropine, 10 mgm./kgm., tubocurarine, 0·1 mgm./kgm., or hexamethonium, 40 mgm./kgm., and the decrease in intravenous toxicity of simultaneously injected neostigmine or tetraethyl pyrophosphate may be quoted as examples:

	Neostigmine	Tetraethyl pyrophosphate
LD 50 alone	0·306 mgm./kgm	0·2 mgm./kgm.
LD 50 with atropine	0·66 "	0·56 "
LD 50 with tubocurarine	4·19 "	0·73 "
LD 50 with hexamethonium	4·5 "	0·666 "

Corresponding values obtained with 'Tensilon' have shown, however, that these antagonists provided no protection at all against the toxicity of this substance.

LD 50 of 'Tensilon' alone	18·6 (17·6–19·6) mgm./kgm.
LD 50 with atropine	17·4 (16·35–18·5) "
LD 50 with tubocurarine	c. 20 mgm./kgm. (2 dose-levels only)
LD 50 with hexamethonium	17·6 (16·45–18·8) mgm./kgm.

These results would certainly seem to be inconsistent with the participation of cholinesterase inhibition or the augmentation of cholinergic function in the toxicity of 'Tensilon'.

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Toxicity of Erythromycin

In the course of experiments using young guinea pigs as test animals, it was found that erythromycin given orally or intraperitoneally caused the animals to look ill after two to three days, with ruffled fur, anorexia, disinclination to move and subnormal temperature, followed by death on the sixth to eighth day with emaciation and signs of diarrhœa. No obvious common cause of death could be found macroscopically or microscopically in sections of liver, spleen, kidney or lung, although occasionally liver necrosis and renal tubular degeneration were seen, accompanied by albuminuria, red cells and casts in the urine and slightly raised blood urea.

It may be seen from Table 1 that, with small numbers of animals, toxicity is independent of age (weight) of the animal or the type of preparation, but is related to the dosage and route of administration, that is, blood and tissue concentration. Guinea pigs weighing 160 gm. were given erythromycin orally or intraperitoneally in doses of 62·5 mgm./kgm. at 12-hr. intervals, and killed 2 hr. after the third dose. The serum and liver concentrations were 2 μgm./ml. and 16 μgm./ml. respectively after injection, and 0·1–0·2 μgm./ml. and 0·9 μgm./ml. orally. A high degree of toxicity is indicated by the lethality of 500–600 μgm./kgm. injected in one dose, where the blood and tissue concentrations must have been extremely low and transient. Guinea pigs injected intraperitoneally with 100 - mgm. erythromycin (625 mgm./kgm.) died in 3–6 hr. Doses used as in Table 1 caused death in 3–12 days, averaging 7·1 ± 0·2 days for forty-five guinea pigs.

Hamsters of 50–60 gm. weight treated intraperitoneally with 30–200 mgm./kgm. erythromycin in one or more doses also died after approximately thirteen days, with a terminal illness closely resembling that of guinea pigs.

This delayed toxicity has not been recorded in other work on erythromycin, where the oral *LD*50

Table 1. Toxicity of Erythromycin for Guinea Pigs

Preparation	Route of administration	Daily dosage (mgm./kgm.)	Average weight of animals (gm.)	No. of days treatment	No. of animals	
					used	dead
Aqueous suspension tablets 'Ilotycin'	Oral	110	180	6	5	4
	,,	66	180	3	5	2
	,,	33	180	3	10	4
	,,	16	180	3	5	0
Aqueous sol. pure crystalline erythromycin	Intra-peritoneal	33	180	3	5	5
'Ilotycin heptonate' saline sol.	,,	5·5*	180	1	5	2
		0·5*	180	1	5	2
		6·2*	300	1	5	4
		0·6*	300	1	5	1
,,	Intra-venous	5·5*	180	1	1	1
		0·6*	180	1	1	1

* Single dose.

for guinea pigs is reported as 413·4 ± 51·7 mgm./kgm. [1]. It may be recalled that penicillin is toxic for guinea pigs, although there is little positive evidence regarding the nature of this action.

We wish to thank Dr. J. E. French for his assistance in the interpretation of the histological sections.

The erythromycin used as 'Ilotycin' in this work was supplied by Eli Lilly and Co., Ltd., the crystalline erythromycin by Abbott Laboratories, Ltd.

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Potent Diphtheria Toxin within the Cells of *C. diphtheriae*

All the exotoxins except diphtheria toxin have been demonstrated within the bacterial cells in a very early stage of culture. So far as diphtheria toxin is concerned, it has been postulated, but never proved, that the exotoxin is formed within the cell. I have, however, previously deduced the possibility of temporary existence of the toxin within the cell from the morphological and biochemical characteristics of this organism[1,2]. I believe that the failure to show the presence of the toxin was due to the fact that physiologically young cells of *C. diphtheriae*, however early they might be harvested, could not be obtained when static culture was used.

By using shaking cultures, I have obtained physiologically young cells containing the highest toxicities ever found. The shaker rotated at the rate of approximately 130 cycles per min. with an amplitude of 13 cm. Each flask of 200 ml. capacity contained 20 ml. of Pope's medium. A series of flasks was sampled at the three stages of growth: logarithmic phase, that of negative acceleration, and maximum stationary phase. The bacilli harvested from each flask were washed with water, suspended in 0·01 per cent merthiolate solution and then tested for toxicities by subcutaneous or intraperitoneal injection. Toxicities of the bacilli harvested at the three stages, such as, for example, 12, 15 and 35 hr. intervals, are compared in Table 1.

Table 1

	Incubation time (hr.)	Bacterial growth (mgm. *N*/20 ml.)	*Lf*/ml. (in culture filtrate)	*MLD*/mgm. *N*
No. 1	12	7·7	0	< 25
No. 2	15	11·8	15	> 300
No. 3	35	13·9	55*	< 25

* Maximum titre produced in this medium. As the toxin titre in the filtrate already reached to 50 *Lf* at the 24th hour, almost all the toxin produced within the cell is thought to be excreted outside in 24 hr.

Table 2

MLD/gm. (dry weight)	Authors
75	Prigge, R. (ref. 3)
1	Bieler, M. (ref. 4)
21,400*	(in this report)

* Cell suspension of *C. diphtheriae* corresponding to 1 mgm. nitrogen was dried at 60° C., measured for its weight, and proved to be 14 mgm.; *MLD* 300 in Table 1 was multiplied by 1,000/14.

It was found that both the very young and the very old bacilli contained little toxin within the cells, and the toxin content of the bacilli was highest in the period of decelerating rate of multiplication. This result was different from that for other exotoxins, because the bacilli harvested in the logarithmic phase, for example, at the 12th hour (see Table 1), showed remarkably lower toxicity than in the period of decelerating growth-rate. About 200–350 *MLD* per mgm. nitrogen was usually obtained from the bacilli during the period of decreasing growth-rate, but once the value of 750 *MLD* per mgm. nitrogen was obtained.

It is inevitable that the toxin content of the bacilli in this period is variable because toxin production and excretion occur together for such a short time. My titre is compared with the highest toxicities reported by other authors in Table 2. The toxicity I obtained was identified by the findings at adrenal glands of injected guinea pigs and by the neutralization test by diphtheria antitoxin. Thus, this work shows that diphtheria toxin is formed within the cell.

I thank Prof. T. Tani for his encouragement and guidance.

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Growth- and Inhibiting-Substances in Relation to the Rest Period of the Potato Tuber

In an investigation of the growth- and inhibiting-substances in the potato tuber in relation to its rest period, Hemberg[1] has shown that potato peelings contain an acid and a neutral growth-substance in addition to acid and neutral growth-inhibiting-substances. On the basis of molecular weight determinations by diffusion through agar, and sensitivity towards acid and alkali, he concluded that the acid growth-substance is in all likelihood indole-3-acetic acid. In addition, he was able to show that the neutral growth-substance could be converted to the acid growth-substance by enzyme action, and concluded that the former is probably indole-3-acetaldehyde. The disappearance of the acid growth-inhibiting substance from the potato tuber towards the end of the rest period is considered by Hemberg to be the primary cause of the breaking of dormancy in the potato tuber.

The purpose of the experiments reported here was to determine and possibly to identify the growth- and inhibiting-substances present in the potato tuber by the method of paper chromatography, followed by the *Avena* bioassay as originally described by Luckwill[1] and Bennet-Clark *et al.*[3]. The methods used were as follows. Peelings from potatoes of the variety Kennebec, stored at room temperature in the dark, were extracted at regular intervals from the time the potatoes were lifted up to the time of sprouting eight weeks later. Peelings were cut into small pieces, covered with peroxide-free ether, and placed in a refrigerator at 4° C. for 48 hr. Ether extracts were then separated into neutral and acid fractions according to the method of Larsen[4]. The final ether fractions were concentrated to small volume and applied as spots to the starting line of chromatograms (Whatman No. 1 paper), run for $3\frac{1}{2}$ hr. at 30° C. with *n*-butanol saturated with $2N$ ammonia as solvent. The ascending test-tube method as described by Rockland and Dunn[5] was employed. Bioassay of developed chromatograms was carried out by the *Avena* straight-growth method using a local oat variety, *Avena byzantina* var. Jongensklip, as test material. Developed chromatograms were divided into fifteen 1-cm. segments, each covered with 1 ml. distilled water in small specimen tubes, and ten 3·3-mm. subapical oat coleoptile sections floated on each eluate followed by incubation at 30° C. for 6 hr. The mean elongation of ten coleoptile sections expressed as a percentage of the original length was plotted against the position of the paper segments on the chromatograms as shown by histograms. Results obtained with the acid fractions of five potato peeling extracts taken at consecutive dates from the time the potatoes were lifted up to the time of sprouting are shown in Fig. 1. The results are purely qualitative, but give an indication of the relative growth-activity of the substances present in each extract. Dotted lines indicate the mean percentage elongation of control segments from blank chromatograms run concurrently, a difference of 2·4 per cent (2 × standard error) above or below the control being considered significant. The positions of the synthetic growth-substances indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), indole-3-acetaldehyde (IAc) and indole-3-acetonitrile (IAN) run concurrently on similar chromatograms were marked by guide lines, and could be revealed as coloured spots by spraying chromatograms with Ehrlich's reagent (1 per cent *p*-aminobenzaldehyde in $1N$ hydrochloric acid). The respective R_F values for the above growth-substances were: indole-3-acetic acid, 0·28–0·30; indole-3-acetonitrile, 0·87–1·0; indole-3-butyric acid and indole-3-acetaldehyde, 0·40–0·42.

Based on a comparison of growth activity with that of guide spots of the synthetic compounds, all extracts apparently contain indole-3-acetic acid and a second acid growth-substance which is invariably separated from this region by a definite zone of inactivity on the chromatogram and could therefore not be ascribed to tailing of the indole-3-acetic acid spot. This second growth-substance occupies the same position on the chromatogram as both indole-3-butyric acid and indole-3-acetaldehyde. It is not an aldehyde, as it invariably occurs in the acid fraction of the extract and does not form an addition product with sodium bisulphite. Consequently it is suggested that this second growth-substance could possibly be indole-3-butyric acid. It will be noted that as dormancy is gradually broken, this second growth-substance shows a constant increase in activity relative to that of indole-3-acetic acid, and when sprouting commences its relative activity is even larger than that of the latter.

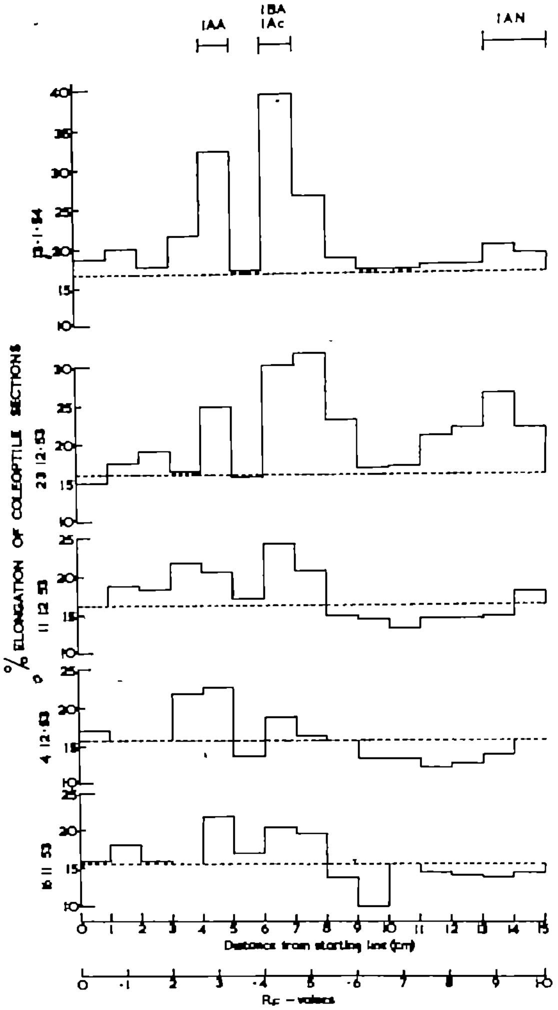

Fig. 1. Histograms showing coleoptile extension-growth in the presence of 1-cm. sections cut from chromatograms of the acid fraction of potato-peeling extracts. Bottom to top: consecutive dates from time potatoes were lifted up to time of sprouting. Dotted lines indicate extension growth of controls. Position of synthetic growth-substances shown by guide lines marked IAA, IAc, IBA and IAN

The presence of an acid inhibitor in the position 8–11 cm. (R_F 0·52–0·74) is strongly evident during the first five weeks, but gradually diminishes up to the time of sprouting, when it has entirely disappeared. However, as will be seen from the histograms, the disappearance of the inhibitor approximately three weeks (23.12.53) before sprouting is apparently associated with the appearance in the extracts of a third growth-substance which is not detectable in the earlier stages of dormancy. This third growth-substance occupies the same position on the chromatogram as synthetic indole-3-acetonitrile, and as the presence of that substance in potato tuber extracts has previously been reported by Bennet-Clark and Kefford[6], it is suggested that it is the same substance. In all extracts there are indications of a fourth growth-substance with an R_F value of 0·08–0·15. Bennet-Clark and Kefford[6], Lexander[7] and Terpstra[8] have reported a growth-substance which moves more slowly than indole-3-acetic acid with approximately similar R_F values. Recently, Stowe and Thimann[9] have suggested that this growth-substance is probably indole-3-pyruvic acid, which they have identified in maize endosperm. It would appear that here again our fourth growth-substance with low R_F may be indole-3-pyruvic acid.

Neutral fractions of potato peeling extracts assayed at the same time as the above gave indications of one or more inhibitors which do not, however, disappear at the end of the rest period. Except for the presence of the nitrile at the time it appears in the acid fraction, no other growth-substances were evident in the neutral fractions. The presence of the nitrile in both acid and neutral fractions is, according to Bennet-Clark and Kefford[6], due to its being carried over from ether into bicarbonate solution and back to ether on re-acidification during fractionation of the original extract. The neutral growth-substance of potato peelings described by Hemberg[1] may be identical with indole-3-acetonitrile as the latter can, like indole-3-acetaldehyde, be converted to indole-3-acetic acid[10].

From the point of view of dormancy, the above results support the theory of Hemberg[1] that the breaking of dormancy in the potato tuber is primarily due to the disappearance of an acid inhibitor. The simultaneous increased activity of both indole-3-acetic acid and indole-3-butyric acid with the disappearance of the acid inhibitor indicate that the latter may function as an anti-auxin or competitive inhibitor. As the disappearance of the acid inhibitor is associated with the appearance of a growth-substance which may be indole-3-acetonitrile, it is possible that the latter is also in some way connected with breaking of the rest period.

A detailed report of the above investigation will be published elsewhere.

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Varietal Susceptibility of Brassicas to Molybdenum Deficiency

MOLYBDENUM deficiency under Irish conditions has previously been reported to occur in clovers and swede turnips[1]. During the 1953 season, a severe outbreak of whiptail on cauliflowers occurred on a commercial plot at one of the centres mentioned. The soil, which had an initial pH of 5·3, had received a dressing of 1¼ tons of ground limestone per acre as well as a dressing of superphosphate, muriate of potash and sulphate of ammonia at 5, 2 and 3 cwt. per acre respectively.

Severely affected	Moderately affected to slightly affected	Unaffected
Cauliflower : Cambridge No. 6 Cambridge No. 7 Self-protecting	Cauliflower : Yates Progress Autumn Giant Brussels sprouts : Cambridge No. 3 Cambridge No. 1 Broccoli : Early Feltham	Cauliflower : All-the-Year-Round Brussels sprouts : Masterpiece Cluseed Broccoli : Mid June 1949 May Wonder April Queen Cabbage : Primo Winningstad Rearguard Kale Savoy : Perfection Market Garden January King Sprouting Broccoli : Early Purple

Shortly after the plants were set out, severe symptoms of whiptail appeared on the varieties Cambridge No. 6 and Cambridge No. 7. The variety All-the-Year-Round, which had received identical cultural treatment, was not affected, though it did show some effects of manganese toxicity.

In another plot where a number of varieties of Brassicas were grown, the Cambridge varieties again showed a severe incidence of whiptail, whereas most other varieties of Brassicas were either unaffected or but slightly affected.

Duplicate plots of affected varieties were treated with sodium molybdate at 2 lb. and 4 lb. per acre; this treatment effected a considerable improvement and resulted in head formation where buttoning had not already taken place. The same varieties were sown on a similar soil type in 1954, and again the Cambridge varieties of cauliflower showed a pronounced susceptibility to whiptail, No. 6 being the most severely affected and No. 7 the least affected. Cambridge No. 5, which was sown in 1954 only, was also affected.

The soil in which the condition occurred showed a level of available molybdenum as determined by

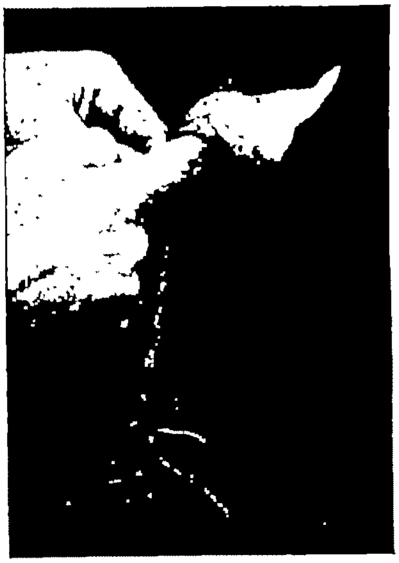

Fig. 1

the oxalate method to be in the region of 0·14 p.p.m.[2]. A symptom of the deficiency which does not appear to have been previously recorded is the production of bell-shaped leaves (Fig. 1). These would appear to result from the fusion of the lamina of basal leaves followed by abscission of the growing point. The level of molybdenum at which particular varieties of Brassicas become affected by whiptail is at present under investigation.

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A Remarkable Disintegrative Effect of Skatole upon Certain Rumen Ciliate Protozoa

Hogg and Elliott[1] noted that indole and skatole were both highly toxic towards the aerobic free-living ciliate *Tetrahymena pyriformis*. A concentration of 0·01 per cent of indole, for example, killed all organisms in a vigorous culture in two hours, but these workers made no mention of any characteristic change in appearance of the cells. We have now shown that these substances are highly toxic to the anaerobic ciliates of the sheep's rumen, particularly the holotrichs (*Isotricha* and *Dasytricha*) and also *Ophryoscolex*. These ciliates had been separated from strained rumen contents, washed and maintained alive and active for several hours in a phosphate buffer (without antibiotic) at pH 7·2 as described by Heald, Sugden and Oxford[2]. On a molecular basis skatole was much more toxic than indole to the rumen ciliates; but if the comparison was made at concentrations near saturation in the buffer employed, indole being the more soluble compound, the respective effects upon the final appearance of the cells were almost equally spectacular. Briefly, not only did all ciliary motion cease in two hours at 37°, but also a phenomenon resembling a drastic mechanical disintegration took place. The outer pellicles of the holotrichs, and also of *Ophryoscolex*, were torn asunder with liberation of the internal contents of the cells, so that after gently shaking the tube, instead of the rapid re-formation of a layer of ciliates at the bottom below a clear supernatant, there was a dense uniform turbidity throughout due to the release of storage polysaccharide granules and other inclusions from the disrupted cells.

The effect is markedly similar to that due to the anionic detergent 'Teepol', as described by Oxford[3]; but since indole and skatole do not, of course, greatly lower the surface tension of the buffer, another explanation of their action has to be found. Any such explanation must take account of the following facts:

(1) The rapid disruptive effect is only exhibited near the saturation point, that is, c. 0·1 per cent for indole, and 0·025 per cent for skatole (c. 0·002 *M*) in the buffer employed. This applies also to those isomers of skatole which have so far been tested, namely, 2- and 7-methylindoles. These appear to have similar solubilities to skatole, which, however, acts much more rapidly than either of the others and produces a denser final turbidity.

(2) Isatin, which is also sparingly soluble in the buffer (c. 0·12 per cent), acts in a fashion very similar to indole. Aniline, however, is not highly toxic.

(3) More highly polar indole derivatives related to tryptophan, like tryptamine, tryptophanol and indole-3-acetic, -propionic and -butyric acids, are not highly toxic and have no disintegrative effect at pH 7 at a concentration of 0·1 per cent.

(4) The toxic effect of indole or skatole cannot be nullified by addition of tryptophan, serine, casein hydrolysate or glucose to the buffer.

It would appear that although a fairly close resemblance to the tryptophan structure, as in skatole, increases the disruptive power of these indole derivatives, the primary requisites for toxicity are physical, namely, slight water- and ready lipoid-solubility, and the absence of any strongly polar centre in the molecule. Since indole—and perhaps skatole—are possible products of bacterial degradation of protein in the rumen, the presence of these and similar compounds may provide an explanation for some of the puzzling variations in density and composition of ciliate population in the normal rumen which undoubtedly occur from time to time.

Our thanks are due to Prof. H. N. Rydon, Department of Industrial Chemistry, College of Technology, Manchester 1, for a gift of a specimen of 7-methylindole.

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Goitre and the Iodine Content of Cow's Milk

During a recent systematic investigation in the Netherlands, it was found that at all seasons marked differences existed between the iodine contents of milk supplied to creameries in goitrous and non-goitrous areas. The location of these areas, in general, corresponds with those found by investigations on thyroid enlargement and thyroid histology in humans and farm animals[1].

In addition to the local differences, a seasonal variation, roughly corresponding inversely to the milk yield, was observed. Therefore, it is essential to make the period of collection of the milk samples as short as possible in order to get strictly comparable results. In the present investigation, some hundreds of samples were collected each time on the same day. The variation of iodine content with time has often been disregarded in previous investigations, and as a result the distinction of goitrous from non-goitrous regions by examination of the milk supply has been needlessly obscured.

In Table 1 a summary of the iodine values, obtained with our method of analysis[2], is recorded.

For a general survey of the iodine status of cattle, the determination of iodine in the milk offers distinct advantages over determination in the blood or histological investigation of thyroid glands. Collection of milk samples is comparatively easy, and the large number of contributing animals living in the same conditions rules out factors of individual variation in quite a simple way.

Table 1

Area	No. of creameries (N)	Mean iodine content of milk: ($\bar{I}$) Summer (in μgm./100 ml.)	Winter
Goitrous	78	0·97 (σ* = 0·026)	2·06 (σ = 0·053)
Transitional	37	1·38 (σ = 0·047)	3·21 (σ = 0·13)
Non-goitrous	43	2·11 (σ = 0·077)	4·88 (σ = 0·15)
Extreme coastal	14	3·43 (σ = 0·21)	8·85 (σ = 0·59)

* $\sigma = \sqrt{\frac{\Sigma(I - \bar{I})^2}{N(N-1)}}$; in which I stands for the actual iodine contents.

I wish to thank Prof. E. Brouwer for suggesting this work, a detailed account of which will be published elsewhere.

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Analysis of Milk in Deficiency Diseases and Intoxications of Cattle

IN the diagnosis of deficiency and of poisoning of animals, one generally relies on the chemical analysis of the classical substrates like blood and liver. Eventually the composition of the food is also taken into consideration. It is surprising that in farm animals, and even in lactating animals, general methods largely derived from medical routine are used and that, for example, the milk as a substrate has been neglected.

Nevertheless, in the Netherlands some successful attempts have been made to obtain information by other methods. Thus examination of urine has been shown to offer an insight into the ingestion of potassium, sodium, chlorine and sulphate by cows at pasture or stall-fed[1]. Information about iodine metabolism may be obtained by histological examination of thyroid glands of newborn calves[2]. (In contrast to the situation for other farm animals and humans, it is possible to collect large quantities of thyroid glands because approximately 45 per cent of all newborn calves are slaughtered a few days after birth.)

We believe that more precise information about iodine ingestion can be obtained by the analysis of milk samples. In the preceding communication, the occurrence of marked differences in the iodine content of cow's milk is reported, reflecting the goitre status in cattle.

Because iodine is not the only variable milk constituent, we suggest the chemical analysis of milk as a method in all cases in which a distinct variability in milk composition depending on food intake has been established. This should include the determination of vitamins[3] and trace elements like iodine and copper[4] in deficiency, and of manganese[5], zinc[5], molybdenum[6], arsenic[6], lead[7], insecticides[8] and other toxic substances in excess (a review of the latter is in preparation).

For a quantitative evaluation of the results of the analyses, undoubtedly some fundamental investigations remain to be carried out in connexion with the influence of the milk yield, stage of lactation, etc. In a research programme requiring a preliminary survey of the availability of the above-mentioned compounds in the food of milking cows over a large number of homogeneous districts, much of the individual variation can be ruled out by examining milk samples obtained from creameries in these districts (see preceding communication).

Elements such as molybdenum and manganese, which may be constituents of the metal of milk containers, etc., are not likely[6] to contaminate the milk to the same extent as surface coatings, like zinc, copper and nickel.

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Autonomous Differentiation of some Chick Neurons isolated in Chorion-Allantoic Grafts

THE problem of differentiation of neurons consists in identifying the factors, of intrinsic or extrinsic nature, that act upon the neural embryonic cells and the time and modality of their action.

The methods of studying the isolated development of neuroblasts (ectopic transplantation, explantation, destruction of connexions or of peripheral organs, etc.) have been employed with clear results for the Mauthner cells of amphibians[1]. Extending these researches to other types of neurons, I have taken into consideration different neurons of the chick, isolating various fragments of the embryonal neuraxis by means of implants into the allantochorion membrane[2].

The purpose of this brief account is to illustrate results on the recurrent axon neurons of the optic lobes and of the Purkinje cells of the cerebellum of the chick in very small implants.

It has been demonstrated[3] that in isolated fragments consisting of about half the embryonic tectum (at the stage of the primary optic vesicle), after the nineteenth day of incubation the recurrent axon neurons are perfectly well differentiated (Fig. 1,*B*); the presence in these isolated fragments of the recurrent axons is the best proof that the peculiar orientation of these fibres is not determined by antagonistic neurobiotactic fields of physiological activity of any kind (as was supposed by Leghissa, 1946).

In implanted fragments of about one-third or one-fourth part of one-half of the tectum, we observed various degrees of deformation of the tectum cells due to great disturbance by the vessels invading the implant and especially to the abnormal organization of the fragment, which tend to reach a ball-like form. These conditions and the limited growing space are factors that make normal differentiation

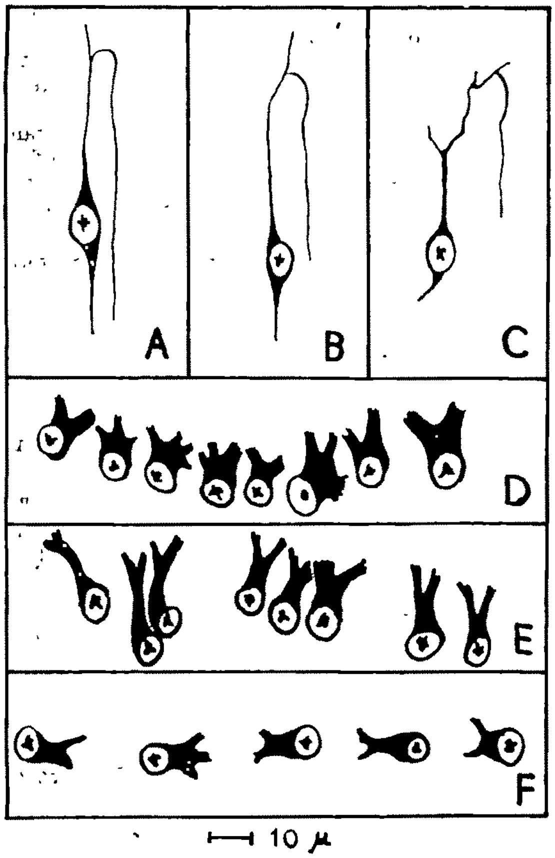

Fig. 1. Camera lucida drawings of some spindle-shaped tectal cells with recurrent axon and of some Purkinje cells of the cerebellum of a normal chick after the nineteenth day of incubation (*A*,*D*), compared with cells of the same age isolated at the primary optic vesicle stage and implanted in the allanto-chorionic membrane; *B*,*E*, from a fragment equal to half the organ (tectum or cerebellum) and *C*,*F*, from a fragment equal to about one-fourth of one-half (see text)

impossible. Nevertheless, even in the smallest bits of tissue these neurons tend to become spindle-shaped, and the axon tends to direct itself in a recurrent way. Very often in these conditions the curve of the axon is wider than the normal, and some collateral branches are present (Fig. 1,*C*).

Similar experiments with cerebellar fragments show Purkinje cells to be very well ordered in a single layer and with the dendritic lobe normally oriented towards the external surface (Fig. 1,*E*). Also, in very small fragments with few Purkinje cells and without any organization of surfaces, the cells are arranged in a single layer and distributed at a regular distance from each other; but the dendritic pole, still clearly evident, is not oriented in a unique direction owing to the absence of a directional organization of the fragment, but is indifferently directed against the neighbouring cell (Fig. 1,*F*).

These experiments lead us to the conclusion that the shape and form of the neurons are intrinsically determined, at the moment of histogenetical determination, and completely independent of any physiological activity. Also the orientation of fibres (for example, the recurrent axons of tectal spindle cells) is to be considered as an intrinsically determined susceptibility of the fibre to react specifically to morphological (not physiological) orientating factors such as the polarity of the fragment and the polarity of the cell itself.

The fundamental importance of physiological factors is shown later by many results, among which hyperplasia is especially evident, when the differentiated cells are physiologically connected.

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[1] Stefanelli, A., *Quart. Rev. Biol.*, 26, 17 (1951).

[2] Stefanelli, A., and Chiti, A. L., *R. Acc. Naz. Lincei*, (VII), 16, 287 (1953).

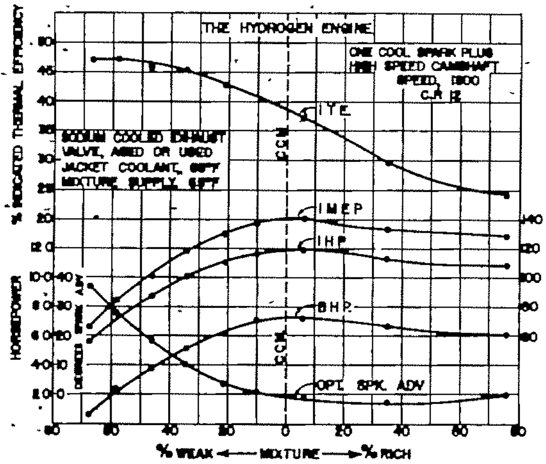
The Hydrogen Engine

It has always been stated by others that it is necessary to use weak mixtures with air when hydrogen is used as a fuel for Otto-cycle engines. Thus Ricardo[1] reported that "if an attempt were made to run with a rich hydrogen–air mixture violent pre-ignition occurred, accompanied by firing back in the carburettor, which rendered further running impossible. Even with the compression ratio lowered to 3·8 : 1, the same thing occurred". Similar effects were obtained later by A. F. Burstall[2] when using a Ricardo *E*.35 engine in the Engineering Laboratory, Cambridge, and still later by Egerton, Smith and Ubbelohde[3], when using an ethyl knock-testing engine for experiments at Oxford.

The igniting effect is generally described as pre-ignition, but by some observers as 'detonation'. Downs, Walsh and Wheeler[4], as a result of experiments with an *E*.6 Ricardo engine, state that "in most cases, owing to the extreme ease with which it ignites, a mixture strength richer than about 25 to 30% weaker than chemically correct cannot be used. If the attempt is made to run with a richer mixture, self-ignition occurs so early on the compression stroke that the mixture is eventually ignited in the induction manifold". Similar igniting effects were obtained by Anzilotti and associates when using a *C.F.R.* engine in a Du Pont Laboratory, Wilmington, U.S.A.

We have found as a result of experiments with a *C.F.R.* engine that premature ignition of hydrogen–air mixtures occurs solely when the exhaust valve or the ceramic core of the spark plug attains an igniting temperature in respect of the mixture, and otherwise only by nuclear ignition due to finely divided carbon produced by the decomposition of lubricating oil. Thus by reducing the temperatures of the spark plug core and the exhaust valve, and avoiding the passage of lubricating oil into the combustion chamber at an excessive rate, it has been possible to run the engine at speeds rising to 1,800 r.p.m., and with a compression ratio as high as 12 : 1. A maximum of 47½ per cent has been obtained for indicated thermal efficiency, and one of 146 lb./sq. in. for indicated mean effective pressure was obtained at 1,500 r.p.m. These values exceed those recorded in the literature of the subject by a wide margin. To obtain still higher values would require an engine designed to avoid leakage of hydrogen past the piston, and a combustion chamber having a reduced surface-to-volume ratio. Typical performance results as obtained with a speed of 1,800 r.p.m. and a compression ratio of 12 : 1 for hydrogen–air mixtures ranging from nearly 80 per cent weak to more than 70 per cent rich are given in Fig. 1.

Our experimental results are not in agreement with the conclusions of Downs, Walsh and Wheeler, that



Engine speed, 1,800 r.p.m.; compression ratio, 12 : 1

self-ignition arising from a chain reaction occurs in an engine.

The experiments were carried out on behalf of the Defence Research Board (Canada), in the Department of Mechanical Engineering, University of Toronto, with the co-operation of Prof. E. A. Allcut, head of the Department, and will be described in detail in a Canadian journal.

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Ultrasonic Absorption in Castor Oil, Carbon Disulphide, Benzene and Xylene

ULTRASONIC absorption in some liquids has been measured by the method of heat development. The apparatus and its working was designed in such a way as to make it free from error due to the variation of generator power and also due to reflexion. A 3 Mc./s., 100-W. quartz generator produced the beam in liquid kerosine, contained in a vessel with cork paddings at the ends. In a small double-walled metallic vessel with asbestos packing, having a suitable coat of cement, two mica windows of 0·002 cm. thickness were fitted to allow the beam to pass in and out again after absorption. Two such vessels were made with exactly similar windows and different separations; the separations of windows were 3·6 cm. and 4·6 cm. Arrangements were made to place the front windows in the same relative position with respect to the quartz. The rise in temperature in these fairly non-conducting trap vessels, with different liquids, was measured in the steady condition. The electrical wattage to produce the same steady difference of temperature between the trap vessel and the outer kerosine was determined by a separate experiment. The temperature of the kerosine in the outer vessel was controlled by running ice-cold water around the vessel.

In the experimental arrangement, the energy absorbed in the trap vessel was $I\{1-\exp(-\beta x)\}$, where β, the energy absorption coefficient, was 2α, α being the usual amplitude absorption coefficient. I is the incident intensity in the liquid, and would be the same for all liquids in the trap vessel if we consider that the interface reflexion remains the same in all cases. In cases of very viscous liquids, however, we expect interface reflexion to be large, unlike the case of ordinary organic liquids. In all liquids, however, for the two vessels, I would be the same, and comparative measurements of wattage due to absorption may be made in the two vessels, and hence the value of α/f^2 for the liquid may be estimated. The expected wattage ratios for different values of α/f^2 are shown in Table 1. The experimental mica separations are used for calculations.

The experimental values of the steady temperature differences measured with accurate thermometers and confirmed by several observations, and of the wattages in the two vessels measured by the electrical method, to give the same steady temperature-differences, are given in Table 2.

If we consider that the beam transmitted to xylene, benzene and carbon disulphide through the mica window remains almost the same, the stiffness or viscosity of the liquids being of the same order, and if we consider that α/f^2 in xylene cannot be greater than 75×10^{-17}, the observed experimental value by other methods, we find, by comparison of Tables 1 and 2, α/f^2 for benzene is also not much greater than

Table 1

$\alpha/f^2 \times 10^{17}$	$\beta = 2\alpha$ with $f = 3 \times 10^6$	$\{1-\exp(-\beta x_2)\}$ $x_2 = 4{\cdot}6$ cm.	$\{1-\exp(-\beta x_1)\}$ $x_1 = 3{\cdot}6$ cm.	$\dfrac{1-\exp(-\beta x_2)}{1-\exp(-\beta x_1)}$
75	0·0135	0·0603	0·0474	1·272
115	0·0207	0·0909	0·0718	1·266
800	0·144	0·4844	0·4046	1·197
5,000	0·90	0·9841	0·9609	1·024

Table 2

Liquid	Temp. diff. large trap and outer vessel	Temp. diff. small trap and outer vessel	Wattage in large trap $I\{1-\exp(-\beta x_2)\}$	Wattage in small trap $I\{1-\exp(-\beta x_1)\}$	$\dfrac{I\{1-\exp(-\beta x_2)\}}{I\{1-\exp(-\beta x_1)\}}$
Xylene	3·0° C.	3·6° C.	2·0	1·6	1·25
Benzene	3·7° C.	—	2·1	—	1·25*
Carbon disulphide	4·2° C.	4·8° C.	3·2	2·5	1·28
Castor oil	7·0° C.	11·2° C.	2·6	2·5	1·04

* Determined with a different set of observations under changed conditions.

75×10^{-17} and that of carbon disulphide not much greater than 115×10^{-17}. This gives the incident wattage on the mica windows as about 32 W. The ratio of wattages in the two vessels agree, within the experimental error of 2 per cent, with the expected values of the ratios for these values of α/f^2. If in the case of carbon disulphide the real α/f^2 was as high as $5{,}000 \times 10^{-17}$, the ratios of wattages in the two vessels would have been 1·024 and the temperature rise in the smaller vessel, from the wattage–temperature graph, would have been 6·3° C. instead of 4·8° C. This is certainly much beyond the probable error of 0·1° C. in measured values of temperature differences. That with a value of α/f^2 of $5{,}000 \times 10^{-17}$ the ratio of wattages in the two vessels should have been 1·024 is beautifully confirmed by experiments on castor oil, where the ratio of wattages in the two vessels agrees with the expected value, within the range of experimental error. The smaller wattages recorded for castor oil are evidently due to a large reflexion from the interface. The experimental results show that the mean absorption coefficients of carbon disulphide and benzene are not much beyond the values for other liquids of the same nature.

The explanation for this discrepancy between the observed mean absorption coefficient and the absorption coefficient determined by other methods may be understood on the basis of variability of velocities and absorption coefficients in the same liquids, as suggested by one of us[1]. This variability would cause the components of a wave pulse to be more and more out of step with distance. No other explanation of this discrepancy in results seems to be feasible.

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[1] Dutta, A. K., *Ind. J. Phys.*, 26, 142 (1952). Dutta, A. K., and Mukherjee, S. K., *Ind. J. Phys.*, 26, 161 (1952).

A New Development in Aids for Sub-normal Vision

The optical aids conventionally used for the improvement of sub-normal vision at near viewing distances (for example, reading) comprise compound, short microscopic systems of varying magnifications, often obtained by placing an additional convex lens over the objective of a Galilean telescopic unit. These microscopic spectacles present a number of disadvantages; thus they have a very restricted field of view (usually less than 30°), they cause changes in spatial perception and, moreover, are heavy, conspicuous, and, in Australia, very costly. Compound systems are employed because of the contention, expressed throughout the literature, that single high-power convex lenses could not provide the necessary field properties.

I have recently succeeded in developing a series of single high-power convex lenses which, with respect to objects placed in their focal planes, are adequately corrected for oblique astigmatism, curvature error, and distortion over a wide field of view (60°–75°).

These lenses can thus be used as simple microscopic spectacle lenses for the improvement of sub-normal vision. They have already given excellent clinical results in a considerable number of cases, which have been reported elsewhere (*Aust. J. Optometry*, July 1954). All the experimental lenses were made by C. J. Tenukest in the Precision Optics Workshop of the School of Applied Physics of the New South Wales University of Technology[1].

Principles of lens design. With spectacle lenses generally, chromatic aberration, spherical aberration and coma are negligible, the latter two because of the small aperture stop formed by the pupil of the eye. The problem is the study of the images formed by the lens on the far-point-sphere of the eye, by pencils passing through a fixed aperture stop effectively located at the eye's centre of rotation (as the eye moves behind the stationary lens). For lenses assumed 'thin', and moderate obliquities (less than 30°), Emsley and Swaine[1] have developed the necessary third-order theory for ordinary 'best-form' spectacle lenses. By combining four of their equations we obtain for the sagittal and tangential image vergencies:

$$L'_s = L + F + \frac{y^2F}{n(n-1)^2}\left[\frac{2n+1}{2}F_2^2 + F_2\left\{(n^2-1)S - \frac{n}{2}(n+2)F\right\} + \frac{n^2}{2}F^2 - n(n-1)FS + \frac{(n-1)^2}{2}S^2\right] \quad (1)$$

$$L'_T = L + F + \frac{y^2F}{n(n-1)^2}\left[\frac{4n+5}{2}F_2^2 + F_2\left\{3(n^2-1)S - \frac{(n+2)^2}{2}F\right\} + \frac{n}{2}(n+2)F^2 - (n-1)(n+2)FS + \frac{(2n+1)(n-1)^2}{2}S^2 + 2F_2L(n^2-1) - n(n^2-1)FL + 2(n-1)(n^2-1)SL\right], \quad (2)$$

where L is object distance (in dioptres), F is total power of lens, F_2 is back surface power of lens, S is distance from lens to eye's centre of rotation (in dioptres), n is refractive index and y is effective lens aperture (obliquity).

For freedom from oblique astigmatism,

$$L'_T - L'_s = 0. \quad (3)$$

For freedom from curvature error,

$$\frac{1}{2}(L'_T + L'_s) = L + F. \quad (4)$$

By making appropriate substitutions, putting the expression inside the brackets equal to zero, and solving for F_2, a series of ellipses are obtained which give the conditions for the 'correction' of either aberration in terms of lens form (F_2) over a range of lens powers (F). Outside the range of the ellipse, the lens form which reduces the aberration to a minimum is found by differentiating the equation expressing the amount of aberration present with respect to F_2.

Emsley[2] has also recently elaborated the third-order theory for 'spectacle distortion' (based on the 'angle condition' instead of the usual 'tangent condition'), for which he gives the following equation:

$$u_1 = u'_2\left(1 - \frac{F}{S}\right) - u'^3_2\,\frac{F}{6S}\left[\frac{(n^2 - 1)}{n^2(n - 1)^2S^2}\left\{(3F^2_2 + F_2(6(n - 1)S - 3nF) + n^2F^2 - 3n(n - 1)FS + 3(n - 1)^2S^2\right\} - 1\right] \qquad (5)$$

For spectacle distortion to be corrected, the quantity in the brackets has to be equated to zero and the equation solved for F_2; again an ellipse is obtained. With respect to the rotating eye, S denotes the dioptric distance from the lens to the eye's centre of rotation, and for the stationary eye the distance from the lens to the eye's pupil.

For a lens used as a simple microscope (magnifying lens) and placed in the spectacle plane, we now have to solve equations (3), (4) and (5) for positive values of F by putting $n = 1{\cdot}5$, $S = 37{\cdot}5$ ($s = 27$ mm.) and $L = -F$.

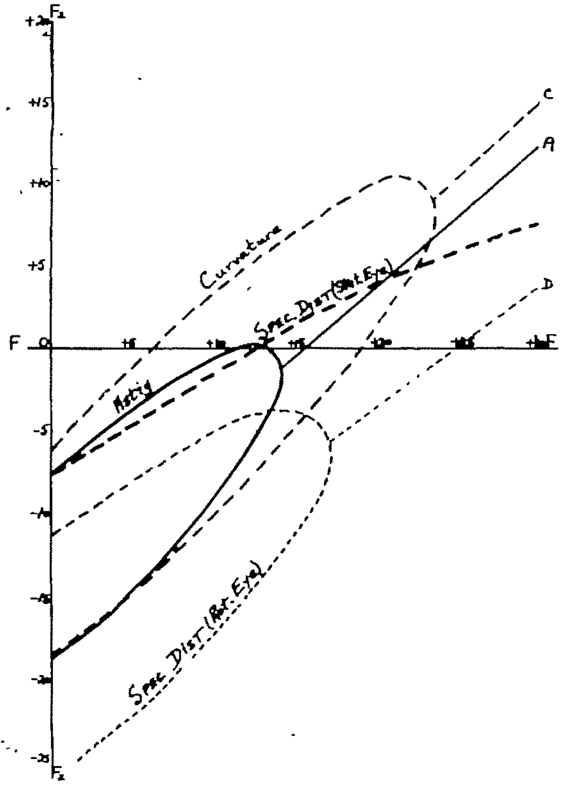

Fig. 1

The semi-ellipses showing the conditions for freedom from each aberration, together with the straight lines giving the conditions of minimum aberration outside the range of the ellipses, are shown in Fig. 1. They are given by the following equations, derived as explained above.

Oblique astigmatism:

$$F_2 = \frac{1}{7}(6F - 93{\cdot}75 \pm \sqrt{1{,}422 + 56F - 11{\cdot}2F^2}) = \frac{48F - 750}{56}\,.$$

Curvature of field:

$$F_2 = \frac{1}{7{\cdot}5}\,(6{\cdot}87F - 93{\cdot}75 \pm \sqrt{2{,}186 + 118F - 9F^2}) = \frac{55F - 750}{60}\,.$$

Spectacle distortion (rotating eye):

$$F_2 = \frac{1}{48}\,(36F - 900 \pm \sqrt{127{,}800 - 432F^2}) = \frac{3}{4}\,F - \frac{900}{48}\,.$$

Spectacle distortion (stationary eye):

$$F_2 = \frac{1}{8}(6F - 240 \pm \sqrt{30{,}704 - 18F^2})\,.$$

Inspection of the graph shows that in several regions the curves intersect or approach each other closely. (Calculation shows that in the region of the curves a change in F_2 of one dioptre will cause oblique astigmatism or curvature error to the extent of approximately $F/50$.)

It is therefore possible to design a series of single high-power convex lenses which, with respect to objects in their focal plane, are adequately corrected for oblique astigmatism, curvature error and spectacle distortion over a considerable field of view, and recognition of this forms the principle of design of the lenses referred to above.

The same principle of intersecting and approaching correction-ellipses can also be successfully applied to the design of 'best-form' spectacle lenses for objects located from infinity ($L = 0$) to a distance of 25 cm. from the eyes ($L = -4$), over a wide range of lens-powers. It is hoped to publish a further communication on this subject at a later date. Finally, consideration is being given at present to the design, along similar lines, of an achromatic doublet eyepiece suitable for various types of optical instruments.

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Sydney. July 1.

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A New Iron Boro-carbide

During a current investigation of the phase relations in the iron–carbon–boron system, X-ray diffraction has revealed the existence of a new boro-carbide which appears to have the structure of the complex cubic carbide reported by Westgren[1] in the chromium–carbon system. He showed that the idealized unit cell contains 92 Cr atoms and 24 C atoms, thus corresponding to the composition $Cr_{23}C_6$; moreover, about 25 per cent of the chromium may be replaced by iron in this carbide. Westgren also reported carbides of similar structure in the iron–molybdenum–carbon and iron–tungsten–carbon systems, in particular in high-speed steels; these carbides, which have been designated 'kappa' by Goldschmidt[2], correspond, at least approximately, to the compositions $Fe_{21}Mo_2C_6$ and $Fe_{21}W_2C_6$. Comparison of the diffraction data for the present boro-carbide with that for the complex cubic chromium carbide as described by Goldschmidt[2] is presented in Table 1. The lattice parameter of the boro-carbide is found to be 10·62 ± 0·02 A.

Specimens were prepared from mixtures of powders (ground to pass a 100-mesh sieve) of an iron–carbon alloy (4·4 per cent carbon) and an iron–boron alloy (5·7 or 8·9 per cent boron) or boron by heating in an evacuated 'Vycor' tube at 850° C. for extended periods. Although various changes in the diffraction patterns were noted during the first few days, further changes were not observed in specimens heated for periods in excess of a week.

Table 1. INTERPLANAR SPACINGS OF CARBIDES

hkl	Boro-carbide* d (A.)	Boro-carbide* Intensity	$Cr_{23}C_6$† d (A.)	$Cr_{23}C_6$† Intensity
311	3·187	W		
222	3·065	W		
400	2 644	W		
420	2 367	S	2·380	MS
422	2·161	S	2 172	M
333, 511	2·037	VS	2 048	S
440	1 872	S	1 882	M
531	1 792	S	1 800	M
600, 442	1·765	M		
620	1·674	VW	1 683	W
533	1 613	W		
622	1 595	MW	1 605	MW
640	1·466	VW		
800	1 325	W		
644, 820	1 284	W	1 291	M
660, 822	1 248	M	1·255	MS
555, 751	1·222	M	1 229	M
840	1 183	W		
753, 911	1·162	W	1 168	M
931	1·111	W		
844	1 082	M	1·086	S
933	1 065	MW	1·070	MW
1,040	0 9830	W	0 9833	M
1,042	0·9668	W	0 9716	M
775	0 9549	W	0 9597	W
880			0 9408	W
971	0 9254	M	0 9300	S

* Present data, from X-ray diffractometer, cobalt radiation.
† Goldschmidt (ref. 3); interplanar spacings converted to angstroms.
Key to intensities · VS – very strong; S – strong; MS – medium to strong; M – medium; MW – medium to weak; W – weak; VW – very weak.

This new boro-carbide has been found in several of the samples in the range 1½–2½ per cent boron and 2½–4½ per cent carbon. Analogy with the Westgren carbides would suggest a composition corresponding to $Fe_{23}(C,B)_6$. The question as to whether this boro-carbide can exist over a substantial range of compositions is not settled; however, all samples so far observed have the same lattice parameter within the stated error of ± 0·02 A.

If we choose to consider the hypothetical carbide $Fe_{23}C_6$, then it may be said that Westgren and Goldschmidt have produced carbides in which chromium, molybdenum or tungsten has been substituted for iron. To the best of our knowledge the present boro-carbide is the first reported case in which another element (boron) has been substituted for carbon in this structure. This type of carbide has generally been found in, and regarded as characteristic of, some stainless and high-speed steels. It is possible that the appearance of boron therein may eventually shed some light upon the pronounced influence of boron upon the hardening properties of steel.

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Effect of Nitrogen Dioxide on the Thermal Decomposition of Ethyl Nitrite

THE value of gas chromatography as a technique for the analysis of the minute quantities of products formed during the kinetic studies of gas reactions is well illustrated by recent work on the gas-phase reaction between ethyl nitrite and nitrogen dioxide. Studies of the behaviour of ethyl nitrite, ethyl nitrate and water on a partition column of kieselguhr wetted with di-butyl-phthalate and eluted with nitrogen revealed that a complete separation of a mixture of the esters and water can be achieved. Using gas chromatography, it has thus been possible to identify three major components, namely, ethyl nitrite, ethyl nitrate, and water, in the residue from the reaction between ethyl nitrite and nitrogen dioxide at about 190° C. Few other micro-analytical techniques would have enabled this to be done so simply or so quickly.

40 mm. of ethyl nitrite and 40 mm. of nitrogen dioxide were allowed to react in a glass vessel of approximately 90 ml. capacity. The temperature of the reaction was about 190° C. Analysis of the residues from interrupted runs for periods up to one hour are given in the table. These show that the quantity of ethyl nitrate produced reaches a maximum after 10 min. and becomes negligible after one hour. The residue of ethyl nitrite was identified on all chromatograms but not quantitatively estimated.

Time of reaction (min.)	2 0	2 8	3 5	5·5	7·5	11·0	15 0	25·0	45 0	60 0
Pressure of ethyl nitrate (mm. mercury)	1·8	2 5	3 9	4 4	5·1	5·3	4·6	3 4	0 9	≃0 0

The formation of ethyl nitrate during the decomposition of ethyl nitrite in the presence of nitrogen dioxide affords direct evidence in favour of the reaction:

$$C_2H_5O + NO_2 \rightarrow C_2H_5O.NO_2, \tag{1}$$

originally suggested by Phillips[1] in explanation of the inhibition of the thermal decomposition of ethyl nitrate by nitrogen dioxide. In this event, it is possible that previous values obtained for the rate of decomposition of ethyl nitrate do not refer to the rate of the reaction:

$$C_2H_5O.NO_2 \rightarrow C_2H_5O + NO_2, \tag{2}$$

since the decomposition involves the equilibrium

$$C_2H_5O.NO_2 \rightleftharpoons C_2H_5O + NO_2. \tag{3}$$

These conclusions would mean that the effect of nitric oxide on the decomposition of ethyl nitrate previously ascribed[2] to the reaction:

$$C_2H_5O.NO_2 + NO \rightarrow C_2H_5O.NO + NO_2, \tag{4}$$

is probably due to the occurrence of

$$C_2H_5O + NO \rightarrow C_2H_5O.NO, \tag{5}$$

proceeding in preference to (1) in the presence of initially added nitric oxide. This would also explain Levy's[3] observation of the production of ethyl nitrite (in quantities greater than 70 mol. per cent) during the normal decomposition of ethyl nitrate.

Acknowledgment is made to Dr. Peter Gray (Cambridge) for recent correspondence on this subject.

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Aug. 11.

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Structural Changes during the Fatigue of Copper

RECENT experiments on annealed low-oxygen high-conductivity copper have shown that, under direct fatigue stresses, the structural changes revealed by back-reflexion X-ray photographs (cobalt $K\alpha$ radiation; film-to-specimen distance, 10 cm.) are markedly dependent upon mean cyclical load.

The tests were carried out on a variable-frequency testing machine, which applied alternate tensile and compressive loads to the test specimen. The mean cyclical loads were conveniently varied within restricted limits by placing weights on a counter-balance pan which was attached to the straining device of the machine by a flexible steel cable passing over a pulley.

At frequencies of both 200 c./min. and 400 c./min., small variations in the value of the counterweight attached to the straining device were found to produce disproportionate changes in the X-ray diffraction patterns of test-specimens after 1,000 stress cycles at about ± 5 tons/sq. in. At the same time, permanent dimensional changes were similarly influenced by variations in the magnitude of the counterweight, as will be seen from Table 1.

Table 1. PERMANENT STRAINS AFTER 1,000 CYCLES AT ± 5 TONS/SQ. IN APPROXIMATELY

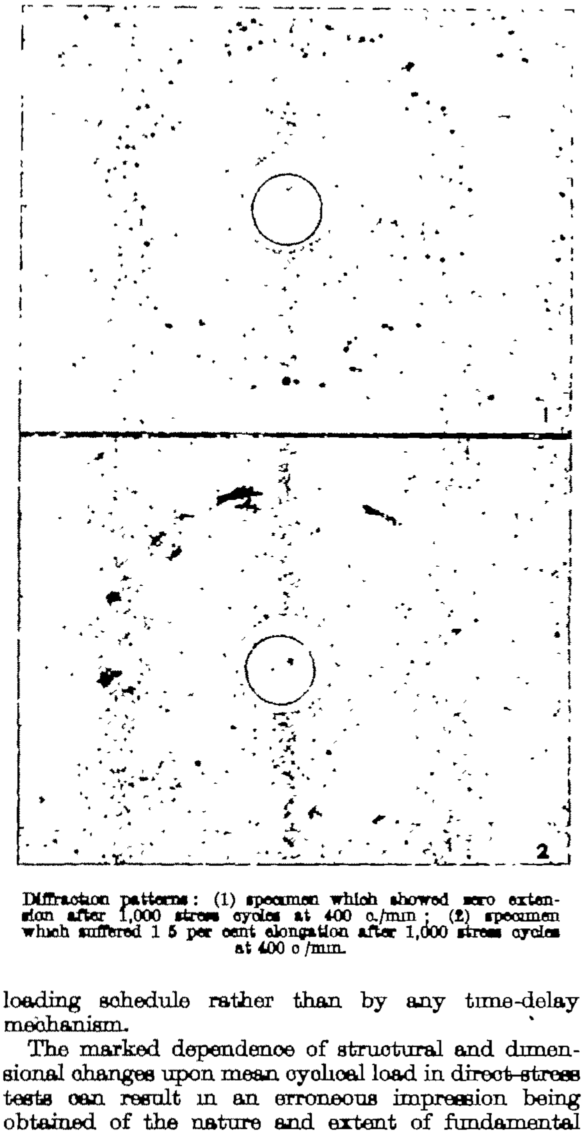
200 c./min. tests		400 c./min. tests	
Counterweight (lb.)	Permanent strain (per cent)	Counterweight (lb.)	Permanent strain (per cent)
40	− 1	40	− 1
60	− 0·8	80	Nil
80	+ 1	120	+ 1·5

In those cases where the permanent dimensional changes were slight or negligible, the X-ray patterns showed relatively small changes except for a general diffusion of the sharp diffraction spots typical of the annealed material (see Fig. 1). However, the changes in the patterns were quite pronounced in all cases where the permanent dimensional changes exceeded about ± 1 per cent, at both high and low frequencies (see Fig. 2).

Wood and Head[2], in their direct reversed-stress tests on oxygen-free high-conductivity copper, attributed their observations of pronounced diffusion and circumferential arcing of X-ray diffraction spots at 'sub-critical' testing frequencies (< 350 c./min. approximately) and the relative absence of changes at higher frequencies to the influence of a delay period, representing the finite time between application of a stress and development of the corresponding plastic strain. These tests were done on the machine used in the present work.

However, repeated tension experiments which I have carried out on similar material have shown that the use of the higher testing frequencies fails to inhibit structural changes (as revealed by X-ray diffraction) and dimensional changes, at least after 100 cycles.

Other work[3] has shown that, even under static loading conditions, annealed copper can withstand reversed stresses of ± 5 tons/sq. in. with only slight changes in X-ray diffraction patterns, providing a suitable 'stepped' loading sequence is followed. It is clear that, in this latter case, structural changes are minimized by the choice of an appropriate preliminary loading schedule rather than by any time-delay mechanism.



Diffraction patterns: (1) specimen which showed zero extension after 1,000 stress cycles at 400 c./min.; (2) specimen which suffered 1·5 per cent elongation after 1,000 stress cycles at 400 c./min.

The marked dependence of structural and dimensional changes upon mean cyclical load in direct-stress tests can result in an erroneous impression being obtained of the nature and extent of fundamental structural changes under fatigue stresses, unless load-balancing operations of high precision are practised. In the absence of confirmatory evidence from low- and high-frequency tests carried out in other types of machines (for example, rotating bending tests), it seems possible that the critical-frequency effect reported by Wood and Head[2] may have been attributable primarily to progressive dimensional changes arising from characteristics of the testing machine.

Some preliminary rotating bending tests have, in fact, been carried out, and X-ray diffraction studies have indicated that the structural changes, even at 21 c./min., may be relatively slight.

Acknowledgment is made to the Chief Scientist, Department of Supply, for permission to publish this communication.

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July 2.

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[1] Johnstone, W. W., and Peggie, J. B., Comm. Aust., Dept. Supply, Aero. Res. Lab., S. and M. Note 190 (1951).

[2] Wood, W. A., and Head, A. K., *J. Inst. Metals*, 79 (2), 89 (1951).

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 22

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. Maldwyn Jones: "Plastics for the Radio Engineer".

University of Edinburgh (in the Natural Philosophy Department, Drummond Street, Edinburgh), at 7.30 p.m.—Mr. W. Lawrence: "The Experimental Synthesis of Speech".

Monday, November 22—Tuesday, November 23

Institution of Gas Engineers (at Church House, Westminster, London, S.W.1), at 9.30 a.m. daily—20th Autumn Research Meeting.

Tuesday, November 23

Institute of Physics, Non-Destructive Testing Group (in the Lecture Theatre of the New Horticultural Hall, Vincent Square, London, S.W.1), at 2 p.m.—Mr. R. Halmshaw and Sr. G. Spiegler: "The Fundamentals of Radiographic Definition, Resolution and Unsharpness".

Institution of Electrical Engineers, Measurements Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Prof. H. E. M. Barlow: "The Application of the Hall Effect in a Semi-Conductor to the Measurement of Power in an Electromagnetic Field"; Dr. A. H. M. Arnold: "Audio-Frequency Power Measurements by Dynamometer Wattmeters".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. Hermann Bondi: "Science as an Education".*

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. C. H. Edlin: "Light and Crime Detection".

Wednesday, November 24

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Dr. H. Weil-Malherbe: "Blood Adrenaline in Relation to Mental Activity".*

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Bicentenary Competition—"Life in 2000 A.D.". Reading of first two prizewinning essays—Wing Commander T. R. Cave-Browne-Cave: "A Scheme for Rooftop Roadways"; Mr. C. E. H. Watson: "A System of Underground Roadways for London".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. S. Hazzledine Warren: "The Clacton Channel Deposits"; Dr. K. A. Joysey: "The Geological Distribution of Carboniferous Blastoids in the Craven Area".

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. M. J. Goddard: "The Development and Design of Direct-Coupled Oscilloscopes for Industry and Research".

Society of Chemical Industry, Food Group (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. R. Mitchell Learmonth: "Some Aspects of Soya as a Bread Improver"; Dr. Betty C. Hobbs: "The Problem of Synthetic Cream".

Thursday, November 25

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. J. P. Stevenson: "Insects and Disease".*

East Malling Research Station (at the Laboratories, East Malling, near Maidstone, Kent), at 3 p.m.—Prof. T. A. Bennet-Clark, F.R.S.: "Water and Plant Growth" (Amos Memorial Lecture).

Textile Institute (at 10 Blackfriars Street, Manchester 3), at 3 p.m.—Prof. S. C. Harland, F.R.S.: "Recent Progress in the Breeding of Cotton for Quality".

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual General Meeting. Prof. H. Davenport: "Simultaneous Diophantine Approximation".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. W. Cronin and Mr. J. F. Lang: "Peat-fired Power Stations".*

Institute of Refrigeration (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Miss M. V. Griffiths: "The Use of Heat Pumps of Small Capacity for Various Purposes in Great Britain".

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. N. Thompson: "The Development and Investigation of Fatigue Cracks".

Thursday, November 25—Friday, November 26

Institute of Metals (at 4 Grosvenor Gardens, London, S.W.1), at 2.30 p.m. on Thursday, and 10.30 a.m. on Friday—General Meeting for the Discussion of Papers.

Friday, November 26

Institute of Metal Finishing (in the Fitzwilliam Room, Grand Hotel, Sheffield), at 3.45 p.m.—Third Annual General Meeting.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion—"Geophysical Aspects of Solar Flares". Chairman: Prof. V. C. A. Ferraro. Speakers: Dr. M. A. Ellison, Mr. H. Elliott, Dr. J. S. Hey, Mr. H. W. Newton and Mr. K. Weekes.

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. P. M. S. Blackett, F.R.S.: Seventh (1954) Rutherford Lecture.*

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. R. D. Lawrence: "Sugar Diabetes, Its Nature and Its Importance".

Saturday, November 27

Botanical Society of the British Isles (in the Lecture Hall of the British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Annual Exhibition Meeting.

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Sir Richard Winstedt: "Malay Folk-Song".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Experimental Officer to work in the Department of Entomology on Aphid Ecology—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting 104 (November 25).

Senior Technician to take charge of the workshop in the Department of Physics—The Registrar, University College of North Wales, Bangor (November 29).

Demonstrator or Lecturer in Pathology—The Registrar, The University, Leeds 2 (November 30).

Lecturer (with an honours degree in engineering and some professional experience) in Mechanical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (November 30).

Senior Lecturer, Lecturer and Assistant Lecturer in the Department of Electrical Engineering—The Registrar, The University, Manchester 13 (November 30).

Assistant Agricultural Economist (graduate in economics and/or agriculture)—The Registrar, The University, Bristol 8 (December 1).

Technician or Radiographer (preferably with qualifications in science, mathematics or radiography) required for therapeutic and tracer measurements with radioactive isotopes—The Secretary, Board of Governors, Hammersmith Hospital and Postgraduate Medical School, Du Cane Road, London, W.12 (December 1).

Assistant Lecturers (2) in Botany—The Registrar, The University, Manchester 13 (December 4).

Head (with a good honours degree, teaching and industrial experience, and preferably with research experience) of the Engineering Department—The Principal, Kingston Technical College, Fassett Road, Kingston-upon-Thames (December 4).

Physiologists, Pharmacologists or Zoologists (with a first- or second-class honours degree, or equivalent qualification) at a Ministry of Supply Experimental Establishment, near Salisbury, Wilts—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting G386/54A (December 4).

University Demonstrator in Physical Chemistry—Dr. F. B. Kipping, Chemical Laboratory, University of Cambridge, Cambridge (December 4).

Scientific Officer (British nationality, with an honours degree in chemistry and postgraduate experience in agricultural chemistry, or an honours degree in agricultural chemistry) in the Chemical Research Division of the Ministry of Agriculture, Government of Northern Ireland—The Secretary, Civil Service Commission, Stormont, Belfast (December 6).

Chair of Glass Technology—The Registrar, The University, Sheffield 10 (December 11).

Mathematicians or Physicists (with a first- or second-class honours degree in mathematics or physics and preferably with experience of analyses of statistics and preparation of appreciations of trials data) at a Ministry of Supply Experimental Research Establishment, near Salisbury, Wilts, for operational research—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 316/54A (December 11).

Senior Scientific Officers (with a first- or second-class honours degree or equivalent in physics or electrical engineering, and at least three years postgraduate research experience), at the Royal Aircraft Establishment, Farnborough, Hants, to work on research in and development of radio and other fusing techniques for guided weapons and bombs—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.320/54A (December 11).

Assistant Keeper (with a first- or second-class honours degree in electrical engineering or equivalent qualifications, and preferably a knowledge of at least one modern foreign language) in the Department of Electrical Engineering and Communications, Science Museum (Ministry of Education)—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.270/54 (December 14).

Chair of Chemistry tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (December 14).

Curator (with an honours degree in zoology) of the Aquarium—The Secretary, Zoological Society of London, Regent's Park, London, N.W.1 (December 15).

Lecturer or Senior Lecturer (adequately qualified in chemistry with specialization in the field of physical chemistry) in Physical Chemistry, at the University of Tasmania and Hobart Technical College—The Agent-General for Tasmania, 457 Strand, London, W.C.2, or the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 21).

ASSISTANT DIRECTOR (well grounded in high polymer and physical chemistry, and able to appreciate the impact of fundamental work in these and allied fields on the practical development of plastics, particularly from indigenous resources) OF THE DIVISION OF PLASTICS AND HIGH POLYMERS—The Secretary, Council of Scientific and Industrial Research, Old Mill Road, New Delhi, India (December 31).

BIOMETRICIAN for duties which include the design of experiments in all phases of tobacco production, together with the analysis of data and related statistical practice—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

LECTURER IN FLUID MECHANICS in the Department of Aeronautics and Fluid Mechanics—The Secretary of University Court, The University, Glasgow (January 8)

LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Reading (January 17).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, The University, Nottingham

BACTERIOLOGIST for work primarily concerned with the production and testing of bacterial vaccines and toxins—Head of the Biological Division, The Wellcome Research Laboratories, Beckenham, Kent.

GRASSLAND AGRONOMIST, a GRASS BREEDER, and a CEREAL BREEDER (with a good honours degree in botany or agricultural botany), and ASSISTANTS to a CYTOLOGIST and GRASS BREEDER (with a pass degree in botany or agricultural botany), at the Welsh Plant Breeding Station, Aberystwyth—The Registrar, University College of Wales, Aberystwyth.

PHYSICIST (with an appropriate science degree and preferably with a knowledge of electronics), to assist in problems related to the treatment of cancer—The Medical Superintendent, Western General Hospital, Edinburgh 4.

PHYSICISTS (4) (with a good honours degree and some research experience) to undertake research on (*a*) shrinkage and dimensional stability of fabrics (Ref. P.1), (*b*) creasing and crease-recovery of fabrics (Ref. P.2), (*c*) the fatigue of textile fibres (Ref. P.3), and (*d*) fibre assemblies (Ref. P.4)—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

RADIO CHEMIST, Principal Scientific Officer or Senior Scientific Officer grade (with a first- or second-class honours degree in chemistry, and at least three years postgraduate research experience), to work in a team engaged on fundamental research work on radioactive materials—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 154/WGH/2.

RESEARCH ASSISTANT (honours graduate, preferably with research experience) IN ORGANIC CHEMISTRY—The Secretary, University College, Exeter.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics) to carry out research into the measurement of radiation with emphasis on the high intensity and high-energy regions—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 81/WGH/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Building Research Station Digest No. 69 (August 1954): Avoiding Defects in Internal Plastering. Pp. 6. (London: H.M. Stationery Office, 1954.) 3*d.* net. [19

Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 31: The Durability of Road Tar (With Special Reference to Its Use in Tar-macadam Wearing Surfaces). Pp. vi+48+4 plates. (London: H.M. Stationery Office, 1954.) 2*s.* 6*d.* net. [29

The Year Book of the International Council of Scientific Unions, 1954. Pp. ii+82. (London: International Council of Scientific Unions, c/o The Royal Society, 1954.) 5*s.* [29

Recommendations on Library Co-operation. Pp. 8. (London: National Central Library and National Committee on Regional Library Co-operation, 1954.) [29

National Central Library. 38th Annual Report of the Executive Committee for the year ending 28 February 1954. Pp. 22. (London: National Central Library, 1954.) [29

London and Home Counties Regional Advisory Council for Higher Technological Education. Applied Research in Technical Colleges. Pp. 44. (Publication No. 18.) (London: London and Home Counties Regional Advisory Council for Higher Technological Education, 1954.) 2*s.* 6*d.* [239

National Physical Laboratory. Notes on Applied Science No. 5: Gauge Making and Measuring. Pp. v+79+1 plate. (London: H.M. Stationery Office, 1954.) 3*s.* net. [249

Journal of Nuclear Energy. Vol. 1, No. 1 (August), 1954. Pp. iv+92+iv (2 plates). Published quarterly. Annual subscription 90*s.* Single issues 25*s.* (London: Pergamon Press, Limited, 1954.) [249

Medical Research Council of Ireland. Annual Report for the year ended December 31, 1953. Pp. 34. (Dublin: Medical Research Council of Ireland, 1954.) [249

Communications and Electronics. Vol. 1, No. 1 (October), 1954. Pp. 120. A monthly journal. Annual subscription 30*s.* Single issues 2*s.* 6*d.* (London: Heywood and Co., Ltd., 1954.) [249

Department of Scientific and Industrial Research and Fire Offices' Committee. Joint Fire Research Organization. Reference to Scientific Literature on Fire—Part 6, 1952. By Miss E. M. Shakeshaft, Miss B. F. W. Baxter and Miss I. G. Wolanska. (Library Bibliography No. 5/Part 6). Pp. 63. (Boreham Wood, Herts.: Fire Research Station, 1954.) [249

British Welding Research Association. Welding Research for Industry. Pp. 24. (London: British Welding Research Association, 1954.) [240

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain—England and Wales. Geology of the Country around Chatham. (One-Inch Geological Sheet 272, New Series.) By H. G. Dines, S. C. A. Holmes and J. A. Robbie. With contributions by Dr. S. Buchan and F. H. Edmunds. Palaeontology by R. V. Melville. Pp. viii+157+5 plates. (London: H.M. Stationery Office, 1954.) 21*s.* net. [249

Scottish Plant Breeding Station. Annual Report (Abridged). Pp. 70. (Edinburgh: Scottish Plant Breeding Station, 1954.) [249

Annual Report and Transactions of the Yorkshire Philosophical Society for the year 1953. Pp. 15. (York: Yorkshire Philosophical Society, 1954.) [249

Friends of the Lake District. Report and News Letter, August 1954. Pp. 16. (Ulverston: Friends of the Lake District, 1954.) [249

Other Countries

Histochemische Methoden. Lieferung 3. Pp. 24. (München: R. Oldenbourg, 1954.) 6 D. marks.

Southern Rhodesia. Geological Survey Bulletin No. 40: The Geology of the Lower Sabi Coalfield. By Dr. W. H. Swift, W. C. White, J. W. Wiles and B. G. Worst. Pp. 115. (Salisbury: Government Printer, 1954.) 15*s.* [249

Annual Report of the Rubber Research Institute of Malaya, 1952. Pp. 115. (Kuala Lumpur: Rubber Research Institute of Malaya, 1954.) [240

Organisation for European Economic Co-operation. Corrosion Problems and Prevention in the Chemical and Petro-Chemical Industries in the U.S.A. (Technical Assistance Mission No. 130.) Pp. 130. (Paris: Organisation for European Economic Co-operation, 1954.) 8*s.* 6*d.*; 1.50 dollars; 420 French francs. [240

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 111, No. 9: On Bolosaurus and the Origin and Classification of Reptiles. By D. M. S. Watson. Pp. 379–450+1 plate. Vol. 111, No. 10: Distribution of the Foraminifera in the Northeastern Gulf of Mexico. By Frances L. Parker. Pp. 451–588+13 plates. Vol. 112, No. 1: The Ant Genus Strumigenys Fred. Smith in the Ethiopian and Malagasy Regions. By William L. Brown, Jr. Pp. 34. Title Page and Index to Vol. 111. Pp. 4. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [249

Museum of Comparative Zoology at Harvard College. Breviora. No. 34 (July 20, 1954): A Review of the Coxalis Group of the Ant Genus Stictoponera Mayr. By William L. Brown, Jr. Pp. 10. No. 35 (July 23, 1954): New or Redescribed Pelomedusid Skulls from the Tertiary of Africa and Asia (Testudines, Pelomedusidae). 1: *Dacquemys paleomorpha*, new genus, new species from the Lower Oligocene of the Fayum, Egypt. By Ernest Williams. Pp. 8+1 plate. No. 36 (August 6, 1954): Present Knowledge of the Snake *Elachistodon Westermanni* Reinhardt. By Carl Gans and Ernest E. Williams. Pp. 17. No. 37 (August 18, 1954): On the Evolution of an Oriental Earthworm Species, *Pheretima Anomala* Michaelsen 1907. By G. E. Gates. Pp. 8. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [240

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 33, No. 4: Philippine Zoological Expedition 1946–1947. Systematics and Zoogeography of Philippine Amphibia. By Robert F. Inger. Pp. ii+183–532. (Publication No. 732.) (Chicago: Chicago Natural History Museum, 1954.) 6 dollars. [249

United States Department of Agriculture. Leaflet No. 363: The Southern Cornstalk Borer. Pp. 6. 5 cents. Leaflet No. 367: The Tomato Fruitworm: How to Control It. Pp. 6. 5 cents. [249

Sveriges Geologiska Undersökning. Ser. A: Kartblad i skalan 1:50000 med beskrivningar. No. 195: Beskrivning till Kartbladet Saro. Av P. H. Lundegårdh och R. Sandegren. Pp. 106. 10 kronor (med karta). No. 196: Beskrivning till Kartbladet Vasteras. Av P. H. Lundegårdh och G. Lundqvist. Pp. 75. 10 kronor (med karta). Ser. C. Avhandlingar och uppsatser. No. 522: Pre-Cambrian Geology of the Pajala District, Northern Sweden. By Tryggve Eriksson. Pp. 38+3 plates. 4 kronor. No. 533: De Geologiska Resultaten Fran Borrningarna vid Hollviken. Del 6: Charophyta from the Middle Trias of the Boring, Hollviken 2. Preliminary Account. By Henning Horn af Rantzien. Pp. 16+1 plate. 1.50 kronor. No. 534: Vatögraniten. Av P. H. Lundegårdh. Pp. 24. 2 kronor. Årsberättelse for År 1951. (Tillhor Årsbok 45 (1951).) Pp. 9. (Stockholm: Kungl. Boktryckeriet P. A. Nordstedt and Soner, 1952–1954.) [249

Museum of Applied Arts and Sciences, Sydney. Annual Report of the Trustees for the year ended 31st December 1953. Pp. 14. (Sydney: Museum of Applied Arts and Sciences, 1954.) [249

Prospects for Atomic Power. By Sir James Chadwick, F.R.S. (Lecture delivered in the McLennan Laboratory, under the auspices of the School of Graduate Studies, University of Toronto, October 15, 1953.) Pp. 12. (Toronto: University of Toronto Press; London: Oxford University Press, 1954.) 6*s.* net. [249

Research Bulletin of the Panjab University. No. 44 (Zoology): Gametogenesis and Fertilisation in *Isoparorchis Eurytremum*. By O. Parkash Dhingra. Pp. 21–37+5 plates. 3 rupees, 8 annas. No. 45 (Zoology): Studies on Insect Spermatogenesis. No. 2. Lepidoptera. On the formation of the Acrosome and Mitochondrial Nebenkern in *Prodenia litura* Fabr. and *Anaphaeis* sp. By Sukhdev Raj Bawa. Pp. 39–47+8 plates. 2 rupees, 4 annas. No. 46 (Zoology): Fish Spermatogenesis, with particular reference to the fate of the Cytoplasmic Inclusion. 2: Spermatogenesis of Elasmobranchs (Pleurotremata). By Hem Sagar Vasisht. Pp. 49–58+5 plates. 2 rupees, 14 annas. No. 47 (Chemistry): Chloramine-B as a Volumetric Reagent. Part 3: Determination of Metals. By Apar Singh. Pp. 59–62. No. 48 (Chemistry): Chemical Examination of the Oil from the Seeds of *Cassia Absus* Linn. By L. Sen Gupta, Kulwant Singh and Ram Parkash Sood. Pp. 63–69. 1 rupee, 1 anna. (Hoshiarpur: Panjab University, 1954.) [249

Pubblicazioni della Pontificia Academia Scientiarum, Città del Vaticano. Commentationes. Anno 16, Vol. 16, No. 2: Analisi Elettro-acustica della Voce Cantata. Da Fr. A. Gemelli, G. Sacerdote e G. Bellussi. Pp. 21–44+9 plates. (Città del Vaticano: Pontificia Academia Scientiarum, 1954.) [249

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THE BRITISH CIVIL SERVICE

THE centenary of the Trevelyan–Northcote report on the organization of the permanent Civil Service in Great Britain has prompted *The Political Quarterly* to devote almost the whole of its current issue to a discussion of the Civil Service in relation to its contemporary tasks and the needs of the British people. The major grounds of current criticism of the Civil Service are fairly and concisely recapitulated; but the excess of criticism and its frequent extravagances are repudiated as firmly as they are by Mr. Herbert Morrison in his recent book and by Prof. K. C. Wheare in his commemorative lecture. The implications of the Crichel Down episode are carefully weighed, but the general verdict remains that the British Civil Service continues to be the best in the world.

Most of the articles contributed to this number pay some attention to the problems with which the scientist is most closely concerned; for example, to the position and recruitment of the professional and scientific classes of the Civil Service, and the way in which expert advice should be given to the Government. Where such problems are not specifically mentioned, as in Sir John Woods's excellent article on Treasury control, the principles which guide current practice are clearly expounded. This article brings out, for example, some of the difficulties which are involved from the national point of view in the extension of the principle of quinquennial or block grants. Against the undoubted advantages from the point of view of planning research or educational policies, for example, which such a practice confers, there are certain drawbacks, which Sir John indicates. Simple or conclusive answers to such questions are rarely to be found, and this article is a valuable contribution to the understanding and goodwill on both sides on which effective public control of expenditure and the efficient use of resources—in money, materials or man-power—ultimately depend.

The essay of least interest to the man of science is that dealing with the Foreign and Commonwealth Services. It contains, apart from Prof. W. A. Robson's article, "Recent Trends in Public Administration", the only reference to the Colonial Service made in the symposium; but this brief reference ignores entirely the problems of the Colonial Scientific Service and the implications both of political developments in the Colonies and of technical assistance and the Colombo Plan for that service. The bearing of Colonial Welfare and Development Acts and the large amount of research now being conducted by or on behalf of the Colonies are nowhere considered.

Of the more general articles, one by Mr. C. R. Attlee deals with the relations of Civil servants, Ministers, Parliament and the public much on the lines of Mr. Morrison's book, and comments on the advantage to the country of recruiting more scientists in the higher ranks of the Civil Service—and also the difficulty of doing so. It may be noted here that in considering recruitment, Mr. L. N. Helsby, First Civil Service Commissioner, expresses the view that over the past nine years the Service has probably attracted at least a fair share of all scientific talent short of the highest class and also, recently, a reasonable share of recruits of exceptional ability. In spite of a serious shortage of engineers and surveyors, he does not believe that the Civil Service is seriously understaffed in comparison with the professions as a whole.

Mr. Helsby does not suggest that the final answers can yet be given to the question whether in the scientific and professional field the Civil Service is getting enough recruits and of the right kind; his present answers are conditioned by the fact that leading industrial firms themselves find difficulty in filling all their posts with exactly the type of person they desire. He maintains that the use made by the Civil Service Commission over the past nine years of the interview method in recruiting scientists has been developed sufficiently to secure the advantages of central recruitment and to meet the special circumstances of government scientific work. He does not, however, really touch on the recruitment to the administrative class, and especially at the highest levels, of scientists and technologists who show themselves possessed of the requisite administrative ability.

That problem, and also the further problem of the status and function of the specialist officer, are faced by Mr. H. R. C. Greaves. Reviewing the structure of the Civil Service, Mr. Greaves notes that, in spite of their present weakness as a group within the hierarchy, the considerable growth in numbers and significance of the professional and scientific officers in the Service, which has placed them near the sources of administrative decision and in close contact with the highest administrators, has given them opportunities of attaining such positions, which some at least have been able to seize. Mr. Greaves is not complaisant. He admits that a widening of the social basis of recruitment to the administrative class might also assist in the recruitment of those whose university training had been in science and not solely in the arts. He points out that the growth of attention to post-entry training and the recognition of Treasury responsibility in this matter give promise of the reduction of hierarchical rigidities, and one of his suggestions for improving the structure of the Civil Service and the correction of departmentalism is a more elastic, less rigid treatment of the hierarchical principle in recruitment, taking advantage particularly of the existence of the specialist or professional groups and of the newer administrators in nationalized services. With this, he suggests that much more could be done in training, in conjunction with the universities, by bringing together young officers from the Civil and other public services, and by the promotion of individuals who have distinguished themselves by creative research and training, to create a cadre of first-rate officers suited for all branches of public service. Thirdly, he suggests a lively and elastic promotion policy conducted by a body of officials, specially trained in the art of selection, ranging wide over all public employees, and concerned only to choose well to the public advantage, regardless of vested interest or departmental prejudice.

Mr. Greaves believes that for such measures to succeed it would be necessary to form a small 'machinery of government department', under the head of the Service and attached to the Prime Minister, which would provide a highly trained and carefully selected general staff for all branches of the Civil and public services. He argues that the experience and knowledge required can only be provided by a greatly strengthened body of officials, coupled with a clearer assertion of the powers of the head of the Service and a more definite assumption of authority by the Prime Minister. The suggestion is somewhat controversial, though Mr. Greaves claims support for it in an answer of Sir Warren Fisher to the Select Committee on National Expenditure in 1942, and it is not in conflict with Sir John Woods's remarks on Treasury control.

Sir John Woods is not concerned that the Treasury should be over-powerful; but he points out that the real question is the way in which control is exercised. Very little direct light is thrown on that question in this symposium. Sir Edward Bridges, viewing the reforms of 1854 in retrospect, tempers his conclusion that those reforms have stood the test of time with some observations on the qualities needed in the Civil servant which bear on this issue. He directs attention to the consequences of the infinitely wider range of duties with which the Civil Service to-day is charged, and the change in its composition compared with that of 1854. It now comprises, for example, very large scientific, professional and technical staffs, many of whom enter the Service after professional experience outside. Many problems are involved in ensuring that the relationships of these professional staffs with their colleagues in the other branches of the Service are on the best possible lines.

Such questions, Sir Edward remarks, are outside the scope of the report of 1854. It might be added that they are not entirely a matter for the Civil Service, and it is at least possible that professional bodies representing the whole of a profession, and not simply that part of the profession employed in the Civil Service, could give valuable assistance in working out solutions. That may be considered a special aspect of a second change which Sir Edward notes and which, so far as concerns the administrative, executive and clerical grades, he regards as the most significant. This is the increasing extent to which Civil servants are brought into contact with the public, through the larger concern of the State in economic affairs and industry, and through the work of the social service departments. Far more than before, the Civil servant is called upon to meet and to deal on behalf of the Minister with members of the public, either as individual citizens seeking information or redress about their benefits under social security, or with industrialists.

This calls for a wider range of qualities from the Civil servant and, because his task is changing and perhaps becoming rather more difficult than before

Sir Edward remarks that even greater care must be taken in his recruitment and training. That suggestion is endorsed in the editorial notes and comments which introduce the whole symposium; incidentally these notes put the symposium in admirable perspective, both by a brief recapitulation of current criticism and by the bibliographical footnotes which include most of the serious contributions to the discussion over the past decade or more. Training is, in fact, regarded as still the weakest part of the Civil Service, in spite of improvements since 1946, and specifically the Crichel Down episode is regarded as representing a failure of training. *The Political Quarterly* believes that Civil servants would not behave thus if they received adequate training and insight in the proper manner of treating individual citizens at an early stage in their career.

The proliferation of organs and the complexity of the machinery is regarded as a contributory factor and adds substance to criticism which has fairly been made of the Government's decision to abolish the Ministry of Food and to transfer its residual functions to a Department the internal organization of which is already complex and of dubious efficiency, and which is not entirely met by the appointment of an independent committee to review the regional and local organization of the two Ministries.

One of the merits of *The Political Quarterly* symposium is that it turns attention to the more vital problems of a modern bureaucracy, and particularly to the need for an approach from outside as well as from within the Civil Service. Two major suggestions are made in this connexion. One is that the Treasury should appoint an advisory council on the Civil Service, consisting of leading Civil servants, business men, industrialists, university teachers of politics or public administration, and others with experience of public life. The council would have the function of advising the government on general or particular matters requiring investigation or consideration concerning not only the well-being of the Service, but also its improved relations with the public and the greater efficiency of its work. The second suggestion is that the government should publish an annual report on the Civil Service. At the least, such a report might forestall the captious criticism which continually arises whenever the quarterly statistics regarding the Civil Service are published. After all is said, the fact remains that the size of the Civil Service is determined by the duties which it is required by Parliament to perform; hence it depends on the administrative implications of national policy, and only to a very minor degree on the efficiency with which the Service carries out that policy.

These suggestions are designed to focus attention, both within and without the Civil Service, on the primary questions of the proper relations between the governed and the governors, and the procedures, attitudes and ethics which should pervade public administration—and at the local government level as well as at the centre. Without due attention to these primary questions, the right answers and the right emphasis are unlikely to be found when we consider the secondary questions of recruitment, salary scales, working conditions, mobility, flexibility and the position of scientific and professional staff. It is not suggested, indeed, that such questions are unimportant; but a clear conception of the functions of the Civil Service in the modern State and of the functions and responsibilities of the scientific expert must guide decisions as to the best means by which such functions are to be discharged and the character of the organization provided for the purpose.

There are several suggestions made to this end. The idea of a Civil Service training college finds firm support as a means of countering departmentalism, in spite of the increase in staff that it would involve. A deliberate policy of interchange between departments, and between departments and nationalized industries, is advocated, instead of mobility being left to chance, as at present. Sir Edward Bridges notes that to-day, of thirty-three 'permanent secretaries' of major departments, sixteen started their official career in other departments, and four others have spent long periods in other departments; but it is not clear how much advantage is being taken of the new opportunities to avoid compartmentalism.

The symposium appears to suggest that the present system of vesting the ultimate control of the Civil Service in an administrative class drawn mainly from the universities is right; the wider basis of recruitment to the universities is securing a reasonable representation of social classes even though full equality of opportunity has not yet been achieved. The real deficiencies are in what is done in the matter of training; nor can confident answers yet be given to such questions as whether we can make the Civil Service more flexible and reduce rigidity of promotion, grading and salaries so as to permit the encouragement of real merit; though something is being done in the Scientific Civil Service (see p. 999 of this issue). Nor can it yet be said that a system of interchange can be worked out with the universities or with the nationalized industries in spite of the advantages of interchange demonstrated by war-time conditions.

The scientist will note that his own special difficulties and problems are fully appreciated, though there is not in the symposium any adequate treatment of the central problems of the limits of expert knowledge and the presentation and consideration of such advice in the task of government which Mr. D. K. Price's recent book illuminated in the American context. Nothing in the contributions to *The Political Quarterly* suggests that we have really worked out the right role of professional staffs in the Civil Service—medical, scientific or engineering—or that we can assume, without further inquiry, that the very great resources which the government is putting into scientific research and development are being efficiently operated. Even if the Civil Service is attracting a fair share of young scientists of the highest ability, it does not follow that they or their colleagues in government service are not being used for duties which could be performed equally well by others less highly trained.

On these and allied questions the symposium is a challenge to realistic and constructive thinking, both by individual scientists and by their professional organizations. Prof. W. A. Robson's article in particular should be noted by them, with its recognition of the much larger place which science now occupies in the sphere of government, and its strong support for administrative training and responsibility for the professional and scientific classes, and for the deliberate extension of their relevant experience so as to increase their usefulness. If, however, within the next few years satisfactory solutions are not found for the problems of how best to present and utilize scientific and other expert advice in the work of government at all levels, to guide policy and decisions and to secure the efficient utilization of scientific and technical man-power within the Civil Service, some large share of responsibility must clearly rest on scientists themselves for failure to grasp the opportunities now before them.

FOOD PRODUCTION AND POPULATION

World Population and World Food Supplies

By Sir E. John Russell. Pp. 514 + 44 plates. (London: George Allen and Unwin, Ltd., 1954.) 50s. net.

THIS book, with its wealth of information on the present position and possibility of development of agriculture in the different countries of the world, is a valuable addition to the growing literature on the question of whether the population will grow to a size that the earth will not be able to support.

The main cause of the present 'explosion' of population is, of course, the application of modern preventive medicine in reducing disease in countries with a high death-rate. In the limited areas where it has been applied, the population is increasing at a rate which will double it in less than thirty years. In recent years, with the help of the World Health Organization and other agencies, practically all countries are now beginning to apply modern hygiene. Hence, estimates of the size of population in the future have had to be revised upwards. In 1946 it was estimated that the population of about two thousand million before the Second World War might reach four thousand million by the end of the present century. The latest estimate is that it may reach that figure by 1980 and, if the present accelerating rate of growth continues, between five and six thousand million within the subsequent fifty years.

It is obvious that the only solution of the population problem is the reduction of the reproduction-rate to the level of the replacement-rate. There is commendable propaganda for birth control to attain that end; but owing to religious opposition, and the fact that many countries are taking measures to maintain or increase the birth-rate, it is doubtful whether the propaganda will have much immediate effect. Some take a gloomy view of the future. The present rather sudden rate of increase of population is, however, not a new phenomenon. It occurred in Western Europe in the eighteenth century, when the population of England and Wales, for example, rose from about ten to thirty-three million in spite of large-scale emigration. It is estimated that between 1800 and 1924 about sixty million people left Europe. Early in the present century, Western Europe passed through this phase of rapid expansion of population, and the birth-rate is now so low that the Western German Minister of Home Affairs recently pointed out that, unless voluntary birth control can be reduced, the European race is on the decline. It is probable that, when the countries at present in the expanding phase of population reach the standard of living and education of Western Europe, the birth-rate will fall and world population will become stable or perhaps even decline. This, however, is by no means certain. In the United States there has been a rise in the birth-rate, and the percentage rate of increase now rivals that of India.

It is impossible to predict with any degree of certainty the size to which world population may grow. The compulsory checks are war, disease and famine. If the attempts to eliminate the first two be successful, then, apart from voluntary birth control, which may take a long time to be effective, there remains only famine. This raises the vitally important question of whether population growth will outrun the capacity of the earth to produce food. On this there are two views, both of which warrant serious consideration.

One, put forward by Vogt, is that owing to soil erosion, which has destroyed about half the original fertile land on the earth and is still continuing, the only way to avoid famine is by birth control, compulsory if necessary, and the stopping of the elimination of disease in over-populated countries until the population is reduced to what the country can support. The other view, like that of Rosin and Eastman, is that with modern technology there is practically no limit to the amount of food that can be produced.

The information given in this book supports the latter view, at least to the extent of showing that a great increase of food production is possible. For example, in India, which is usually quoted as the outstanding case of an over-populated food-deficit country, the use of fertilizers in proper amounts would increase the yield of different crops by 30–100 per cent. The cultivation of rice by the Japanese method, using fertilizers, increases the yield more than 100 per cent. Then there are more than a hundred million acres of fertile land overrun by weeds and jungle which could be cleared by bulldozers. Shortage of water is a limiting factor in agriculture, but less than 10 per cent of the water in the rivers is used for irrigation. With pumps for small areas and multi-purpose dams like the Damodar Valley project, to convert the destructive force of floods to electricity and provide water for irrigating, vast areas could be brought into cultivation.

The physical possibilities for increased production in India are very much the same for all food-deficit countries. If the land at present under cultivation, or which could easily be put under cultivation, were made to yield to its maximum, the food supply of these countries could be doubled. Soil erosion could be stopped and the ruined land reconditioned. But technology cannot be applied to bring about the rapid increase of food supplies in the food-deficit countries owing to the lack of the necessary fertilizers, agricultural equipment and other industrial products. Where these are available, together with the incentive of a guaranteed market, food production can be rapidly increased, as occurred during and after the Second World War in Britain, when production was increased about 30 per cent, and in the United States, where surpluses have piled up to the value of 6,229 million dollars by March of this year. In the food-deficit countries the main obstacle is the lack of the necessary industrial products which they are too poor to purchase. The average income in these countries is only about £20 per head—less than a tenth of what it is in Western European countries. Though the Food and Agriculture Organization, the American and the United Nations Technical Assistance Scheme, and the British Colombo Plan are doing excellent work with their limited funds, progress is too slow. Up to 1951 world population had increased by 12 per cent since the Second World War, while food supplies had increased by only 9 per cent. Owing to three good harvests, the supply per head is now about equal to what it was in 1938, but the greater part of the increase is in the already well-fed countries. In the Far East, even if targets for 1956–57 are reached, production per head will still be about 10 per cent below the 1938 level when 80 per cent of the population suffered from malnutrition and periodic hunger. It is estimated that the long-term investment of about £4,000 million a year—that is, about 10 per cent of what the world is spending on armaments—would be needed to put an end to hunger and poverty within a reasonable time.

With modern engineering and agricultural technology, to the latter of which the author of this book has made a notable contribution, it is now possible to provide sufficient food for all mankind, even though the population should grow to twice its present size. The main difficulty is the adjustment of the economic and political structure of the world to the new age of abundance which science has made possible.

BOYD-ORR

A TREATISE OF GENETICS

Traité de Génétique

Par Prof. Ph. L'Héritier. Tome 1: le Mécanisme de l'Hérédité Génétique Formelle. Pp. iv+344. 1500 francs. Tome 2: la Génétique des Populations. Pp. iv+345–518. 900 francs. (Collection "Euclide": Introduction aux Études scientifiques. Biologie Animale—Section dirigée par Maurice Caullery.) (Paris: Presses Universitaires de France, 1954.)

THERE is an unquestionable demand for an elementary treatise of genetics. One written by Ph. L'Héritier, who has contributed brilliantly and decisively to two fields of genetics, cannot fail to arouse expectations. The two published parts of this treatise, however, though thoughtful and informative, are somewhat disappointing in three respects. First, they lack balance between the various parts of the subject. Second, they wander repeatedly from a logical sequence in the main argument. Third, they ignore the difficulties and evolution of basic ideas such as gene, allele, etc.

For example, in Vol. 1 (the mechanism of formal genetic inheritance) a whole chapter out of a total of six deals with interspecific hybridization, a subject which has limited relevance to formal genetics. The formal genetics of *Drosophila* is given a share far in excess of the very large one which everybody will agree it deserves. In contrast the formal genetics of man, of *Neurospora*, of *Aspergillus*, of cotton, etc., with their distinct contributions to our ideas of mutation, segregation, organization of genes, etc., are barely mentioned, if at all. In Vol. 2 (genetics of populations) the treatment is prevalently theoretical, with little reference to the vast amount of experimental work on populations either in Nature or in the laboratory. This is the more regrettable in view of the distinctive contribution which L'Héritier himself has made to this field.

An example of disconcerting sequence in the logical development of the subject is that multiple allelism and 'pseudo' allelism are dealt with before linkage and crossing-over. An example of avoidance of the terminological and semantic difficulties is the following definition: ". . . the mendelian character is represented in the hereditary make-up by a discrete particle, called the gene . . ." (p. 21).

On the credit side of this treatise there is the very elementary but clear and adequate treatment of the mathematical theory of population genetics, possibly the most extensive treatment of the subject so far still comprehensible to the non-mathematician. In the first volume, linkage and mapping of the chromosome are treated in a very satisfactory and intelligible way at the elementary level. The last chapter, on the mechanism of mutation, again gives an excellent bird's-eye view of a field which is at present rather fluid.

On the whole, it seems to the reviewer that this treatise, though useful as a reference book for people who are already well versed in the field, will not be equally useful for those who want to acquire a general balanced view of the concepts, the methods and the implications of genetics.

G. PONTECORVO

PLEISTOCENE GEOLOGY AND ARCHÆOLOGY OF NORTHERN FRANCE

Les Limons Quaternaires du Bassin de La Seine

Stratigraphie et Archéologie Paléolithique. (Archives de l'Institut de Paléontologie Humaine: Mémoire 26.) Par François Bordes. Pp. ii+472. (Paris: Masson et Cie, 1954.) n.p.

THIS magnificent volume of the Archives de l'Institut de Paléontologie Humaine is of first-rate importance to all students interested in the Pleistocene geology of northern France and the succession of early Palæolithic industries in the region. In conjunction with Commont's work in the Amiens district and the volume by Georges Dubois on the Pleistocene of northern France which was published by the Société Géologique du Nord in 1924, it gives a picture of the late geological succession in the north-eastern part of the country.

The importance of F. Bordes's new work is not so much in his conclusions but in the fact that he gives such a very large number of sections in gravel and loess pits along the River Seine from Paris to the sea and some others from neighbouring districts. Sections in the Amiens district are given to allow correlation with the work of Commont in the Somme valley. Each section has been carefully studied, and any finds, faunal or archæological, are recorded. Pages of illustrations of implements found are given. The conclusions arrived at, though clearly given, are subservient to the evidence upon which they are based. Whatever may be the final verdict on the Pleistocene successions in the valleys of the Seine and Somme and the correlation of the archæological and geological records, the facts recorded in this volume will have to be taken into account and will provide the basis for the resultant conclusions.

After a first part dealing with methods of study, the sections in a number of pits in the Paris region are considered, and afterwards the Mantes–Vernon area is dealt with in some detail. There follow accounts of sections and finds in the regions of Evreux–Nogent-le-Roi, Gisors–Fleury-sur-Andelle, Elbeuf, Rouen–Neufchâtel, Pont-Audemer and Duclair–Fécamp–Le Havre. For purposes of comparison there follow studies of sections in the Amiens, Beauvais–Clermont and Meaux–La Ferté-sous-Jouarre areas. Then comes the third part of the book, namely, several chapters dealing with the loesses of the region. M. Bordes divides the younger loess into three levels and the older loess into two. He considers the mode of deposition of the material, the fauna contained and the climate under which it was laid down. He studies the evolution of the human industries and their correlation with the loess levels, and ends with three short pages of general conclusions.

An excellent bibliography and list of the sites investigated, together with a map of the district covered, conclude the volume. Altogether, this is a first-class work, full of facts both from the geological and archæological angles, and all students of the subject will welcome it. M. C. BURKITT

ELECTRICAL MACHINES AND TRANSFORMERS

Electro-Magnetic Machines

By Prof. R. Langlois-Berthelot. Translated and revised in collaboration with Lieut.-Colonel H. M. Clarke. Pp. 535. (London: Macdonald and Co. (Publishers), Ltd., 1953.) 65s. net.

WHEN one reads the first sixty pages of this book, one gets the impression that it was written for youths, say, of fifth-form standard. But on reading further one soon realizes that the author's aim is more ambitious, and it appears that a sound knowledge of at least the elements of calculus and vector analysis is required for the full understanding of the book. But those who are not interested in the mathematical treatment of the subject will also find the book attractive, inspiring and thought-provoking. At a time when so much is spoken and written about the necessity of providing in Britain more opportunities for the education of technologists, the few pages in the last chapter on the relation between scientific and technical points of view and on the field of industrial research should appeal to many readers. Technological aspects are given prominence throughout. A special feature of the book is that the general principles and rules are outlined in a straightforward manner and that afterwards various complications to be met with in applying the rules are stated.

The book is written in that clear, logical style to be expected from a French author, and a word of praise should also be said about the competent translation. Much information is contained which is not to be found collected together elsewhere. In this connexion, mention should particularly be made of the chapters on insulation and on ventilation, as well as the section concerning standardization of dielectric test requirements and the concise treatment of transient conditions.

Numerical examples scattered all over the book will prove helpful to the student and designer, and occasional hints for practical exercises to be performed by students will be welcome to the teacher; although he will miss, perhaps, specific problems usually to be found in British and American textbooks of this kind.

The six main parts of the book deal with the following: the family of electrical machines; general anatomy and physiology of electrical machines; the machine from the designer's point of view; the machine from the user's point of view; abnormal conditions of operation; and miscellaneous general comments, including a general introduction to technique of electrical machines. Some appendixes deal with the notations and symbols used, with simple relations like sinusoidal functions, complex quantities and polyphase systems, and with a brief introduction to circle diagrams and the like.

While the book deals in a general way with transformers, synchronous and asynchronous alternating-current machines, single- and three-phase collector machines and direct-current machines, further volumes are apparently planned by the author, a second one being already in preparation dealing in greater detail with transformers and alternators.

A few critical remarks may be permitted. It is somewhat astonishing that under the heading "Various Special Machines" no mention is made of the direct-current cross-field machines invented just fifty years ago by E. Rosenberg. They have been extensively used for lighting railway trains, the feeding of searchlights and for arc-welding purposes not only in Germany and Austria but also in France, where before the First World War quite a number of trains of the P.L.M. Railway were equipped with them; and also their further development connected with the name of Pestarini might have been mentioned, as the 'metadynes', 'amplidynes', 'rototrols' and 'magnicons' are now frequently used in regulating technique—for example, as auxiliaries for the excitation of large and small alternators or of the generators of Ward-Leonard sets.

In a book of this size, perhaps more emphasis could have been laid on the importance of a good power factor in induction motors. True, the power factor is mentioned in several places, particularly also in the appendix. But in the part dealing with the machine from the user's point of view a warning might have been expressed against installing outsize induction motors in industrial plant, since this happens frequently in practice; as the power factor declines markedly at partial loads, an undesirable inductive load must be carried by the supply mains in these cases.

Very few misprints have been noticed, but one must be mentioned. In the explanation of the positive and negative phase-sequence on p. 447, the compositor apparently omitted half a sentence. But all these are minor blemishes, and the book can be strongly recommended and is a very welcome addition to the literature of electrical machines, in spite of the fact that this is already rather extensive. Author, translators and publishers can be congratulated upon this production. R. NEUMANN

Les applications de la mécanique ondulatoire à l'étude de la structure des molécules

Réunions d'études et de mises au point, tenues sous la présidence de Louis de Broglie. Pp. 224+2 plates. (Paris : Éditions de la Revue d'Optique théorique et instrumentale, 1953.) 1600 francs.

THIS volume contains the text of the eleven lectures and introductory address delivered at the eighth in the series of annual conferences on physical topics which have been held since 1944 under the general presidency of Prof. Louis de Broglie. Applications of wave-mechanics to the study of the structure of molecules was the topic chosen for the 1951 conference, and the lectures were delivered on various dates during April–June of that year. Both experimental and theoretical applications are featured. J. Lecomte gives an interesting and informative review of progress in the technique of infra-red spectrometry during 1940–50, and J. Wyart discusses the determination of interatomic distances by X-ray and electron diffraction, while O. Chalvet and C. Vroelant deal briefly with the theoretical calculation of interatomic distances.

On the more chemical side there is an excellent description by P. Ramart-Lucas of the influence of the steric effect on the electronic structure of carbon and nitrogen, and this is supplemented by a discussion by C. Sandorfy of the theories of the electronic spectra of organic molecules. In the sequence of three papers by N.-Q. Trinh, H. Lumbroso and A. Laforque, respectively, considerable detail is given, together with numerous references, of the work on electrical polarization and dipolar moments, and A. Pacault, N. Lumbroso and J. Hoarau in a short article briefly refer to the evidence concerning the structure of molecules to be gained from measurements of magnetic anisotropy.

The two remaining articles in the volume are of a more general nature. The first, by R. Daudel, is of an introductory character and outlines the part played by the de Broglie wave in the study of the structure of molecules, pointing out that there is no difficulty in principle but solely in the numerical solution of the wave-equation applicable to the particular case. The second article, by P. Chanson, describes the various methods used to obtain visual pictures of the atoms and molecules.

Though the lectures were delivered in 1951 and published towards the end of 1953, a useful attempt has been made by several of the authors to bring their material up to the date of publication by the addition in footnotes of brief references to recent important contributions. S. Weintroub

Rotgrünblindheit als Erlebnis

Führer durch die Farbwelt für Rotgrünblinde. Von Dr. Heinz Ahlenstiel. Pp. viii+47. (Göttingen: "Musterschmidt", Wissenschaftlicher Verlag, 1951.) n.p.

THIS little book, which first appeared in 1951 but which has since been translated by Mr. R. W. Burnham and printed privately by the Eastman Kodak Co., is an intriguing attempt by the author to describe the world of colour as seen by the colour-defective, the author himself being a protanope (the type of defective frequently described as red-blind).

Certain aspects of the treatment may seem a little naive, but there are some thought-provoking references both to the difficulties which face the colour-defective and also to effects which the intelligent and observant colour-defective can use to help him. This is well illustrated, for example, in the case of red object colours, which are, of course, a frequent source of confusion to persons with poor colour discrimination. In the first place, as the author points out, red objects possess an abnormally high purity to the colour-defective, even though their basic (defective) hue is yellow; and secondly, many red dyes and pigments are dichroic. This dichroism is such that, in thick layers, the appearance will, to the red-defective, be dark yellow, but in thin or diluted layers a light greyish-blue. Hence, a red surface of paint or fabric is likely to possess, on account of inevitable variations in density of the dye or pigment, a characteristic texture of yellow and blue which will enable the observer to identify the surface as red!

Effects such as these are not readily anticipated by a person with normal colour vision, and this book will prove stimulating reading not only to those interested in colour vision, but also to anyone of a philosophical turn of mind concerned with visual experience. W. D. Wright

The Physics of Viruses

By Ernest C. Pollard. Pp. xi+230. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 5.50 dollars.

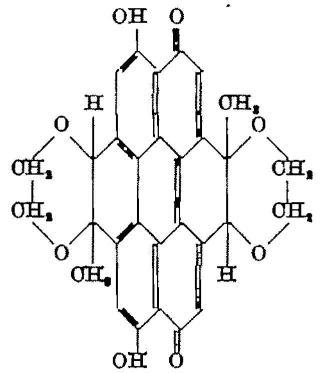
THERE is need for a book which catalogues and describes the many different techniques which the physicist has brought to the aid of the biologist, and especially the virus worker, during the past twenty years. However, it is never quite clear what the intentions of the author of this little book were, and to whom it is really directed. The treatment is too patchy and incomplete to make the work of value as a laboratory manual for the biophysicist, and the numerous erroneous statements about viruses will scarcely commend the book to the pathologist seeking a brief and reliable survey of the physical methods open to him.

The opening sentence consists of a definition of a virus that is so unrestrictive as to include ionizing radiations and many inorganic ions; such carelessness is regrettably only too common in many parts of the book. In Chapter 2, for example, Dr. E. C. Pollard mentions the use of the electron microscope for particle counting, but does not say that special techniques are necessary for the purpose, let alone describe them. Later in the same chapter, the description of, and references to, the techniques for cutting the very thin sections essential for electron microscopy are so incomplete as to be altogether misleading to anyone not already acquainted with the subject, and too many of the few electron micrographs included are of indifferent technical quality. The combined result gives no indication whatever of the range, scope and limitations of the instrument in virus research.

These deficiencies, serious though they are, should not be allowed to obscure the fact that the book does contain what is probably the only short account of the very large amount of work done since 1946 using ionizing radiation as a tool in virus research. Here the author, a nuclear physicist, is on his home ground, and this is easily the best part of the book. There are author and subject indexes, and the book is produced to the high standards one has come to expect of the Academic Press. It is a great pity that the care and obvious ability of the publishers are not matched in the text. H. L. Nixon

CHEMISTRY OF SOME NATURAL PIGMENTS

At the meeting of the British Association this year in Oxford, a symposium was held on September 6 on "Complex Natural Colouring Matters". After a short introduction by Sir Robert Robinson, Sir Alexander Todd gave a lucid account of the recent work which has been carried out in the Cambridge laboratory on the structure of aphins, the pigments obtained from the hæmolymph of various species of Aphidiae. For each species so far examined, the following four types of compounds have to be considered: the water-soluble protoaphins, which are probably glycosides and represent the 'native' precursor of the pigments; the fat-soluble xanthoaphins which are formed after the death of the insect by enzymic action; the orange chrysoaphins representing an intermediate state in the transformation chain; and the deep-red erythroaphins which represent the relatively stable end-products of each series. The two series which have so far been examined in detail are the aphins-*fb* obtained from *Aphis fabae*, the blackfly which attacks broad beans, and the aphins-*sl*, derived from *Tuberolachnus salignus*, the willow aphid. The contribution of Sir Alexander Todd was concerned entirely with the structures of erythroaphin-*fb* and erythroaphin-*sl*. Papers already published in the *Journal of the Chemical Society* have shown that both these two substances have the formulæ $C_{30}H_{[illegible]}O_{8}$, that they contain two carbonyl groups (quinone) and two hydroxyl groups, while the remaining four oxygen atoms are inert and are probably present in an ether linkage. The results of zinc dust distillation and of examination by infra-red and ultra-violet spectroscopy have shown that there is present in both compounds a 4 : 9-dihydroxyperylene-3 : 10-quinone structure. The structure now proposed for the two erythroaphins is based on the following arguments.



Substitution reactions show clearly that positions 2, 5, 8 and 11 in the perylene nucleus are free. Zinc dust fusion yields, among other products, a coronene derivative, suggesting that the saturated part of the molecule is attached to the perylene ring at positions 1 and/or 12 and 6 and/or 7. The formation of acetaldehyde on heating with hot 60 per cent sulphuric acid, and also symmetry considerations, make it appear probable that in these two erythroaphins two dioxan rings are fused with the central perylene nucleus.

Both erythroaphins are optically active, but their specific relations differ markedly. From the fact that erythroaphin-*fb* yields 1·7 moles of acetaldehyde and erythroaphin-*sl* only 0·8 mole, it is deduced that the two alicyclic ring junctions in the former are both *cis*, whereas in the *sl*-isomer one junction is *cis* and the other is *trans*. This deduction is in accordance with modern concepts of the stereochemistry of elimination reactions and also provides a satisfactory explanation of some of the complex interconversion and isomerization reactions of the erythroaphins and their derivatives. Although the structures proposed may not be established with complete certainty, all the known facts, physical and chemical, fit beautifully this ingenious interpretation.

The second contribution, by Prof. R. P. Linstead, was mainly concerned with recent work carried out in the Chemistry Department of the Imperial College of Science and Technology, London, on the chemistry of chlorophyll. This pigment, which plays an important part in photosynthesis in plants, is chemically related to the porphyrins; but, whereas the porphyrins are red and show five discrete absorption bands in the visible and near ultra-violet regions of the spectrum, chlorin, the basic macrocyclic structure present in chlorophyll, is green and is distinguished by a strong and sharp band in the red region. It has been shown, mainly by the work of the late Hans Fischer, that chlorins possess two more hydrogen atoms in the ring system than the corresponding porphyrins, and these additional hydrogen atoms are mainly responsible for the differences in colour and presumably of biological function of these two classes of complex organic molecules. The introduction of these two hydrogen atoms also creates a new element of asymmetry in the molecule and accounts for the optical activity of chlorophyll and its derivatives. Porphyrins are optically inactive, unless they acquire asymmetrical carbon atoms in their side-chains.

The placing of these two hydrogen atoms in the ring system proved to be a particularly difficult problem which was only solved in principle by Fischer in 1940 by oxidative degradation of various chlorophyll derivatives. Oxidation of porphyrins with chromic trioxide has been used for a long time in structural studies; thus with mesoporphyrin, which is related to the protoporphyrin of hæmoglobin, it produces two molecules of ethylmethylmaleimide, derived from the two non-acidic rings I and II, and two molecules of a maleimide propionic acid (hæmatinic acid), derived from the acidic rings III and IV. In 1940, Fischer and Wenderoth succeeded in isolating from a chlorophyll derivative in the form of a silver salt a dihydrohæmatinic acid which was optically active. This observation, together with other available knowledge, indicated that the two hydrogen atoms occupy the β-positions in ring IV. However, Fischer was unable, by the methods then available, to obtain the dihydro acid in a crystalline state, nor was it possible to determine the steric configuration of the compound.

Prof. Linstead and his colleagues have tackled the problem of the 'extra hydrogens' in three ways: in the first place (with Dr. M. Whalley), stable extra hydrogen atoms have been introduced into tetramethyl tetrazaporphin, which is a compound of related structure in which the four methene bridge groups are replaced by nitrogen. This azaporphin took up on catalytic hydrogenation four atoms of hydrogen. On oxidation, good yields of *meso*-1 : 2-dimethyl-succinimide and dimethylmaleimide were obtained, indicating that the hydrogen atoms had indeed entered into the β-positions. This work also demonstrated that the tetrahydride structure involving the β-positions corresponds to a moderately stable reduction-level, at least in the azaporphin series.

Although porphin, the completely unsubstituted porphyrin, had been known for some time, the corresponding chlorin had so far not been synthesized. Prof. Linstead and Dr. U. Eisner have now obtained this substance in the following manner: pyrrole is converted by a Mannich reaction to 2-dimethylaminomethylpyrrole, and this on treatment with a Grignard reagent yields a complex mixture of pigments from which chlorin is isolated in low yield by counter-current distribution and chromatography. The light absorption of the chlorin is extremely close to that observed by Stern with the various natural chlorins supplied by Fischer. Chlorin also gives the correct analysis for a dihydride and can be converted to porphin.

Finally, Prof. Linstead described recent work with Dr. G. E. Fichen on dihydrohæmatinic acid. This compound possesses two dissimilar asymmetric carbon atoms and will therefore exist in two racemic forms. The anhydrides, the imides and various salts of both series have been prepared, and a relatively easy interconversion from one series to the other has been observed to take place. Natural dihydrohæmatinic acid has been prepared by oxidation of pyrrophæophorbide-*a* (a degradation product of chlorophyll *a*) and has been separated from methylethylmaleimide by chromatography on silica gel. The natural substance has $[\alpha]_{5461} = -51°$. In respect of all other properties examined, it closely resembles one of the two racemic materials prepared by synthesis. The configuration of the two asymmetric carbon atoms has not yet been determined, and further developments of this work will be of great interest.

The third contribution, by Dr. A. Neuberger, was concerned with the biogenesis of porphyrins. After a short survey of their biological role, the structure of some of the naturally occurring porphyrins was briefly discussed and the point was emphasized that all the porphyrins associated with proteins are formally derivable from ætioporphyrin III, that porphyrins of type I are also found in Nature, while isomers of the series II and IV are apparently not synthesized by living matter.

From the wide distribution of cytochromes and catalase it can be deduced that almost all cells can synthesize porphyrins, but up to eight years ago there was no information as to the nature of the precursors. However, in 1946, Shemin and Rittenberg showed by means of labelling with heavy nitrogen that the nitrogen of glycine is used in a highly specific manner in the synthesis of protoporphyrin. Later work done in the United States by Shemin and in Britain by Muir and Neuberger produced convincing evidence that all four nitrogen atoms of porphyrin are specifically derived from glycine. When carbon-labelled glycine became available, it was shown by Altman that the carboxyl carbon atom of glycine is not incorporated into porphyrin, while parallel work done in the Columbia laboratories and at the National Institute for Medical Research, Mill Hill, demonstrated that the methylene carbon atom of glycine was used. In fact, for each nitrogen atom of glycine two methylene carbon atoms were found to be incorporated into each of the four basic units. By oxidative degradation it was found that one of these glycine methylene carbon atoms gives rise to the methene bridge, while the other is incorporated into the pyrrolic ring. Later, it was shown by Shemin that one of the two α-carbon atoms originates from the second glycine methylene group. This, of course, accounts only for eight out of thirty-four carbon atoms of protoporphyrin. Experiments with carbon-labelled acetate carried out in Columbia and at Mill Hill suggest that α-oxoglutarate and a substance closely related to it provide all these other carbon atoms; but it has been finally shown by Shemin that the substance concerned is mainly a succinic acid derivative substituted on one of the carboxyl groups, probably the coenzyme-*A* complex of this dicarboxylic acid. The position thus is that each of the four basic units of uroporphyrin can be thought to be formed by condensation of two molecules of glycine with two molecules of a succinic acid derivative and that one of the two nitrogens and the two carboxyl groups of glycine are lost before, during or after this condensation.

The identification of the intermediate between glycine plus succinic acid and the porphyrins has proved to be a difficult task and is by no means completely solved. Neuberger and Muir considered that the basic unit is a pyrrole substituted on one of the α-positions with elements of a potential methene group. This may have been formed by an initial condensation of two glycine molecules followed by combination with succinic acid. However, work with substances such as β-hydroxy aspartic acid was discouraging, and this idea was discarded also for other reasons. If the basic pyrrole has already one of the two α-positions substituted, it is easy to see how the symmetrical porphyrin of type I is formed, but the synthesis of the asymmetrical type III is more difficult to explain. A more reasonable assumption was that the basic pyrrole has two free α-positions, and this pyrrole would then combine with a further molecule of glycine giving one or other of two different α-substituted substances. It was therefore assumed that glycine would condense with succinic acid giving, in the first place, α-amino β-oxoadipic acid which would then be converted by loss of carbon dioxide to δ-aminolævulic acid. This acid might then react with a further molecule of succinic acid to give δ-succinamidolævulic acid, which could be reduced to the hypothetical pyrrole. However, biological experiments showed that the succinamido compound is inactive.

In the meantime, Westall had crystallized porphobilinogen, a substance excreted by patients suffering from acute porphyria. Its structure has been established by Cookson and Rimington as a pyrrole having an acetic acid and a propionic acid side-chain in the two β-positions and an aminomethyl group in one of the two α-positions. Soon afterwards Falk, Dresel and Rimington showed that porphobilinogen behaves as a porphyrin precursor, and it thus seems that the original idea of the Mill Hill workers may be partially correct and that an α-monosubstituted pyrrole is the first cyclic intermediate in the synthesis. From the structure of porphobilinogen it can be inferred that δ-aminolævulic acid itself might be the sought intermediate. This was shown almost simultaneously by Shemin and Russell and by Neuberger and Scott, and confirmed by Falk and Dresel. Recent work at Mill Hill, which was briefly reported by Dr. Neuberger, has greatly strengthened this concept that glycine and succinic acid combine to give δ-aminolævulic acid, which gives rise to porphobilinogen and then to porphyrins.

DUKINFIELD HENRY SCOTT (1854–1934)

By DR. AGNES ARBER, F.R.S.

A PALÆOBOTANIST, writing in the early nineteen hundreds, spoke of D. H. Scott as then belonging to the same class as Nathorst and Zeiller—these three standing head and shoulders above all others in fossil botany. For Scott this verdict is certainly borne out by his long series of books and memoirs, which covers a period of forty years (1894–1933). So many well-documented obituary notices are accessible (see list at the end of this article) that it would be superfluous to reiterate the facts of his career. In this, his centenary year, I propose to confine myself to a few special aspects of his life and work.

Scott's inborn trend towards a life of research was fostered by his personal circumstances. At the age of thirty-eight he became honorary director of the Jodrell Laboratory at Kew, and from this time onwards he was free from the daily grind of academic duties. Fourteen years later he retired into the country, thus securing a still more leisurely and unhampered existence; but, while he enjoyed the liberty of the amateur, he did not suffer from the amateur's drawbacks. He had been disciplined by reading classics at Oxford; then by an engineering training; and, later, by ten years of teaching—a long enough time to put him in possession of all that this particular form of experience had to offer him. Moreover, the absence of enforced day-to-day contacts did not involve any isolation from the scientific world. Indeed, fifty years ago he had become the focal centre of British botanical life to a degree that now, in this period of specialization and sub-division of the subject, would be impossible for any one man. His commitments included such responsibilities as the chairmanship of the Editorial Board of the *Annals of Botany*, and he did much work in connexion with the learned societies to which he belonged; he also gave unstinted time and thought to helping other research workers, whose indebtedness to him can scarcely be exaggerated. None of these doings was of a mechanical type, and they all lay in the field of his genuine interests and his chosen subject; they left his mind unstrained, so that he could put the best of himself into his studies.

In thinking about D. H. Scott, comparisons with Charles Darwin (forty-five years his senior) present themselves unbidden. Both men had the advantage of freedom from monetary cares, so that liberty and independence came to them naturally; and they had each a happy domestic existence, with an extensive but close-knit background of kith and kin. The minds of both were not so much remarkable for brilliance as for the unwearying tenacity which enabled them to pursue the same problems continuously over many years. This power of dwelling on a subject steadily for an indefinite period was one that Darwin recognized in himself, and it is known to have been a principal factor in the process through which Newton's discoveries came into being. Possibly it was this concentrated tenacity which induced in both Darwin and Scott a strict canalization of all mental energy into science; at least in later life, no branch of literature or of the arts can be said to have played an essential part in the existence of either of these biologists. Another resemblance, which though trivial is perhaps not without significance, is that both men inclined to a certain informality in the presentation of their material. This was partly, I think, a reaction against the pomposity of the professional pundit, and partly an eager desire to appeal to a wider circle than that of initiates. It may be recalled that Sachs expressed regret about the style of writing which Darwin adopted, on the ground that it degraded the severity of scientific thinking (cf. Pringsheim, E. G., "Julius Sachs", p. 167; 1932). Darwin's slightly casual approach finds some parallel in Scott's books, and also in what has been called his 'hearth-rug' manner of addressing scientific meetings. Underlying even such petty resemblances, there was undoubtedly a fundamental affinity between Scott and Darwin, which expressed itself in Scott's glowing, though not uncritical, admiration of Darwin's work.

The gains that have accrued to science from the technical progress of the present day, and from the resulting development of team-work research, are as obvious as they are vast; but they are correlated with certain losses, none the less real because they are less tangible. There is one loss, especially, that may in the long run prove tragic. It is that, as the amateur (but not amateurish) pursuit of science—typified, respectively, in a major and a minor form in Darwin and in D. H. Scott—becomes more and more impracticable, contemplative leisure fades irrevocably from scientific life. That uninterrupted periods of still meditation are essential, if the deeper insight is to be won, was recognized even long ago, when the *tempo* of day-to-day existence was much quieter than in our mechanized age. In the seventeenth century, Descartes affirmed that liberty and leisure were a necessity for the purposes of concentrated thought; moreover, he acted on this belief, betaking himself to exiled retirement, to avoid time-consuming distractions. Spinoza, again, though he was not, like Descartes, a man of means, declined a professorial chair, basing his refusal partly on the conviction that he could only teach a class at the sacrifice of his research in philosophy.

Though D. H. Scott's achievements were conditioned by his unhurried existence, which made continuous thinking possible, this does not imply that he consciously adopted the contemplative attitude. My impression is that he was not disposed to give any spontaneous consideration to processes going on in his own mind, though in correspondence he might sometimes be stimulated into revealing a defined position. He wrote to me in 1931, when he was in the seventies: "your letter causes me to enter on the religious duty of self-examination! . . . But am I an Aristotelian or a Platonist? When I read a little of the old philosophers some 55 years ago, my sympathies were certainly with Aristotle, who appeared to talk fairly plain sense. I could make nothing of Plato's philosophy, though I admired his style. . . . My interest is pure Natural History. I like to see things as they are, and to think how they became so. I don't care for Physiology. . . . But neither do I care a bit for . . . 'final patterns, eternal moulds'—all mere imaginations of the philosophising brain". In an earlier letter he had stigmatized logic as "a deceitful guide"; in his own work he relied on a strictly empirical procedure. Empirical conclusions demand, however, a theoretical basis; this, in Scott's case, took the form of a fundamental belief that "similarity (suitably determined)", distinguished from that which could be recognized as "superficial", might be accepted unquestioningly as "a mark of blood relationship". This belief was stressed in a correspondence which I had with him, in 1930, about parallelism in evolution, as contrasted with the older picture of a monophyletic genealogical 'tree' of the plant world; the visual image of such a 'tree' had, indeed, served him throughout his studies as the frame of reference for his botanical thought. He wrote: "When I have occasionally seemed to favour parallelism ('up to a certain point, you know'—like Mr. Brooke in 'Middlemarch') my idea has not been a bundle of sticks separate all the way up, but rather a Lombardy Poplar, with a trunk bearing a number of long, parallel branches". This partial acceptance of parallelism was an instance of Scott's anxious desire not to turn a blind eye upon arguments militating against his views; he was, moreover, prepared to discard his most cherished theories as soon as he had brought himself to feel that knowledge acquired since his conclusions were reached had proved his evidence to be less than adequate. A cogent example is his relinquishment of the idea of the filicinean origin of seed-plants, which had meant much to him. It is recorded that he was fond of quoting Pope's couplet:

> "And spight of Pride, and in thy Reason's spight,
> One truth is clear; 'Whatever Is is RIGHT'."

This loyalty to abstract truth had, however, to contend with an innate conservatism, involving a lesser loyalty to the purely Darwinian scheme of things, which had dominated his younger days. As a general attitude to life and to religion, the tolerant form of nineteenth-century agnosticism, which seemed the most consistent position for a convinced Darwinian, was congenial to Scott's turn of mind; but, in his later years, his views tended somewhat more in the direction of theism.

It is perhaps not too far-fetched to suggest that certain traits in D. H. Scott's scientific personality were inherited from his great-grandfather in the paternal line, the Rev. Thomas Scott (1747–1821); D. H. Scott's mother could claim collateral descent from the same cleric, so that there was more than the normal chance of the reappearance of hereditary characters derived from him. To-day, Thomas Scott is most vividly remembered for his friendship with Cowper, and for the fact that "John Gilpin" was first adumbrated under his roof, though not by him. He was, in his time, known widely as a Biblical commentator. In his spiritual autobiography, "The Force of Truth" (edit. 1, 1779), he set forth the process he had gone through in reaching his religious convictions. The passage may be quoted, since it is just what his great-grandson, D. H. Scott, might have written, if he had analysed in eighteenth-century parlance his own cautious and balanced scientific method: "I sat down very coolly to search for the truth, I proceeded very gradually, and with *extreme caution*; I took no opinion upon trust; I gave up none of my sentiments, until the arguments by which I had learned to defend them were satisfactorily answered; nor did I admit any new articles into my creed, till either every objection was obviated, or I was pressed on the other hand with such as were still more unanswerable" (quoted from the 1821 edit.).

D. H. Scott's most conspicuous impact on the study of plants has been through his classic corpus of memoirs on structural palæobotany, begun under W. C. Williamson's inspiration; but a more general effect has radiated from his original training in research (1880–82) under Julius Sachs. Scott himself said that going to work in a German laboratory, when he was in his twenties, was, to him, like a pilgrimage to Mecca to a pious Mussulman. It was fortunate that, at Thiselton-Dyer's suggestion, he decided upon the University of Würzburg, since it is no exaggeration to say that Sachs possessed one of the finest minds that have ever been devoted to plant study. Goebel, his assistant, who was about Scott's age, had been a pupil of Hofmeister (born 1824), and was thus a link with the heroic age of German botany. Sachs himself bore the impress of a wider and deeper intellectual tradition. The Czech physiologist, Purkinje (born 1787), who has been described by Nordenskiöld as ranking among the great geniuses of biological discovery, employed Sachs, from the age of eighteen, as his personal assistant. This relation with Purkinje meant that Sachs, in his formative years, had intimate contact with a man who had been directly influenced by Goethe, for it was the "Farbenlehre" that had stimulated Purkinje's early studies in the physiology of sight, and had led to his friendship with the poet. Sachs's school at Würzburg thus inherited some of the best elements in the stream of biological thought which can be traced back to the Goethe period. After Scott's sojourn in Germany, he introduced unconsciously, wherever he might find himself, the spirit of research with which he had been imbued in Sachs's laboratory, and this spirit—passed on through a succession of younger botanists—continues to work as a living leaven among students of the plant world.

Accounts of D. H. Scott's life and work, in alphabetical order of authors' names: Arber, A., "Dict. Nat. Biography", Supp. 1949, for 1931–40; Oliver, F. W., *New Phyt.*, 33, 73–76 (1934); Oliver, F. W., *Ann. Bot.*, 49, 823–40 (1935), with bibliography by Edwards, W. N., and Wonnacott, F. M.; Rendle, A. B., *J. Bot.*, 72, 83–88 (1934), with D. H. Scott's autobiographical notes; Sahni, B., *Current Science*, 2, 392–95 (1934); Scott, D. H., *New Phyt.*, 24, 9–16 (1925) (reminiscences of research in Germany); Scott, D. H., in Oliver, F. W., "Makers of British Botany", 243–60 (1913), for Scott's precursors in fossil botany, and especially for his relation with W. C. Williamson; Seward, A. C., *Nature*, 133, 317–19 (1934); Seward, A. C., Obit. Notices Fellows Roy. Soc., 205–27 (1934); Weiss, F. E., *Proc. Linn. Soc.*, Session 146, 1933–34, 166–69.

BRITISH WELDING RESEARCH ASSOCIATION

OPEN DAYS

THE laboratories of the British Welding Research Association, at 29 Park Crescent, London, W.1, were open for inspection during November 23–24, the previous occasion being in February 1950. Visitors may well have been surprised at the evident expansion in research effort, with the corollary increases in research facilities, equipment and number of staff during the space of but a few years.

The main research effort is divided equally between steels and the light alloys, though visitors heard and saw something of the working of the Liaison Department, the Library and Information Services, and the other and minor research activities now in hand.

One of the most interesting developments from the steel welding researches is a method for the assessment of weldability of high-strength low-alloy steels by means of a dilatometric method. This method depends on the relationship between hardened-zone cracking and the temperature at which transformation ceases in the hardened zone. This simple means of assessing weldability was demonstrated. Also on view was some of the work using weldability cracking tests which has led to this development.

Mechanical tests at very high temperatures are being made on specimens cut from weld metal, and the results related to the defect known as hot cracking. In these tests, a 6-kVA. high-frequency generator is used. A wider range of investigation of the same problem is being made, using the 'Murex' hot-crack machine.

An investigation is being made of the problem of fissuring in weld metal; that is, the occurrence of very fine intergranular cracks. It has been found that these are liable to occur for given threshold values of hydrogen content and cooling-rate.

Visitors saw something of some relatively new work on the welding of structural steels, using the self-adjusting arc process. The field of high-temperature brazing was represented, and creep tests of brazed turbine assemblies were in progress.

Good progress has been made in the microscopical identification of inclusions in steel plate and weld metal, using a Reichert *MeA.* metallurgical camera (with polarizing equipment) and a Reichert 'Zetopan' metallurgical microscope for visual work. Here the use of diamond dust for the preparation of metallographic specimens has been invaluable; the technique was demonstrated.

Apart from routine chemical analysis, micro-gas analysis has been increasing in importance during recent years. The latest methods for the determination of hydrogen by vacuum extraction were shown, and the way that these have been adapted to deal with the problems of determining hydrogen, not only in weld metal but also in the parent wire and plate materials. One interesting problem has been the determination of the relative amounts of hydrogen dissolved in the aluminium welding wire and that produced by reaction from corrosion products on the surface. These experimental investigations sometimes require the artificial introduction of hydrogen, and this is done by means of cathodic charging.

The light alloy researches cover a fairly wide range of welding processes and aluminium (and magnesium) alloys, but certain problems with respect to heat flow, dilution effects and porosity have been found to be basic to this field of study.

The work on heat flow, which is derived from an investigation of the welding of heat-treatable alloys, is concerned with the production of basic formulæ by means of mathematical analysis, in parallel with measurements of the thermal cycles characteristic of the weld pool and various positions in the parent plate. Methods have been developed for the location of thermocouples in the plate metal, and also in the weld pool itself. The temperatures can be recorded using a ciné camera with a sensitive millivoltmeter, or, where faster rates are involved, using a cathode-ray oscillograph with a d.c. amplifier and camera. It has been found that the arc and weld pool cannot here be treated as a point source, and some progress has been made in the determination of weld pool shapes by calculation.

An important advance has been made respecting the dilution effect; that is, the extent to which the composition of the weld metal is changed by dilution with melted parent-plate material. Nomograms have been prepared to facilitate the estimation of weld metal composition obtained with particular welding conditions. This has been found to be important in the metal-arc welding of *H*.10 plate and in the tungsten-arc welding of a high-strength heat-treatable aluminium alloy, in particular with regard to the development of suitable filler-wire compositions. In the assessment of joint properties in light alloy materials, porosity is especially important. For the measurement of porosity a code has been drawn up for its assessment under the microscope, following detailed investigations. Visitors were able to see the method used for the measurement of elongation over small gauge lengths, found necessary to investigate the variation in ductility across a welded joint. Various forms of weldability cracking tests were shown, in some of which slotted plates are used to give quite severe conditions without the necessity of employing rigid and cumbersome jigs.

Investigations are also in progress on a number of specific alloys, including the metal-arc welding of *H*.10 plate from the point of view of eliminating cracking and porosity, the development of improved filler materials for *H*.14, *H*.15 and *D.T.D*.683 alloys, and the self-adjusting arc welding of *NP*.5/6 alloy.

The relatively new self-adjusting arc process has naturally required some investigation, and, in particular, work on the fundamental characteristics of the process has been done in co-operation with the Electrical Research Association. The effect of power source characteristics on the degree of self-adjustment has been determined. In parallel, work has been done on drift in power source output. This is making possible the development of idealized generators for the process, or at least the modification of existing generators in this direction. The efficacy of the improved power source characteristics was demonstrated by comparative welding tests over a stepped plate.

OBITUARIES

Sir John Lennard-Jones, K.B.E., F.R.S.

THE death on November 1 of John Edward Lennard-Jones has deprived British theoretical chemistry of its most senior and distinguished representative. Yet he did not begin his career as a chemist. Born in 1894, he was educated at the University of Manchester and then at Trinity College, Cambridge. The First World War interrupted his studies and he became a flying officer (pilot) in the R.F.C. and later experimental officer at the Armament Experimental Station, Orfordness. In 1919, however, he returned to the University of Manchester, this time as lecturer in mathematics. This post was followed by a readership in mathematical physics and later the first professorship in theoretical physics, both at Bristol. It was during this time that he became deeply interested in the nature of interatomic forces, and introduced the semi-empirical law of force $a/r^n - b/r^m$ with which his name will always be associated. These Bristol years were productive of other new ideas, and in particular it was then that Sir John initiated the wave-mechanical study of molecular structure in the form of molecular orbitals. His first paper on this topic, published in 1929, is still a standard piece of work, and the whole subject owes a great debt to him for the way in which he brought out in a simple way the mathematical implications of experimental studies on quantum numbers in molecules then being made by R. S. Mulliken and others.

This migration from mathematics through physics to chemistry made him an excellent holder of the John Humphrey Plummer chair of theoretical chemistry established at Cambridge in 1932. At the same time (1933) he was elected a Fellow of the Royal Society. This post at Cambridge was—and still is—the only chair of theoretical chemistry in Britain. While he was in Cambridge, Lennard-Jones (or 'L. J.' as he was known to his many friends) laid the foundations of the present vigorous school of theoretical studies in Britain. During this time he extended his earlier work on molecular orbitals, he made some useful progress in the very difficult field of chemical interactions at a metal surface, and he developed the 'cage-model' of liquids. Had it not been for the Second World War, in which he played a conspicuous part as Superintendent of Armament Research and Director-General of Research (Defence) at the Ministry of Supply, there is no doubt but that he would have done even more.

At the end of the War, Sir John returned once more to Cambridge, and although he became chairman of the Scientific Advisory Council of the Ministry of Supply, he and his younger colleagues completed an extensive study of the most fundamental problem in all chemistry—what is meant by a chemical bond ? But by this time his administrative abilities were becoming widely known. He was a member of the Advisory Council for the Department of Scientific and Industrial Research, a member of the Scientific Advisory Committee of the National Gallery, and president during 1948–50 of the Faraday Society. His quiet manner and understanding approach to difficulties made him an excellent chairman on all occasions where conflicting claims had to be reconciled. It was not surprising, therefore, that in April 1953 he was invited to follow the late Lord Lindsay and become the second principal of the new University College of North Staffordshire at Keele. He threw himself whole-heartedly into this work, which he so evidently liked, and in which he had become much appreciated, not only in the College itself, but also in the neighbourhood.

Sir John received many honours. He held the D.Sc. of Manchester and the Sc.D. of Cambridge; he was made K.B.E. in 1946, was awarded the Davy Medal of the Royal Society in 1953, and an honorary D.Sc. at Oxford on the occasion of the British Association meeting there only a few weeks before his death, when he was president of Section B (Chemistry). He had recently been awarded the Longstaff Medal of the Chemical Society. All those who knew him respected the complete integrity of his life, the exceptional simplicity and clarity of his lectures and his obvious enjoyment of everything that he did. His home life was a most happy one; he is survived by his widow, a son and a daughter.

C. A. Coulson

Mr. B. H. St. J. O'Neil

The unexpected death on October 24 of Brian Hugh St. John O'Neil at the age of forty-nine has deprived the Ancient Monuments Department in the Ministry of Works of the chief inspector who followed Mr. J. P. Bushe-Fox, whose death was so recently recorded in these pages (*Nature*, November 6, p. 860).

Educated at Merchant Taylors' School and St. John's College, Oxford, of which he was a scholar, Mr. O'Neil began a career in the City of London, but soon deserted to Westminster and the Ancient Monuments Department in fulfilment of interests always near his heart. His most particular delight was in medieval and post-medieval fortifications and in early artillery, of which he had a profound and detailed knowledge, well employed, for example, in a recent visit to advise upon the treatment of early Portuguese fortifications in West Africa. He spoke and wrote of these matters with an authority and relish good indeed to meet. But his work extended also with distinction to other fields. He was no mean numismatist, as his classic study of Theodosian silver coin-hoards in late fourth-century Britain proves. He could take a prominent part in discussions concerning late-Roman copies of earlier coinage. No less notable was his discussion of the Silchester dykes and their relation to Britons and Saxons. Among his field-work should be specially cited his excavation of Frith Ffaldwyn Iron-Age fortress in Powys and the Caerau settlement in North Wales, and the unstinting unofficial help accorded in the excavations by his wife of Roman villas at Park Street, Whittington Court and Bourton-on-the-Water.

His appointment as chief inspector of ancient monuments brought him into close quarters with war-time and post-war problems in archæology. The application of State aid to the examination and record of sites threatened by destruction was liberally and wisely interpreted by him, and presently extended to cover sites of national importance which private resources, impoverished by taxation and inflation, were no longer equal to tackling. This was a valiant service to knowledge of which the full effects are not yet apparent, for he was planning publication in promising fashion, talking of the matter with the writer less than a week before his death. We have lost far too soon a judicious innovator, a good (if perhaps fatally self-sufficient) administrator, a zealous public servant, a keen scholar and a staunch friend, who in all these capacities will be widely and deeply mourned.

I. A. Richmond

Miss Rosamund F. Shove

After a long illness borne with great fortitude, Miss Rosamund F. Shove died on October 17 in Richmond Hospital, aged seventy-six. Until the last few months of her life she had hoped to renew some of her many activities in the field of science and remained keenly interested to the end. Educated at Girton (1896–99), Miss Shove was trained in research by Prof. A. C. Seward; and in 1900 "The Morphology of the Stem of *Angiopteris erecta*" appeared in the *Annals of Botany*. Miss Shove's professional career included seventeen years of science teaching in schools, followed by twenty years of university and training college work in biology and hygiene. Her last post was at the Maria Grey Training College (1921–38). She served on the council of the Linnean Society during 1943–47.

In 1937 Miss Shove became honorary secretary of the School Nature Study Union, and in 1940 undertook the editorship of its journal, *School Nature Study*, at a critical time. She sustained both the Union and the journal throughout the War and continued her labours until 1953, when the jubilee number was published. The journal had appeared regularly each quarter, thanks to her tireless devotion.

At the British Film Institute, Miss Shove was a faithful member of a volunteer panel who viewed natural history films from many sources. She contributed many film and book reviews to *School Nature Study*, besides several illustrated articles based on her discriminating observations; for example, a life-history of a beautiful, ineradicable weed, a pink-flowered *Oxalis*.

Her small garden at Kew contained many cherished plants, some under glass; in the large collection of dwarf trees, each in its own pot, are an English elm forty-two years old and a youthful common lime. I was delighted to learn that this collection had been accepted recently for the Royal Botanic Gardens, Kew.

Other evidence of the lasting influence of a gifted botanist will be passed on by her many grateful pupils, students, colleagues and other friends.

MADELINE MUNRO

NEWS and VIEWS

Botany at Singapore: Prof. R. E. Holttum

PROF. R. E. HOLTTUM, who was the first professor of botany in the University of Malaya, has just retired after spending the greater part of his life in Malaya. He intends to live at Kew, where he will continue his studies on Malayan plants, particularly ferns. Prof. Holttum was born at Linton in Cambridgeshire and was educated at Bootham School, York, and St. John's College, Cambridge. He took the Natural Sciences Tripos with first-class honours in Parts I and II, winning the Frank Smart Prize in 1920. He first went to Malaya in 1922, when he joined the staff of the Botanic Gardens. He was appointed director of the Gardens in 1925, and remained at this post until 1949, when he joined the newly created University of Malaya and brought the Department of Botany into being. Prof. Holttum's appointment was particularly valuable in the early and formative years of the University, for he has travelled widely through Malaya, Borneo and Indonesia and has an unparalleled practical knowledge of the flora of this region. During the past five years he has been very active and has set a tradition that his successor will find it hard to surpass. He has published many papers on ferns, bamboos, gingers and orchids, which are his principal botanical interests, and the past two years have been marked by the publication of some of his major works: "Orchids of Malaya" (Singapore, 1953), "Gardening in the Lowlands of Malaya" (Singapore, 1953), "Plant Life in Malaya" (London, 1954); a fourth volume, "Ferns of Malaya", is in the press. Prof. Holttum's activities in Singapore have been by no means confined to botany, for he has taken a leading part in various important societies. He will be remembered with affection by his students, his colleagues and his many friends in Singapore, who wish him a long and happy retirement near the Royal Botanic Gardens at Kew.

Research in British Power Industries: Gas and Electricity

IN a debate in the House of Commons on November 9 on the annual reports and statements of accounts of the gas and electricity industries, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, said that he had agreed with the Gas Council for capital expenditure this year of £61 million. Electricity development was estimated by Lord Citrine at £1,250 million over the next six years; it should provide 1·6 million kilowatts next year and 1·95 million kilowatts in 1959. This includes a five-year programme costing £50 million to bring electricity to 70 per cent of the farms and 80 per cent of rural housing of Britain. In the first half of this year, industrial consumption of gas increased by 8 per cent and that of electricity by 14 per cent; but the gas industry had saved 250,000 tons of coal last year and the electricity industry 1 million tons. Mr. Lloyd also referred to research on the utilization by the gas industry of inferior and cheaper coals, and to the discovery of a process for making gas from fuel oil alone, for which sixteen new plants are being erected. Questioned by Mr. A. Robens as to whether sufficient money was being spent on research in these two industries, the Parliamentary Secretary to the Ministry, Mr. L. W. Joynson-Hicks, said that the figures quoted by Mr. Robens, £229,000 for the gas industry and £242,900 for the electricity industry, did not represent anything like the full expenditure on research of these two industries. Much of the expenditure, he said, is of a capital nature which is not specifically allocated to research; much work is also being done by the British Electrical and Allied Industries Research Association, and the British Electricity Authority contributes to research being carried out by at least half a dozen other bodies. He promised to attempt to obtain a figure for the total expenditure on research by the industries, but was of opinion that research is not being held up on financial grounds.

Nuclear Power

MR. LLOYD, referring to nuclear power, emphasized the dependence of industrial power from this source upon the ordinary electricity supply system, the expansion of which is already being planned to feed industry from nuclear power stations when the practical difficulties have been overcome. Mr. Lloyd explained why at present in the experimental atomic power stations steam generation is not close-coupled with the furnace, and also referred to the problem of nuclear fuel and the possibility of utilizing as fuel most of the uranium extracted from the ore. Engineers from the British Electricity Authority are already attending training courses at Harwell, and from now on there will be a steady stream of electrical engineers attending these courses. The British Electricity Authority is collaborating closely with the Atomic Energy Authority, and also with the plant manufacturers, in the design of experimental nuclear power stations by making freely available its experience regarding turbines and power-station construction generally. Mr. Lloyd also said that, with the view of encouraging enterprise and, where proper, a spirit of adventure, the Government has decided to encourage these two nationalized industries to compete with each other as actively as possible and with the oil industry. In the course of the debate, Mr. G. Nabarro expressed the opinion that the prototype and pilot nuclear power station at Calder Hall, with a capacity of 60,000 kW., would be completed by the end of 1956, and that such plants would be making a substantial contribution to grid supplies of electricity well within ten years. Mr. Joynson-Hicks, however, maintained that it would be unreasonable, in view of the vast amount of work and planning to be carried out, apart from research, to expect nuclear energy to be available on a large scale commercially through the grid system of Britain within less than about ten years. He also said that the Government will not overlook the importance of keeping a balance in capital expenditure on the development of nuclear power, on electricity supply generally and on the coal industry.

Nuffield Foundation Grant for Colonial University Colleges

THE Nuffield Foundation has announced that it is setting aside £250,000 for the benefit of the new Colonial university colleges. From this capital sum the University College, Ibadan, Nigeria, and the University College of the West Indies, Jamaica, are to receive grants of £50,000 each; grants to other Colonial university colleges, including a scheme of research into education in the Colonies, are being considered by the Foundation. At Ibadan, £5,000 of the £50,000 grant will be used to build and equip a house—to be known as Nuffield House—for academic visitors. The balance of £45,000 will be held and invested by the Foundation, and the income from this sum for five years will be used to finance a Nuffield visiting professorship for Nigeria. At the end of five years the scheme will be reviewed by the College and the future of the fund will be decided. The first Nuffield visiting professor to be appointed to Ibadan is Prof. P. W. Richards, professor of botany in the University College of North Wales, Bangor, who has published many papers on tropical rain forests. The £50,000 grant to the University College of the West Indies, near Kingston, Jamaica, will be invested in a fund to be known as the Nuffield Endowment Fund. The income from the Fund will be used by the College to finance pilot projects. The choice of projects will rest with the College Council, without emphasis on any particular subject or type of study. The progress of any project so assisted will be reviewed at the end of five years.

Archives of Machine Design: New Polish Journal

THE first number of a new engineering quarterly journal has just appeared; it is entitled *Archiwum Budowy Maszyn*—literally, *Archives of Machine Design*—and is sponsored by the Machine Design Committee of the Polish Academy of Science (Tom 1, Zesyt 1; pp. 120. Warszawa: Polska Akademia Nauk, 1954; 15 zlotys). Summaries of five hundred to a thousand words, in Russian and English, are given at the end of each contribution. This issue comprises four papers of twenty to thirty pages each and one of less than ten; they range over a wide field of mechanical engineering science and treat essentially practical problems from a scientific point of view. The first two papers, on safety factors and a statistical approach to the analysis of failures, respectively, lead to criteria for the more economic design of machine elements. A paper on the conductivity of fibrous insulating materials reports some pure research work with theoretical analysis of the results, some of which are novel. The final paper introduces an improved method for the design of internal combustion engine cams, involving a parabolic variation in the acceleration as a function of time; with the design information given, such a cam should be more effective than the traditional type and no harder to design. This new journal, which shows an outlook intermediate between the German and the Russian, is undoubtedly to be welcomed.

Microscopy of Metals

SINCE Sorby in 1864 first published an account of his work on the microscopic examination of the etched structures of metals, and after an incubation period of nearly two decades, the importance of the microscope in both theoretical and industrial metallurgy has increased greatly. During the past twenty or twenty-five years, in particular, the rate of advance has been spectacular, and the use of polarized light, dark-ground illumination, phase-contrast and the reflecting microscope, among other techniques, has increased its scope of utility enormously. It was therefore appropriate that the refresher course of the Institution of Metallurgists in 1953 was devoted to a consideration of these new, and in some directions quite exciting, techniques. The papers presented are now published by the Institution (pp. 132; from the Institution, London, 1954; 15*s*. 6*d*.) and provide an account, not easily available elsewhere, of the help that the modern microscope can give in the examination of metals and alloys. Five lectures are reprinted, two of which deal with the principles of the microscope and, in particular, of these newer techniques, and with the preparation and examination of the sample. There is then an extended treatment of the use of polarized light and of phase-contrast and interference metallography, and, a matter of growing importance, of the hot-stage microscope for the examination of materials at elevated temperatures. In this publication a condensed but sound account is given of the general, present position, and there are few microscopists interested in this field who will not benefit from its study. The papers are well illustrated by a large number of photomicrographs, and, though a few of these show too clearly from the 'screen' that they are reproductions, the general standard is good.

Cave Sites of the Mogollon Culture in New Mexico

THE finds from the cave sites of the Mogollon culture of west-central New Mexico are of no great antiquity; indeed, the earlier ones do not date before 1100 A.D. and the later group perhaps to 1300 A.D. But they are no less interesting for that, and the careful study of four cave sites, two of them containing cliff dwellings, by Paul S. Martin, John B. Rinaldo and Elaine Bluhm, has been well worth while (Fieldiana–Anthropology, Vol. 42: Pub. 731 of the Chicago Natural History Museum; pp. 227; 1954; 2 dollars). The culture of the Mogollon Indians has long been under investigation, but these are the first cliff dwellings that have been carefully dug and of which the details have been published. The caves occur in New Mexico in the Pine Lawn valley district. The excellent illustrations make it easy to follow the excavations. After describing the digs, a critical study of the pottery and other finds from the various levels follows. Several different types of arrow head were unearthed, and it is interesting to learn that certain types go with certain styles of pottery and seem to be characteristic of certain levels. This may prove to be an important check on studies elsewhere based exclusively on the pottery sequence. The volume is very well put together, and altogether constitutes an excellent piece of work.

An Actinophage for Potato Scab

A NUMBER of actinophages active against species of *Streptomyces* have already been reported. In a recent paper, F. H. S. Newbould and E. H. Garrard have described the isolation of a phage specific for *S. scabies*, the pathogen of potato scab (*Canadian J. Bot.*, 32, No. 3, 386; 1954). This phage was isolated from soil surrounding scab-infected potatoes. Tested against fifteen scab-producing *Streptomyces* cultures isolated from scab lesions, thirteen were lysed, one partially lysed and one was resistant. Against fifteen non-scab-producing strains of Actinomycetes, also isolated from scab lesions, thirteen were not lysed and two showed evidence of partial lysis. Tested against Actinomycetes cultures isolated from soil, the phage was less specific and the results were inconclusive. Lack of phage specificity is attributed to variation among *Streptomyces* cultures.

The Night Sky in December

FULL moon occurs on Dec. 10d. 00h. 56m., U.T., and new moon on Dec. 25d. 07h. 33m. The following conjunctions with the moon take place: Dec. 2d. 16h., Mars 6° S.; Dec. 12d. 22h., Jupiter 3° N.; Dec. 21d. 15h., Saturn 6° N.; Dec. 21d. 20h., Venus 7° N.; Dec. 31d. 12h., Mars 6° S. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Dec. 16d. 00h., Venus 0·7° N. Mercury, a morning star, rises 1h. 20m. before the sun on December 1 and draws nearer the sun during the remainder of the month; it will not be easily seen at any time during December. Venus, a morning star, rises at 5h. 40m., 4h. 40m. and 4h. 20m. on December 1, 15 and 31, respectively; its stellar magnitude varies between $-4\cdot0$ and $-4\cdot3$, and the visible portion of the illuminated disk between 0·08 and 0·34. It is interesting to notice that the planet becomes brighter in spite of its increasing distance from the earth—from 28 to 45 million miles during the month—the increase in brightness arising from the large increase in the visible portion of the illuminated disk. Mars is an evening star, setting about 22h. 15m. during December: stellar magnitude 0·5–0·8, and the visible portion of the illuminated disk 0·862–0·881. The decrease in brightness, in spite of the increase in the visible portion of the illuminated disk, is due to the increase in the planet's distance from the earth from 112 to 132 million miles during the month; it moves from a little north of ι Aquarii early in the month close to the constellation Pisces on December 21. Jupiter, an evening star, rises at 19h. 40m., 18h. 40m. and 17h. 25m. on December 1, 15 and 31, respectively. Its stellar magnitude, $-2\cdot1$ during most of the month, becomes $-2\cdot2$ towards the end, the increase in brightness being due to the planet's decrease in distance from the earth by 23 million miles; careful observation will show the westward movement in Cancer. Saturn, a morning star, rises at 5h. 30m., 4h. 45m. and 3h. 50m. on December 1, 15 and 31, respectively; it has a slow movement from α towards ν Librae, and this can be easily detected by careful observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 11d. 05h. 19·4m., μ Gemi. (*D*); Dec. 11d. 06h. 0·8m., μ Gemi. (*R*); Dec. 12d. 04h. 16·9m., 56 Gemi. (*R*). (*D* and *R* refer to disappearance and reappearance, respectively.) The meteor shower during December 11–13, the Geminids, which attains its maximum about this time, will not be easily observed owing to moonlight. An annular eclipse of the moon on December 25, invisible at Greenwich, will be visible in South Africa and the southern Indian Ocean. Winter solstice occurs on Dec. 22d. 09h.

Announcements

MR. J. R. WHINFIELD, a member of the Terylene Council of Imperial Chemical Industries, Ltd., at Harrogate, has been made an Honorary Fellow of the Textile Institute, in recognition of his outstanding contribution to the science and technology of man-made fibres. Mr. Whinfield is the twelfth recipient of this award.

THE American Documentation Institute has presented a scroll of appreciation to Dr. Atherton Seidell, one of the founders of the Institute, for his work in establishing microfilm services, which have been of particular value to documentation centres and libraries in general. Dr. Seidell founded in 1941 the *Current List of Medical Literature*. He is also noted for his development of an inexpensive viewer for short strips of microfilm and a microfilm projector.

THE Second Middleton Memorial Lecture will be given by Prof. K. Mather, professor of genetics in the University of Birmingham and director of the Agricultural Research Council's Unit of Biometrical Genetics, in the Senate House, University of London, on December 9, at 5.30 p.m. He will speak on "Fundamental Science in Agricultural Research, with Special Reference to the Development of Genetics". Admission is free, without ticket.

AN exhibition of scientific books and periodicals from The Netherlands will be opened at the Science Library, Imperial Institute Road, London, S.W.7, on December 1. The exhibition will remain open until December 22.

THE fifth annual meeting of the Société de Chimie Physique will be held in Paris during May 31–June 3, 1955, when the chemical actions of ionizing radiations on liquids will be discussed. Those wishing to read papers must send in the titles by December 15, 1954, and the full text by February 28, 1955, so that the papers can be printed in advance of the meeting. Further information can be obtained from the secretary-general of the Society, Prof. G. Emschwiller, École Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris 5^e.

THE Meldola Medal, which is the gift of the Society of Maccabaeans and is normally awarded annually, is being offered for early award in 1955 to the chemist who, being a British subject and less than thirty years old on December 31, 1954, shows the most promise, as indicated by published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

SIR GEORGE BEILBY Memorial awards, which are considered at intervals by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. The administrators request that their attention be directed, not later than December 31, to outstanding work of the nature indicated. All communications should be addressed to the Convenor of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

SPECIAL posts have again been created this year in the Scientific Civil Service under provisions included in the White Paper (Cmd. 6679; 1945) designed to provide for the promotion of individual research workers of exceptional merit. The promotions are effective from July 1.

Deputy Chief Scientific Officers

Dr. S. K. Kon, who has been head of the Nutrition Department of the National Institute for Research in Dairying since 1937, has made extensive researches which have led him to be recognized both nationally and internationally as a leading authority in nutritional science. In particular, his work has covered the nutritive value of milk and milk products, methods of assay of vitamins (especially vitamin A and the B vitamins) and the synthesis of vitamins in the animal organism, and this and studies in several other fields of nutritional biochemistry have provided both new knowledge and valuable practical applications. He has been editor of the *Proceedings of the Nutrition Society* since the inception of that Society in 1944 and of the *British Journal of Nutrition* from its beginnings in 1947.

Dr. H. R. C. Pratt studied chemistry at Birkbeck College, London, and, later on, chemical engineering, his Ph.D. thesis in 1951 on "Studies in Azeotropic Distillation" being based on work done during the Second World War. He held research and development appointments in industry before joining the Atomic Energy Research Establishment, Harwell, in 1949 as leader of a group investigating chemical engineering operations of special interest to atomic energy. Dr. Pratt has himself made a significant contribution to liquid–liquid extraction and for one of his published papers he was awarded, with R. Murdoch, the Moulton Medal of the Institution of Chemical Engineers last year. He is also interested in the methods of production of heavy water, and his developments in water distillation techniques have brought this method into the realm of practical economics.

Senior Principal Scientific Officers

Dr. H. A. H. Boot graduated from the University of Birmingham in 1938 and later, during the Second World War, was co-inventor, with Dr. J. T. Randall, of the cavity magnetron which established and maintained for the Allies so great an advantage in the field of radar. During 1945–48 Dr. Boot held a senior Nuffield research fellowship at Birmingham and was engaged on the design of the cyclotron. He then joined the Royal Naval Scientific Service and since then has been mainly occupied at the Services Electronics Research Laboratory in research, development and design for the manufacture of advanced types of magnetron of very high power.

Mr. K. V. Diprose entered the Royal Aircraft Establishment in 1935 on leaving Cambridge, where he had read for the Mechanical Sciences Tripos, being awarded the J. B. Seeley Prize in Aeronautics. He has displayed outstanding scientific and design ability in several fields, including the instrumentation of wind tunnels, the aerodynamics of airscrews, early jet-engine research, analogue computing instruments and data-reduction schemes for wind tunnels. He is a leading British authority on analogue computers, and the present general recognition of the importance of a co-ordinated approach to the whole problem of the design of experiments, processing of data and computing of results, is due in large measure to his efforts during the past ten years.

Mr. T. M. Fry worked on underwater detection problems for the Admiralty during 1939–45, before proceeding to the University of Cambridge. After graduating in 1947, he joined the Atomic Energy Research Establishment, Harwell, where he investigated changes in the properties of graphite and other solids resulting from exposure to the radiations in nuclear reactors. As well as its importance for the development of nuclear power, this type of work provides a new method for investigating the solid state. Since 1951 he has devoted his attention mainly to a study of the fast-breeder reactor, and in addition, since 1947, he has been associated with Mr. F. T. Bacon's hydrogen–oxygen cell research at Cambridge.

Dr. E. R. R. Holmberg graduated from the University of Cambridge in 1939 and entered Admiralty service the following year. He was appointed to the Mine Design Department and during the next five years played a significant part in solving the many problems involved in ship demagnetization. In 1945 he was transferred to the Admiralty Gunnery Establishment, where his mathematical ability was directed to theoretical studies of missile guidance and control systems. Since 1950 he has been serving in the Department of Operational Research. In 1952 he was elected to the Geophysical Committee of the Royal Astronomical Society and has had a number of papers published in the *Monthly Notices* of the Society in which, as in his defence research work, he has shown a marked originality of outlook and incisiveness of method.

Dr. D. Kuchemann was engaged in aeronautical research at A.V.A. Gottingen with Prof. Betz after obtaining his doctorate at the University of Göttingen in 1936. He gained a considerable reputation there for his work on basic aerofoil theory, wind-tunnel corrections and the aerodynamics of propulsion. He joined the Royal Aircraft Establishment in 1946 in the Wind Tunnels Group, where he has made important contributions to research on swept wings and the flow about high-speed aircraft configurations, both from the theoretical and experimental aspects, which have led to a greatly improved understanding of the fundamentals of high-speed aircraft design.

Mr. S. W. Noble joined the Telecommunications Research Establishment, now the Radar Research Establishment, at Swanage in 1940, after varied industrial experience. He was engaged on research in the radar field until 1944, when he commenced work on advanced circuit research with which his name is now prominently associated. He has made outstanding and distinctive contributions to electronic circuit design, in which field he is an acknowledged leading authority.

Dr. F. Pasquill has been mainly engaged in problems of atmospheric diffusion and turbulence near the surface of the earth, since his appointment to the Meteorological Office in 1937. His association with the Chemical Defence Experimental Establishment, Porton, during his early years of service, was marked by a valuable experimental study of evaporation from a plane-free liquid surface into a turbulent air stream. Later, in charge of a small Meteorological Office group attached to the School of Agriculture, Cambridge, to study micro-meteorological problems with application to agriculture, he devised a method and equipment for the investigation (by the use of accurate vertical profile measurements of humidity and temperature) of the exchange of heat and water vapour between a grass-covered surface and the air immediately above. This led to a successful evaluation of evaporation from the surface. The aerodynamic drag of grassland was also investigated. Dr. Pasquill is now engaged in research on atmospheric diffusion processes on a more extended scale.

DR. J. M. SHEWAN studied chemistry in the University of Aberdeen, being awarded a medal in physical chemistry in 1932, and gained his Ph.D. for work at the Macaulay Soil Research Institute. He then entered on a career in marine bacteriology and biochemistry at the Torry Research Station, where his work has included the only really detailed study of the strict anaerobes of fish, a survey of the aerobic microflora of gadoids, and the discovery that the microflora of fish varies considerably with species, locality, time of year and method of catching. In the preservation of fish he has shown how the microflora changes in composition, as spoilage proceeds, and he has made pioneering studies of the effect of phenolic substances in wood smoke in the curing of smoked fish. He is at present engaged in unravelling the taxonomic confusion which exists in the field of marine bacteriology, and on an extensive study of the extractives of fish which are the substances first attacked by bacteria. In connexion with the preservation of fish on ice, he has developed a sensory scoring system which, as a research tool, has become of great use in defining and controlling standards of freshness.

MR. G. W. C. TAYLOR joined the Research Department, Woolwich Arsenal, in 1929, transferring to the staff of the Explosives Research and Development Establishment, Waltham Abbey, on its formation in 1945. His early experience was in the chemical analysis and testing of explosives, which was followed by photographic and radiological investigations. Since 1939 he has been concerned with a special class of explosives, carrying his researches from the laboratory stage to full-scale manufacture, and this has led to investigations on the control of crystallization which have given rise to practical results of the greatest value. Much of his work has been of a pioneering nature in a region hitherto unexplored because of the formidable hazards and difficulties involved.

MR. J. H. WILKINSON graduated in mathematics from the University of Cambridge and then worked on ballistics in the Ministry of Supply for some six years before joining, in 1946, the Mathematics Division of the National Physical Laboratory, Teddington. He has worked on the design and exploitation of high-speed automatic electronic digital computers, and has been very closely associated with the theoretical design, electronics and practical use of the Laboratory's machine, the Pilot ACE. In particular, he has made a very thorough study of practical methods of calculating latent roots and vectors of matrices, which are of wide application, especially in problems of aircraft design.

DR. H. G. WOLFHARD studied physics at the University of Göttingen, gaining his doctorate in 1938, and later joined L.F.A. Volkenrode, where he worked until 1946, taking charge of a group on combustion towards the end of this period. He joined the Royal Aircraft Establishment in the same year, where he has worked in the Chemistry Department and, more recently, in the Rocket Propulsion Department in charge of the combustion section. During 1946–52 he worked part-time with Dr. A. G. Gaydon at the Imperial College of Science and Technology, London. He has been outstandingly successful in the application of spectroscopy to the study of flames and combustion processes.

WORLD POWER RESOURCES

IN his presidential address given before the Institution of Electrical Engineers on October 7, Mr. J. Eccles was concerned mainly with the power resources of the world. He sketched in outline the origins of the earth's main resources of fuel, first tracing the exceedingly gradual evolution of man's use of mechanical power up to the opening of the industrial era. He then showed that, with the enormously accelerated rate of consumption of fuel which has developed during the past two hundred and fifty years, a further period of several hundred years will see the substantial exhaustion of the world's resources of coal and oil; indeed, the supply of oil fuel may well become critical during the lifetime of the present rising generation.

Dealing with other available forms of energy, apart from nuclear energy, Mr. Eccles first considered water power and tidal power. Some forty per cent of the world total of inland water power is located in Africa, and this total without, of course, regard to location, could supply at least three-quarters of the world's present energy requirements. He remarked that one of the largest and most spectacular sources of water power lies at the western end of the Mediterranean, for this inland sea loses water through evaporation at a rate exceeding its river inflow, so that water is constantly flowing through the Straits of Gibraltar and, to a lesser extent, through the Dardanelles. If both straits were dammed, the level of the Mediterranean would gradually fall, and rough calculation shows that, having established a differential of 70 ft., 12 million kW. (which is 75 per cent of the present demand for electricity in Great Britain) could be developed from suitable turbines operated by inflow from the Atlantic.

Summing up the position in regard to what may be termed the conventional sources of energy, Mr. Eccles said that, when coal and oil are exhausted, and in the absence of a successful outcome of the attempts to harness the nuclear fission or fusion process for industrial purposes, it should be possible to muster man's present-day energy requirements from all the known sources, but that energy transmission or population transportation would present enormous technical and social problems.

If the present pattern of civilization is to endure, the problems of nuclear energy must be mastered. It has been established, said Mr. Eccles, that, on the basis of present costs, an expenditure of about

£50 per pound of pure metal would be sufficient to mine and to refine sufficient uranium to provide the world's present energy requirements for some 1,500 years, or on a similar basis, an expenditure of £100 per pound could furnish these requirements for 8,500 years. The abundance of hydrogen in the earth's crust could provide almost unlimited power from the hydrogen–helium reaction, but the industrial application of this must await the discovery of means of enabling the reaction to proceed at a lower sustained temperature.

Because of the possibility of supplying the world demand for power by means of nuclear fission, it is now sometimes argued that all development effort should be applied in that direction and the development of other sources abandoned. Mr. Eccles, however, did not hold this view: when there is, for example, "a local surplus of water power, the energy could be used to purify fissile material so as to provide power in lands where the alternatives are insufficient. Since fissile material, even in its natural state, is easily transportable, such packaged fuel might solve the power transmission problem".

Finally, Mr. Eccles referred to the minute fraction of existence of the human race within which this tremendous demand for power has developed, and he emphasized the paramount necessity to match, by means of continued technological advancement, the world's progressive demands for the basic necessities of food and fuel. "In sum, therefore, man having evolved during a million years has, over the past 250 years, developed a mode of living which is unique in human history. This achievement has thus lasted for only 0·025 per cent of his sojourn here and already it has made great demand on the energy resources of our planet. Unless he is able and willing to match his technology to the unfolding needs of the situation, he has no prescriptive right to a continuance of this latest civilization, and the history of civilizations discloses that discontinuity—decay and rebirth—is the normal method by which successive stages have been reached. However, to-day man is equipped with a knowledge of natural laws (science) and an ability to harness these laws to his needs (engineering) that were absent in all previous civilizations, and there is good reason for thinking that the present mode of living can be greatly prolonged if he will but use this knowledge and ability aright."

AIRCRAFT ELECTRICAL SYSTEMS

A VACATION school on "Aircraft Electrical Systems" was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during September 20–24 and was attended by nearly seventy engineers drawn from electrical and aircraft industries, research organizations and the College of Aeronautics, Cranfield. The purpose of the school was to bring out the scientific principles underlying the design and application of all forms of equipment used in aircraft electrical systems in relation to both present and future requirements. The course was very successful, particularly since those who participated contributed a large part to the discussions. The conclusions drawn were that more co-operation is needed between design and installation engineers and that, notwithstanding the special conditions of aircraft work, much can be learned from ordinary industrial practice; educational work was also stressed, particularly the part being played by Imperial College.

In his opening address, Sir Frederick Handley Page emphasized the importance of fundamental research in that it often leads ultimately to useful practical results. After directing attention to electrical and aeronautical engineering as the two newest branches of the art, he referred to the interesting problems which have arisen as they have progressively come together, and to the need for closer liaison between members of these two branches. In an introductory survey, D. F. Welch (British Thomson-Houston Co., Coventry) outlined the problems facing the aircraft electrical engineer. Since 1940 power requirements have risen from 1 kW. to 200 kW. for large aircraft, and with these powers the potentially destructive power of a fault has focused fresh attention on circuit protection. The avoidance of any breakdown is doubly important in that the introduction of power-operated controls and the electrical operation of essential flying instruments mean that the safety of an aircraft is now dependent on the maintenance of the electrical power supply. M. Hancock (Royal Aircraft Establishment, Farnborough), speaking on environmental conditions and functional requirements, pointed out that these lead to acute differences between aircraft and ground-based electrical engineering practice: operation at high altitude increases arcing problems in switchgear and decreases machine cooling, while the wide temperature-range over which the equipment must function increases insulation and lubrication problems. Mechanical problems, vibration, weight and bulk considerations are all factors with special problems in relation to aircraft. In the third lecture, J. H. Rea (Rotax, Ltd.) dealt with power systems, and discussed the factors which determine the choice of system, methods of load analysis which distinguish between 'safety' and 'comfort' loads, and methods of weight analysis which lead to the lightest installation capable of supplying the load. The place of the battery, with particular reference to the problem of engine starting, was also considered.

The more specialized lectures given at the course commenced with that of R. F. Sims (Farnborough), who first discussed the physical causes of the abnormal brushwear experienced at high altitudes, outlining remedial measures such as the use of special materials or the control of the moisture content of the machine-cooling air, and then in the second part of his lecture considered vibration problems. After a general survey of cooling problems, Dr. C. S. Hudson (Farnborough) reviewed the effects of radiation, natural and forced convection, and conduction, and discussed methods of calculating the pressure head required in a cooling system. The topic of d.c. machines was covered in the next lecture by B. Adkins (Imperial College, London), who showed how machines must be compactly constructed in order to obtain the output required with minimum weight. He also pointed out how the insulation, the methods of connecting and securing the windings, and the grease used for lubrication, all set a limit to the permissible temperature rise.

On September 22 the members of the course visited the works of Vickers-Armstrong, Ltd., at Weybridge, including the company's Electrical Laboratory and the Research Department, and the seventh lecture, on electrical installation engineering, by H. Zeffert (Vickers-Armstrong), was partly a commentary on the visit, for Dr. Zeffert described and demonstrated many types of plugs, sockets, terminal blocks and cables. The main run of lectures was continued on the next day with one on a.c. machines by W. Philipp (Rotax, Ltd.), who discussed the problems of alternator design, both for the long speed-range machines now in use and for the constant-speed machines which will be required when a constant-speed drive, taken either from an engine-driven hydraulic gear or from a separate turbine, becomes available; he also spoke on conversion equipment, using invertors, rotary transformer or motor-alternators, and on induction motors. From machines the programme of the course turned to system operation and protection, in which K. J. Payne (British Thomson-Houston Co., Coventry) considered power system maintenance, servicing the system or correcting faults being, of course, impossible during actual operational use. After a general discussion on the limits of operation of the components of a typical system and their effects on system performance, and also protection techniques, Mr. Payne described the transient behaviour of inverters and motors and the effects of electrical and mechanical shock loads. The theme of A. Grieve's (British Thomson-Houston Co., Coventry) lecture was switchgear, the factors involved in the design of switches, and the limitations imposed on performance by the fundamental properties of the materials and of the environment in which they are to operate; in discussing the characteristics required of a circuit breaker, he said that protection against most forms of fault can be incorporated in any unit of switchgear.

In the concluding survey, in which he discussed future trends, S. F. Follett (Ministry of Supply) stated that future aircraft will fly faster and higher, so that environmental changes will most influence future practice; he felt that the need for reliability should be stressed, and that reliability should be proved on life-tests which approximate to aircraft conditions and allow for the effect of vibration.

MARINE BIOLOGY IN LATIN AMERICA

During September 15–17 a group of Latin American specialists in marine biology met in Concepción (Chile) in order to study the possibility of establishing an international network of marine biological laboratories in Latin America and other ways of facilitating the collaboration in this field among the Latin American countries. The meeting was convoked by the Unesco Science Co-operation Office for Latin America and was a sequel to the recommendations for setting up international and regional laboratories made at a meeting held in Montevideo in 1952 upon the initiative of the Unesco Office (see *Nature*, 170, 605; 1952). The scientists attending the meeting were from the Argentine, Brazil, Chile, Cuba, Mexico, Peru, Venezuela and Uruguay. The Regional Office in Santiago de Chile of the United Nations Food and Agriculture Organization collaborated in arranging the meeting.

After studying the present situation of research in marine biology in Latin America and its future possibilities, the delegates entered on an extensive discussion about the possibilities and ways of establishing an international network of laboratories. It was unanimously decided to create immediately under the auspices of the Unesco Science Co-operation Office a Latin American Committee in order to co-ordinate and facilitate the research work in marine biology. The Committee would remain in office until a permanent organization had been set up. The meeting requested the Unesco Office to prepare a draft convention for an international network of laboratories and convoke a meeting of official delegates in order to establish the corresponding organization.

The meeting also studied what other steps could be taken immediately pending the realization of the more far-reaching recommendations, in order to promote research in marine biology, and advised the Unesco Office that two training-courses on the methodology of marine biology research and a symposium on plankton should be organized in 1955. It was also recommended that the *Marine Biology Journal*, produced by the Montemar Station in Chile, should be widened in scope with a Latin American editorial board.

The Brazilian representatives to the meeting have been duly authorized by the Governor of the State of São Paulo to put at the disposal of the Unesco Science Co-operation Office for international research work the complete network of marine biological laboratories and stations and research vessels of the State of São Paulo. This offer will make it possible to initiate shortly international research and training programmes in marine biology under the auspices of the Unesco Office.

UNITED NATIONS ORGANIZATION

ANNUAL REPORT OF THE SECRETARY-GENERAL FOR 1953–54

The ninth annual report of the Secretary-General of the United Nations to the Member States on the work of the Organization during July 1, 1953–June 30, 1954* is not an encouraging document. It gives a picture of diversity of effort which closely matches that to be found in the reports on the work of the League of Nations, and, as with that organization, it is in the technical fields that progress is most marked. Elsewhere, and above all in the political field, the gap between purpose and achievement is wide; nor does it appear that all Member States are concerned to advance the declared purposes of the United Nations. The Secretary-General comments on the need for a careful balance in the development of regional arrangements outside the framework of the United Nations. Choice of such arrangements for the maintenance of peace should not be permitted to cast doubt on the ultimate responsibility of the United Nations, or to impair the right of a Member State to a hearing under the Charter.

Referring to the lack of progress in disarmament, the Secretary-General comments on the potentialities of the development of an international partnership, open to all nations, in the use of atomic energy for peaceful purposes, especially for the economically under-developed areas of the world. Apart from recording President Eisenhower's statement of December 8, 1953, the report makes no other reference to the use of atomic energy for peaceful purposes. The report also puts on record the opinion of the United Nations Commission on the racial situation in the Union of South Africa that the doctrine of racial superiority, on which the apartheid policy is based, is scientifically false, extremely dangerous to internal peace and international relations, and contrary to the dignity and worth of the human person; but the report is so careful to give both sides of the case, and to avoid giving offence, that it presents a picture of frustration which, while it may exceed the reality, completely bewilders the ordinary reader.

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* United Nations. Annual Report of the Secretary-General on the Work of the Organization, 1 July 1953–30 June 1954. (General Assembly—Official Records: Ninth Session. Supplement No. 1 (A/2663).) Pp. xv+120. (New York: United Nations; London: H.M.S.O., 1954.) 1.25 dollars; 9s.; 5 Swiss francs.

It is a relief to turn to the chapters of the report which deal with economic and social questions where, by and large, the United Nations is carrying on so much that was begun under the auspices of the League of Nations. In the field of narcotic drugs, 6-methyl-Δ-6-deoxymorphine and its salts and five synthetic narcotic drugs have been brought under control, and a new list of factories manufacturing narcotics has been completed on the basis of information supplied by governments and will be published shortly. A programme of studies on the cultivation and wild growth of the cannabis (Indian hemp) plant, the production, licit and illicit distribution and consumption of drugs from it and their control has been approved, and papers on synthetic substances with morphine-like effects and on addiction-producing effects in relation to chemical structure have been prepared, while a programme of scientific research on opium continues to be pursued.

On the Expanded Programme of Technical Assistance for the economic development of under-developed countries, the report adds little to recent reports (see *Nature*, November 20, p. 960). Reference is made to the easing of financial management which resulted from the holding of the pledging conference before the beginning of the year, but financial resources are still inadequate to meet all the requests received. Of the 23·5 million dollars earmarked for expenditure in 1953, 18·1 per cent was for health services and 7·7 per cent for educational purposes, including research. For 1954, 75 per cent of total resources, excluding carry-overs, will be automatically available for allocation to the participating organizations, but the system of allocation for future years is under review. Commenting on the regular programme of technical assistance, the report notes that technical assistance has become an accepted means of international co-operation and has been instrumental in changing the climate of opinion in international affairs. More intensive use of its possibilities has been assisted by a better-defined conception of technical assistance in most recipient countries, and in a measure the success of technical assistance projects is indicated by the increase in their average duration. In discussing the development of public understanding generally, the Secretary-General suggests that the Technical Assistance Programme has been an important factor in the growth of public understanding at least of the non-political work of the United Nations during the past twelve months. It is clear that much remains to be done, though the means by which such educational work is best effected calls for further discussion than is possible in the present report. There are some sound comments on the role of the Secretariat; but while the Secretary-General rightly insists that there are limits to the work which can be entrusted efficiently and effectively to a Secretariat of any given size, and even to the amount of work which can usefully be undertaken by an international organization not circumscribed by such limits, his references to the question of staff loyalty and independence on which the smooth functioning of an international civil service fundamentally depends are purely factual and fail to bring out what is at stake.

ORIGINS OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

In the 1954 Year Book of the International Council of Scientific Unions*, the secretary-general, Prof. A. V. Hill, contributes a valuable account of the origins of the Council. In the latter part of the nineteenth century a number of international scientific organizations were started. Some were to advance science by direct co-operation. Others were to facilitate personal acquaintance and interchange of opinion; international scientific congresses held periodically are in this class. Others aimed at establishing uniformity of standards of measurement, and of these the earliest was the Bureau International des Poids et Mesures, which was established at Sèvres in 1873 as the outcome of an international commission set up in 1869 for the construction of metric standards.

For some years before 1898 the Academies of Munich and Vienna, with the Royal Societies of Gottingen and Leipzig, had met annually as an association to discuss matters of common interest. In 1898 the meeting was to be held in Göttingen, and the Royal Society of Gottingen invited the Royal Society of London to take part; the latter agreed to join the association if its scope was so extended as to assume a fully international character. In 1918 the Royal Society, the Academy of Sciences in France and the National Academy of Sciences in the United States discussed informally the future organization of scientific undertakings which had been carried on before the First World War by international co-operation; ultimately the academies of all the Allied countries were invited to send representatives to a conference which took place in London in October 1918. This was followed by a meeting in Paris a month later, when an executive committee was appointed to draft the statutes for an International Research Council which, with a number of affiliated International Unions, might deal with matters of international scientific interest. A General Assembly of this Council was held at Brussels in July 1919, when the statutes of the Council were approved. International Unions for Astronomy, Geodesy and Geophysics, Chemistry and (shortly after) Mathematics were formed: and to these were later added Scientific Radio, Physics, Geography, Biological Sciences, Crystallography, Theoretical and Applied Mechanics, History of Science, and Mathematics (reconstituted in 1952).

At the start, the International Research Council retained control over the Unions and only allowed countries to join the Unions which already adhered to the International Research Council. Differences of opinion about this and other matters led to a reorganization in 1931, by which the Council was transformed into the International Council of Scientific Unions. Under the new arrangement the Unions became autonomous within the framework of the new Council, the General Assembly was permitted to meet elsewhere than in Brussels, and adherence of a country to any Union no longer required adherence to the Council.

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* The Year Book of the International Council of Scientific Unions, 1954. Pp. ii+82. (London: International Council of Scientific Unions, c/o Royal Society, 1954.)

In 1946 the United Nations Educational, Scientific and Cultural Organization (Unesco) was formed and a formal and mutual draft agreement between Unesco and the International Council of Scientific Unions was approved by the Council in 1946 at its first General Assembly after the Second World War. This agreement was modified in 1947 and again in 1952. The present agreement is described in the year book of the Council, which also contains details of members of the various councils, statutes and rules, the activities of the Council and the state of its finances.

WEIGHING IN THE LABORATORY

The principles of the design, adjustment, use and testing of good-quality knife-edge balances and weights employed for precise weighing in scientific laboratories forms the subject of the seventh in the series of "Notes on Applied Science" issued by the Department of Scientific Research*. The information given, which is based largely on the experience gained at the National Physical Laboratory, Teddington, in maintaining the standards of mass and in testing weights and balances, should be of great value to those in industry and research who are concerned with precise weighings.

The contents, which are in two parts dealing respectively with knife-edge balances and weights, are much more detailed than in previous numbers of the series and include illustrations of the precision 1-kgm. balance at the National Physical Laboratory which is used for the comparison of national standards of mass, of the Imperial Standard Pound and the British National Copy of the International Kilogramme, and several tables and three appendixes. In Part 1 the chief features—functioning and adjustment of the simple equal-arm balance—are outlined clearly and fully with particular emphasis on the essential practical requirements. Various types of balance are discussed, and comparative information is summarized in two useful tables. The methods and technique of weighing are described, and net buoyancy corrections to obtain mass from weighings in air, and values of the density of air for the ranges 5–30° C. and 600–800 mm. of mercury are tabulated. A clear distinction is drawn between the conceptions of sensitivity and accuracy of performance of a balance, and a guide is given to the varieties of balances readily available.

In Part 2 the suitability of the various materials used for the construction of weights is considered first. Plain polished brass is unsatisfactory; and, of the coating materials, lacquer is too hygroscopic, uncoated nickel plating fogs and gold plating is often porous and is also liable to loss of weight due to wear. The construction, adjustment and tolerances are discussed next, followed by a brief description of the tests and methods of verification of weights carried out at the National Physical Laboratory, which will be of considerable interest to those who are contemplating sending weights for test at the Laboratory or who intend to carry out their own tests.

In the three appendixes, the simple fundamental analysis of the equal-arm undamped knife-edge balance substantially as given in Glazebrook's "Dictionary of Applied Physics", the mathematical discussion of the motion of the damped beam, and the effect of air-buoyancy on a single-pan balance are given separate treatment.

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* National Physical Laboratory Notes on Applied Science. No 7: Balances, Weights and Precise Laboratory Weighing. Pp. iv+42+plates. (London: H.M.S.O. 1954.) 2s. net.

AGES OF URANINITES BY A NEW METHOD

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In a previous communication in *Nature*[1], I suggested that the generation by radioactive decay of smaller atoms of tetravalent lead within the crystal lattice of uraninites caused a shrinkage in the unit cell proportionate to time; some preliminary results were given in a table. Using artificial uranium oxide (UO_2) as an end-point to denote zero time, four results clearly supported the thesis; but three others, agreeing well among themselves, were apparently too high and in conflict. Further work has indicated an obvious solution, namely, that there are, in fact, two different types of uraninites involved: those agreeing with the thesis I call α-uraninites and are considered normal; those which are apparently anomalous are called γ-uraninites.

The pitchblendes are classified as β-uraninites. As their spectra are usually too poor for accurate measurement, they are for the moment disregarded for age determination. Present work indicates that they are abnormally high in oxygen; this excess can be removed by heating in hydrogen to give cube-edges comparable with α-uraninites for purposes of age determinations; these results will be shortly announced.

The characteristic feature of γ-uraninites is that their cube-edges are reduced on heating in air to correspond to that of an α-type analogue, whereas α-uraninites upon similar treatment disintegrate to give an X-ray pattern of U_3O_8. This phenomenon was first detected in two analysed samples, previously given as from Namaqualand, but more accurately, from the Gordonia district, South Africa[1]. In presenting the data, a thoria correction—also discussed previously—has to be applied, and this is −0·0013 A. for each per cent ThO_2 when $ThO_2 + UO_2$ total 100 per cent—this suffices for a first approximation. The thoria content differs slightly in the two samples, which gave the following results:

	Gordonia	
	(Holmes) γ-type	(Mountain) α-type
Untreated	5·485 A.	5·444 A.
Corrected for ThO_2	5·462 A.	5·428 A.
Heated	5·450 A.	(disintegrates)
Corrected for ThO_2	5·427 A.	

The agreement now in the cube-edges derived from Holmes's heated sample, namely, 5·427 A., and Mountain's untreated one, which is 5·428 A., is remarkable—but not unique: similar results have been encountered from Brazil and Norway:

Boqueirao, Brazil (*ex* Harvard Coll.); untreated	5·481 A. (γ-type)
As above after calcination	5·449 A.
Same locality (*ex* Marble); untreated	5·445 A. (α-type)
Moss, Norway; untreated	5·488 A. (γ-type)
As above after calcination	5·449 A.
Saterdalen, Norway; untreated	5·450 A. (α-type)

The results agree within the limits of error in the determinations.

When γ-types are weathered, commercial nitrogen, which contains a little oxygen, serves to reduce the cube-edge and to differentiate between α- and γ-types; β-types are recognized by an increase in cube-edge when heated in hydrogen. These manipulations are necessary when the chemical differences of the three types of uraninites become apparent.

It is clear that each of the three types forms its own series showing shrinkage with time. The X-ray examinations of numerous uraninites, before and after heating, support this supposition; but the lack of accurate age determinations is a handicap in checking such results. In developing the present X-ray method, it is found preferable in practice to use results from heated γ-uraninites together with untreated α-uraninites, as generally the α-type is concentrated in the lower ages.

This classification of uraninites into three types can be deduced from certain laboratory studies of the uranium oxides, although total agreement among investigators may not have been reached. The relevant data have been largely assembled by Katz and Rabinowitch in their comprehensive text-book[2]. In dealing with the range $UO_{1\cdot75-2\cdot3}$, Zachariasen[3], Jolibois[4] and Alberman and Anderson[5] have made valuable contributions.

Jolibois provides evidence for the possible compound $UO_{2\cdot33}$ which he "... interpreted ... as a new uranium oxide U_3O_7 (or $UO_3.2UO_2$)"[2], and Alberman and Anderson prepared "... two well defined cubic phases, viz. UO_2 and a phase of composition close to $UO_{2\cdot3}$ ('β-UO_2 phase')"; further oxygenation gave them a tetragonal phase. At the other extreme, "Zachariasen found a homogeneous face-centered cubic phase with a composition of approximately $UO_{1\cdot75}$ (or U_4O_7, tetrauranium heptoxide) ... U_4O_7 may be a separate compound analogous to Th_4S_7"[2]. There is therefore considerable evidence for three oxides of uranium in the range discussed here, and these three are characterized by a fluorite structure with different parameters, namely:

$UO_{1\cdot75}$ (possibly U_4O_7)	5·488 A.
UO_2	5·470 A.
$UO_{2\cdot33}$ (possibly U_3O_7)	5·440 A.

(A confusion of A. with kX-units seems to exist in the data presented by Katz and Rabinowitch.)

Uraninites are thought to fall in the range given above, and the analogy in the laboratory is suggested to account for the threefold classification of the uraninites in this way:

γ-uraninites correspond to U_4O_7 ('γ-UO_2' ?)
α-uraninites correspond to UO_2
β-uraninites correspond to U_3O_7 ('β-UO_2').

With this classification and the thesis of tetravalent lead generation, a fine order can be brought into the apparently chaotic data on cube-edges. My investigations over a period of years on uraninites support this classification in several respects. All uraninites, after allowance for thoria, have cube-edges less than 5·488 A., and this indicates that no uraninite lies in the range $UO_{1-1\cdot75}$—where also no laboratory product exists. Three separate age-series can be recognized corresponding to the three oxides given above, using their cube-edges as criteria; and in these all α-uraninites, and all but possibly one β-uraninite, have cube-edges less than 5·470 A. and 5·440 A. respectively. As suggested in the classification, γ-uraninites require oxidation, whereas β-uraninites require reduction in order to compare their cube-edges directly with those of α-types.

Differential thermal analysis evidence was obtained upon my suggestion: an α-uraninite (Rhokana Mine) differed from a γ-uraninite (Gordonia). The latter showed a gentle exothermic curve[6] which is in harmony with oxidation of $UO_{1\cdot75}$ to UO_2.

X-ray studies of thorianites are also illuminating, as here no hexavalent state of thorium can contribute to the shrinkage of the unit cell. All thorianites belong to the γ-type and therefore suggest, in analogy to U_4O_7, the oxide Th_4O_7. Although this oxide is apparently not yet known, Th_4S_7 has been prepared and suggests its possibility. In that event thorianites may well be regarded as the equivalent of Th_4O_7 rather than ThO_2.

The amazing coincidence that three compounds closely related chemically should at the same time yield almost identical X-ray patterns has prevented the recognition of the close parallel in Nature where analogous differences exist in the uraninites. Many chemical and mineralogical differences now find a more ready explanation.

Table 1

Sample	Type	Isotope age	Cube-edge (corrected for thoria)
UO_2	α	Zero	5·470 A.
Connecticut, U.S.A.	α	250 m.y.	5·463 A.
Belgian Congo	α	620 „	5·448 A.
Bisundni, India	α	735 „	5·443 A.
Gaya, India	γ	955 ± 40 m.y.	5·436 A.
Wilberforce, Canada	γ	1,035 „	5·432 A.
Gordonia, S. Africa (Mountain)	α	1,025 „	5·428 A
Gordonia, S. Africa (Holmes)	γ	1,025 „	5·427 A.
Witwatersrand, S. Africa	γ	2,000 „ (ref. 7)	5·400 A

The previously published table has been amended and corrected to give the results in Table 1, to which for the sake of interest and completeness the Witwatersrand value has been added to show the continuation of the shrinkage with time up to 2,000 million years. [Aug. 27.

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[2] Katz, J. J., and Rabinowitch, E., "The Chemistry of Uranium" (1951).

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[4] Jolibois, P., *C.R. Acad. Sci., Paris*, 224, 1393 (1947).

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ESTIMATES OF AGE FOR SOME AFRICAN MINERALS

By Prof. J. T. WILSON, R. M. FARQUHAR, P. GRETENER, R. D. RUSSELL and H. A. SHILLIBEER

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ABOUT two hundred radiogenic and ore leads from Canadian Precambrian minerals and a few potassium-bearing feldspars and micas have been analysed and dated at the University of Toronto. The results have been published[1–3] or are in the press[4]. Intercomparisons are being made with other laboratories[5]. These and other earlier age determinations have led to new interpretations of the structure of the Canadian Shield[6–11].

To test these conclusions for other continents, forty-five African minerals and a few from other continents have been analysed. The results for Africa are given here so that they can be compared with African geology by those acquainted with its details. These ages appear to agree well with those for uranium, thorium and lead minerals from Africa already published by Nier[12,13], Holmes[14–17], Ehrenberg[18] and Geiss[19]; but their relation to the results of Wasserstein[20] and Davidson[21] need further investigation. The rubidium–strontium method of age determination still appears to be in a state of development[22–24].

Our experience suggests that the following general conclusions about age determinations and continental structure may be tenable.

(*a*) We agree with Nier and Holmes that the ages obtained for uranium minerals are the most reliable when concordant ages are obtained by both chemical and isotopic analyses. This is the case for the monazite from Bikita, Southern Rhodesia[17]. Such results and preliminary measurements by R. D. Russell (unpublished results) suggest that radon loss does not appreciably affect age determinations by the lead ratio (^{207}Pb/^{206}Pb) method for old, fresh, uranium minerals, although it can lead to large errors in age determinations for young and altered minerals.

(*b*) Ages calculated from the argon–potassium ratio (^{40}A/^{40}K) for potassium-bearing feldspars and micas are in agreement with those obtained by the above methods. A value of 0·089 for the branching ratio of potassium-40 has been used to calculate the argon–potassium ages. This branching ratio was obtained by using radiogenic argon measurements carried out independently at two different laboratories[25,26].

(*c*) Isotopic analyses of many old lead ores can be used to date them[2,27]. The ages agree with those determined for apparently contemporaneous uranium and thorium minerals. It is considered that this method can be made still more precise, and that the curves used for dating them[27] may be modified. The ages given in Table 1 are therefore tentative.

(*d*) Vein minerals, including galena, give only minimum ages, and, unlike pegmatites, may be very much younger than the surrounding country rocks.

(*e*) All minerals more than about 2 × 10^9 years old have been found to come from areas underlain by rocks of Keewatin and Timiskaming types and by granites cutting them. Such areas are already known and dated in or around Ontario; Yellowknife, North West Territories; Uganda–Kenya; Southern Rhodesia; Transvaal–Swaziland; Sierra Leone; North Belgium Congo; Mysore, India; Kalgoorlie, Australia, and perhaps in the Sveco-Fennidian area. They are regarded as continental nuclei. They have a different type of structure and petrology from later belts, a higher proportion of lavas, and they may have been formed when temperatures in the earth were higher than in more recent times.

(*f*) All Archean-type rocks younger than about 2 × 10^9 years old form belts, each of which is marked by pegmatites formed during a limited range in time; they are markedly gneissic; they do not

Table 1. ISOTOPIC RATIOS AND ESTIMATES OF AGE FOR GALENAS

No.	Tor. No.	Location	Lead-206/Lead-204	Lead-207/Lead-204	Lead-208/Lead-204	Age in 10^6 yr.	Source
1	193	Rosetta Mine, Barberton, S. Africa	12·65	14·27	32·78	2,860 ± 60	1
2	616	Kokosho Mine, N. of Bondo, N. Belg. Congo	12·81	14·39	32·84	2,790 ± 90	2
3	593	Midland Farm, Belingwe, S. Rhodesia	13·62	14·95	33·67	2,450 ± 120	3
4	392	Vein in Kambui schists, Sierra Leone	14·01	15·15	34·27	2,280 ± 120	4
5	592	Leopard Mine, Lower Gwelo, S. Rhodesia	14·02	15·10	34·14	2,270 ± 120	2
6	395	Risks Mine, Kakamega, Kenya	14·05	15·06	34·21	2,220 ± 130	2
7	393	Borderland Mine, Busia, Uganda	14·05	15·10	34·24	2,220 ± 130	3
8	596	Wanderersrest Mine, S. Rhodesia	14·06	14·99	33·68	2,300 ± 120	3
9	500	Vein cutting Masaba Granite, Uganda	14·15	15·21	34·20	2,200 ± 120	5
10	594	Dona West Mine, Umtali, S. Rhodesia	14·40	15·45	34·39	2,100 ± 160	3
11	191	Doornhoek, Marico Distr., S. Africa	15·19	15·60	35·23	1,740 ± 200	1
12	396	Copper Queen Mine, S. Rhodesia	15·39	15·50	35·17	1,660 ± 200	3
13	615	Zambula Mine, Kibali, N.E. Belg. Congo	16·18	15·63	36·06	1,250 ± 200	2
14	188	Stavoren, Groblersdal Dist. S. Africa	16·19	15·53	36·31	1,290 ± 260	1
15	189	Groenvlei, Potgietersrust Dist., S. Africa	16·26	15·89	36·64	1,170 ± 270	1
16	622	Lubi Camp, Kasai, Belgian Congo	17·52	15·86	37·73	*	2
17	621	Near Kamituga, Kivu, E. Belg. Congo	17·78	15·65	37·53	*	2
18	373	Abenab, S.W. Africa	17·96	15·88	38·60	*	6
19	197	Bamba Kilenda, Lower Congo	18·14	15·92	38·48	*	2
20	623	Mt. Homa, Ituri, N.E. Belg. Congo	18·18	15·92	38·33	*	2
21	198	Hapilo, Lower Congo, French Equat. Africa	18·22	15·98	38·54	*	2
22	196	Kengere, S. Katanga, Belg. Congo	18·22	15·91	38·27	*	2
23	394	Broken Hill, N. Rhodesia	18·25	15·97	38·92	*	3
24	624	Mulungwishi, S. Katanga, Belg. Congo	18·26	15·67	38·40	*	2
25	625	Tsumeb Mine, S.W. Africa	18·32	15·88	38·66	*	3
26	617	La Mia, near Matadi, Lower Congo	18·32	15·64	38·01	*	2
27	618	Kasunga, near Muika, N. Katanga, B. Congo	18·35	15·96	38·06	*	2
28	192	E. Geduld Mine, Witwatersrand, S. Africa	18·48	16·22	35·00	Anomalous†	1
29	190	Langlaagte, Pietersburg Dist., S. Africa	18·51	16·33	39·29	*	1
30	195	Kipushi, S. Katanga, Belg. Congo	18·52	15·97	38·28	*	2
31	597	Kitaka Mine, N.W. of Mbarara, Uganda	19·67	16·40	38·51	Anomalous	3
32	619	Up. Fungwe Riv., Centr. Katanga, B. Congo	20·48	16·11	38·87	Anomalous	2
33	163	Witwatersrand, S. Africa (ref. 2)	58·94	24·10	40·19	Anomalous†	7

* These ratios indicate ages younger than 800 million years which cannot at present be precisely dated by this method.

† The lead-208/lead-204 ratio for No. 28 indicates an age between 1,500 and 2,000 million years, but since it appears that radiogenic lead-206 and lead-207 have been added in anomalous amounts to it and in much larger amounts to No. 33, this age cannot be regarded as certain.

Table 2. ISOTOPIC RATIOS AND ESTIMATES OF AGE FOR RADIOGENIC LEADS

No	Tor. No.	Location	Mineral	Measured abundances 204	206	207	208	Radiogenic abundances 206	207	208	207/206 in %	Age in 10⁶ yr.	Source
1	297	Pope Mine, Salisbury, S Rhodesia	Microlite	0·26 ±0·03	73·85	15·19	10·72	70·37	11·35	2·01	16·13 ±0·50	2,510±100	3
2	162	Witwatersrand, S. Africa	Uraninite	0·05 ±0·008	84·78	11·57	3·61	81·83	10·37	1·60	12·67 ±0·50	2,070±100	7
3	497	Voandelaka, Madagascar	Euxenite	0·14 ±0·005	73·95	6·53	19·40	71·52	4·36	14·18	8·08 ±0·12	645± 60	8
4	112	Kalongwe, Belg. Congo	Pitchblende	0·035 ±0·115	93·90	5·76	0·32	93·76	5·62		5·99 ±0·04	615± 20	2
5	543	Sierra Leone, B.W. Africa Lat. 8° 49′ N., Long. 11° 48′ W.	Monazite (alluvial)	0·047 ±0·005	9·24	2·51	88·20	8·59	1·81	86·61	21·0 ±2·0	2,930±200	4

Six other isotopic analyses of radiogenic leads from Shinkolobwe have already been published by us (refs. 2, 32). The range of ages, 612–655 × 10⁶ years, agrees with Nier's results. These age values have been calculated using the constants:
$(^{238}U) = 0·153(7) \times 10^{9}$ yr.$^{-1}$, $(^{235}U) = 0·972(2) \times 10^{9}$ yr.$^{-1}$; $^{238}U/^{235}U = 137·8$.

Table 3. ARGON–POTASSIUM RATIO AND ESTIMATE OF AGE FOR A POTASSIUM-BEARING MINERAL

No.	Toronto No.	Locality	Mineral	Argon-40 / Potassium-40	Br ratio	Age in 10⁶ yr.	Source
1	1,084 (A)	Pope's Claim, Salisbury, S. Rhodesia	Lepidolite	0·269	0·089	2,610	3

SOURCES OF SPECIMENS LISTED IN TABLES 1, 2, AND 3

(1) L. T. Nel, director, Geological Survey of South Africa, Pretoria.
(2) L. Cahen, Musée Royal du Congo Belge, Tervuren, Belgium.
(3) A. M. Macgregor, director (retired), Geological Survey of S. Rhodesia, Salisbury.
(4) N. W. Wilson, Geological Survey of Sierra Leone, Freetown.
(5) K. A. Davies, Uganda Development Corp., Ltd.
(6) J. G. Dennis, Department of Geology, Columbia University, New York.
(7) C. F. Davidson, Geological Survey of Great Britain, London.
(8) Ward's Natural Science Establishment, Rochester, N.Y.

contain a high proportion of lavas and they resemble the cores of young primary mountains. The Mozambique belt is an example (0·5–0·7 × 10⁹ years old). These gneissic provinces and young mountains both form broad belts lying beside or between continental nuclei and become progressively younger at greater distances from the nuclei (for example, Keewatin nucleus, Grenville gneissic belt and Appalachian Mountains of eastern North America).

(*g*) We agree with Leith[28], who recommended that the names Archean and Proterozoic should be used for "types of rocks not time", for we find that the maximum known age of some belts of Archean gneisses is much less than the minimum age of some Proterozoic-type rocks in other places. For example, the Archean-type Grenville belt contains many pegmatites all much younger (0·8–1·1 × 10⁹ years) than the veins which cut the flat-lying Proterozoic-type rocks at Martin Lake, Saskatchewan (1·6 × 10⁹ years). There seem to be similar circumstances in Africa.

(*h*) It is considered that the sialic blocks of the continents have been built entirely in geological time, for even the present rate of extrusion of lava, which has been estimated[29] to be 1 km.³ per year, would have sufficed to build the continents in about 4 × 10⁹ years. The work of MacGregor[30] and of Ewing[31] in the West Indies shows that the lavas there are predominantly acid and are rising from the depths through a basaltic ocean floor to form new additions of continental composition at the earth's surface. This appears to be the commonest type of volcanic process.

We wish to thank the geologists named for supplying the specimens and for their advice and interest. F. Dixey, A. Holmes, J. D. Louw, B. F. J. Schonland and E. S. Willbourn have also been very helpful. Additional samples to yield at least 15 mgm. of lead or consisting of a few hundred grams of potassium-bearing minerals would be welcomed.

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LETTERS TO THE EDITORS

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The Positive Column of High- and Low-Current Arcs

TRANSITIONS from a diffuse to a concentrated positive column have been observed to occur in electrical discharges in hydrogen as the current is increased[1], and a similar transition occurs from the 'low-current' to the 'high-current' carbon arc in air[2a-d]. As a result of a wide investigation of arcs in these and other gases, a purely thermal theory of these transitions has been developed, in contrast to the suggested explanation based on the magnetic pinch effect[2a,3]. A development and numerical integration of the equation of energy balance for the positive column of the arc after the manner of Brinkman[4] has enabled the radial temperature distribution for different central temperatures, and the variation of central temperature with current, to be calculated. In this the characteristic relationship between the temperature and the thermal conductivity, including the contributions of the classical kinetic theory and of the diffusion of ionized and dissociated pairs, which has been studied by a number of authors[2b,4-6], is of paramount importance. The data for nitrogen are illustrated in Fig. 1. The two maxima of the thermal conductivity at about 7,000° K. and 14,000° K. result from the dissociation and ionization of the gas respectively. In diatomic gases, the 'low-current' arc exists with central temperatures corresponding to the positive slope to the first maximum of the thermal conductivity–temperature curve, and the development of the concentrated core of the 'high-current' arc occurs in the region of negative slope, that is, between 7,000° and 9,000° K., for the arc in air or nitrogen.

The two relationships referred to above are both very similar for air and nitrogen at temperatures above 5,500° K., but have only been completely calculated for arcs in nitrogen. Figs. 2 and 3 show that good agreement between theory and observation is obtained in both cases, if Gaydon's value[7] of 9·76 eV. is adopted for the dissociation potential of N_2; the previously accepted value of 7·46 eV. does not show this agreement, and in the past has led to mistaken views as to the nature of the phenomena.

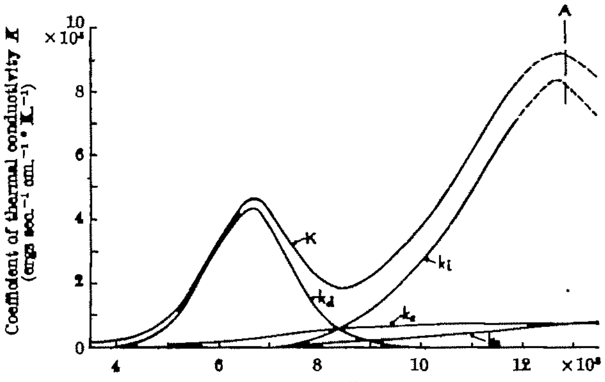

Fig 1. Variation of thermal conductivity of nitrogen, with temperature: k_a, classical conductivity of atoms and molecules; k_e, contribution of free electrons; k_i, contribution from diffusion of ionized pairs; k_d, contribution from diffusion of dissociated pairs; $K = k_a + k_e + k_d + k_i$

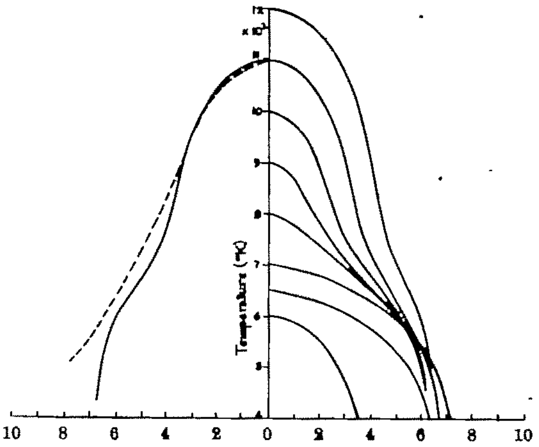

Fig. 2. Radial temperature distribution in arcs: ———, calculated (nitrogen); — — —, experimental, Maecker (air, ref. 8)

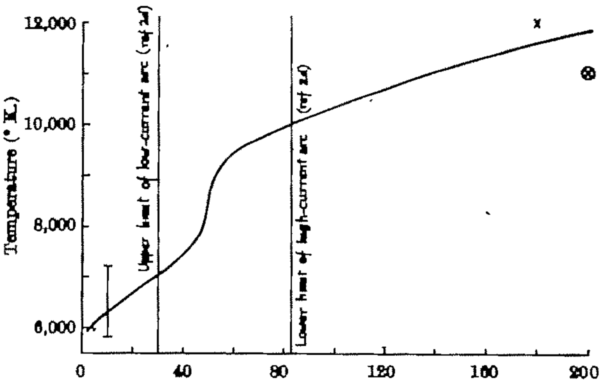

Fig. 3. Variation of central temperature with current for arcs in nitrogen. ×, Ornstein (ref. 9); ⊗, Maecker (ref. 8). Range of observed values for low-current arcs in air is indicated by vertical line on the left

Finkelnburg has suggested[2d] that the upper limit of the 'low-current' arc and the lower limit of the 'high-current' arc are about 7,000° and 10,000° K., respectively, and these values will be seen from Fig. 3 to be in general agreement with the present theory, the transition coinciding with the rapid increase in central temperature between 7,000° and 9,500° K. As regards the current at which the transition occurs, spectroscopic examination of carbon arcs in air in these laboratories showed that at about 50 amp. a narrow central core is formed emitting atomic lines and a continuous background. Though higher values are usually quoted for this transition current for the carbon arc in air, these refer to arcs between cored carbons. The positive column of these arcs contains impurities of low ionization potential which lower the arc temperature, so that the critical transition temperature is only reached at a higher current.

After the transition, the central temperature of the 'high-current' arc increases with current up to the second maximum in the thermal conductivity–temperature curve, which is caused by the increase of thermal conductivity with increase in the fraction of the gas which is ionized; when a temperature of about 14,000° K. is reached a second, inner, core is developed during the succeeding negative slope of the curve, from point *A*, Fig. 1, onwards. It is suggested that this second 'ionization' core will account for the observations by Guillery and Zill and by Beck of the "supercontracted arc stream" referred to by Finkelnburg[2d].

I wish to acknowledge my indebtedness to Dr. C. E. R. Bruce for instigating this study and to F. Goatcher for general assistance throughout, and to the director of the British Electrical and Allied Industries Research Association, Dr. S. Whitehead, for permission to publish this communication.

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Resistance to Flow of Liquids over Solids by Thin Films extending from the Edge of Pools or from Menisci

In an investigation on the rate of spreading of liquids, including lubricants, (*a*) as a pool over horizontal surfaces, (*b*) between approaching and receding parallel flats, and (*c*) through capillaries, an unexpected resistance, associated with thin films extending beyond the boundary of the pools or from the menisci, has been measured in each kind of experiment. The angles of contact of water, benzene, *n*-hexane, etc., were small or zero, especially on surfaces wet with the respective liquids, and the large differences between the observed and calculated rates of movement in capillary ascent and fall could not be explained by the usual contact-angle hypothesis using the horizontal component $\gamma \cos \theta$ instead of γ, where γ is the surface tension and θ the angle of contact. Graphs relating the rate of radial spread over a horizontal surface of a pool of liquid with the height or square of the height of the pool were found to be curvilinear with an intercept on the force axis[1]. Similarly, a graph relating the rate of movement of an index of liquid in a precision capillary tube and the force acting was found to be curvilinear even with a liquid such as *n*-heptane[2]. In Fig. 1 is shown such a graph for benzene in a scrupulously clean dry tube. The dotted-line portion of the graph was for slow movement which was non-Newtonian, the index of benzene ascending a tilted tube (indicated on the graph by a negative force) or passing along a horizontal tube spontaneously. When the tube was tilted down slightly from the horizontal, the rate of movement for small forces remained non-Newtonian and was reversible, the index recoiling when the tube was placed horizontally after movement. More regular movement occurred with forces greater than three dynes, but the rate was considerably less than that calculated from Poiseuille's equation of flow. The predicted rate corrected for flow reversal at the menisci is shown by the broken line.

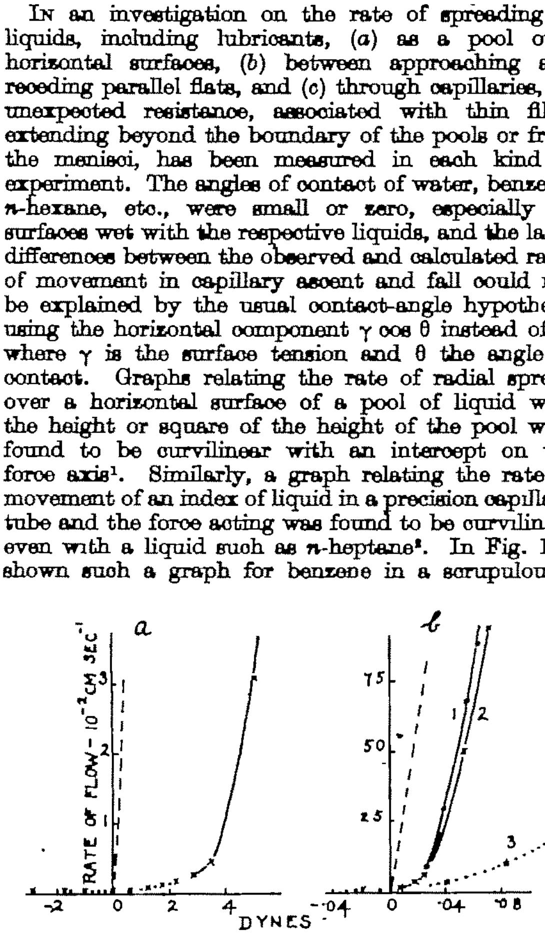

Fig 1. Relation between rate of flow in a capillary, 1 mm. diameter, and force acting: (*a*) benzene; (*b*) 1, *n*-hexane; 2, *iso*-octane; 3 toluene. Rate of flow in units of 10^{-4} cm. sec.$^{-1}$

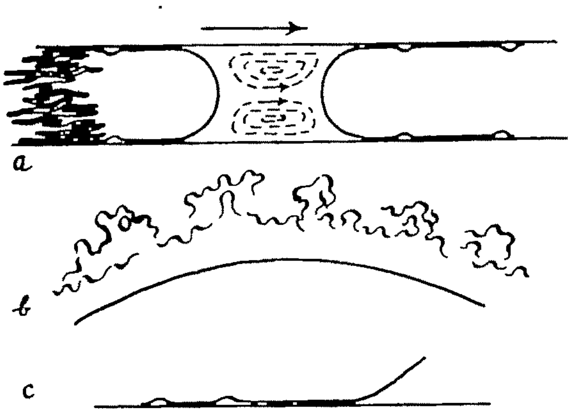

Fig. 2. Thin films adjacent to liquid menisci and pools. (*a*) Benzene index moving slowly in a wetted capillary showing filiform edging of rear thin film (rotation of liquid in index is shown by broken lines). (*b*) Edge of a drop of liquid (after Hirtz and Bernard, ref. 5), and (*c*) side view, indicating the thin film ending in a small ridge of liquid

A similar behaviour can be found with an air bubble moving in a tube filled with liquid. The contact angles appear to be zero, but the top meniscus is flattened and the bottom extended, while the graph relating force acting and rate of movement indicates non-Newtonian movement.

In a dry tube ahead of the advancing meniscus of a column, say, of *n*-heptane, it is possible to see interference colours due to the deposition of a film of heptane, while with water the formation of droplets ahead of the meniscus can be seen under the microscope. Migration of liquid molecules from the liquid front (primary creep) together with vapour deposition is responsible for the presence of thin films ahead of the meniscus and forming part of it, so that its periphery may extend to a distance of several diameters.

In recession, the meniscus is attached to the film on the wet walls, the periphery again being extended to several diameters. The resistance, which is usually much higher for the receding than for the advancing meniscus, varies with the length, elastic properties and strength of the thin films attached, the recessional flow being non-Newtonian and rhythmic in character[3]. In Fig. 2 is indicated the position of the thin films, which usually end in a ridge or in a filiform fringe.

A striking example of the high resistance offered in recessional flow is afforded by the results obtained in the spreading and retraction of a small pool, say of 0·05 ml. of liquid, between approaching and separating parallel flats respectively. In the approaching flats experiment, radial movement during the first stages is approximately in accord with the formula $r^4 = cFt$, where $c = 4V^2/3\pi^3\eta$ and r is the radius of the pool, F the force acting, t time, V the volume of liquid and η the viscosity. There is a curious hesitation in movement when the film reaches a film thickness of about 10 μ, due apparently to the instability and rupture of the film because of its much increased specific area, and there is a decided resistance to further spreading, which is usually filiform in character[4]. When the force is reversed to separate the plates a hysteresis effect is observed, especially when wetting is poor, as with a pool of 0·05 ml. of a glycerol–water mixture (viscosity, 150 centistokes) between glass surfaces slightly contaminated with oil. When the pool was 3·8 cm. in diameter, the time taken for the plates to separate with a force of 200 gm. weight was found to be 350 sec., which is several times the calculated value. Similarly, with a diameter of 4 cm. and the same force acting, no movement of separation was observed over 24 hr.; on scrupulously clean glass the observed time for separation was several times that of the calculated value, taking into consideration the surface tension forces tending to hold the plates together, namely, $2\pi^2r^4\,\gamma\cos\theta/V + 2\pi r\,\gamma\cos\theta$.

It appears that the cavitation of the film, observed during the separation of the plates, together with the filiform periphery, sets up additional surface tension forces to those given above.

Liquids flowing slowly over solids have highly versatile behaviours depending among other things on their molecular structure and aggregation; with toluene, less resistance to flow than with benzene was recorded, while with the xylenes the *para* isomer was found to be the most freely flowing. With binary mixtures of liquids it was possible to correlate increased spreading-rates with lower coefficients of friction and higher strengths of adhesion[1]. With pools of some aliphatic alcohols on brass, methyl alcohol spread the least, but on aluminium it spread the most; of some aliphatic acetic esters on metals and okerin surfaces, methyl acetate was less freely flowing than amyl acetate of higher viscosity.

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A New Type of Diffusion Cathode

RECENT progress in the field of thermionic emitters has largely been directed towards obtaining continuous current densities higher than those which can be obtained from oxide cathodes with reasonable lives. Examples of this trend are the *L* cathode[1], the impregnated tungsten cathode[2] and the moulded nickel–barium carbonate layer cathode[3].

A new type of cathode combining the features of the impregnated *W* cathode and the moulded cathode has recently been developed. The cathode is made by preparing a mixture of nickel powder and barium–strontium carbonate powder. A small percentage of an appropriate reducing agent is added to the mixture. The ball-milled mixture is loaded into a retaining cylinder, which may be of nickel, 'Kovar' or molybdenum or other suitable refractory material and is compressed using a pressure which is determined by the desired value of final porosity. Typical cathodes contain 70 per cent by weight of nickel powder, 29 per cent barium–strontium carbonate and 1 per cent zirconium hydride. Pressures of between 20 and 160 tons/in.² have been used. The retaining cylinder is then removed from the press tool and is mounted in the valve in the ordinary way, the pressed emitting material being mechanically strong and well able to resist the stresses experienced in handling and mounting.

The outgassing and activation procedures are similar to those usually employed with oxide cathodes except that the times are somewhat longer. The emission is allowed to build up to between 1–3 amp./cm.² on the pump before sealing off, and when carefully stabilized cathodes for measurement purposes are required, the cathode is aged at the same density for several hours after seal-off.

Fig. 1 shows typical pulsed-emission results for these cathodes, compared with conventional oxide cathodes and with published data for the *L* cathode. These results are very similar to those of MacNair, Hannay and Lynch. The graph also shows data representing conditions under which good modern oxide cathodes can be operated for reasonable lives and a tentative line for the new *BN* cathode. Diodes using *BN* cathodes have survived 3,000 hr. at 3 amp./cm.² and 1,070° C., and 6,000 hr. at 1·5 amp./cm.² and 1,020° C. They are resistant to ionic

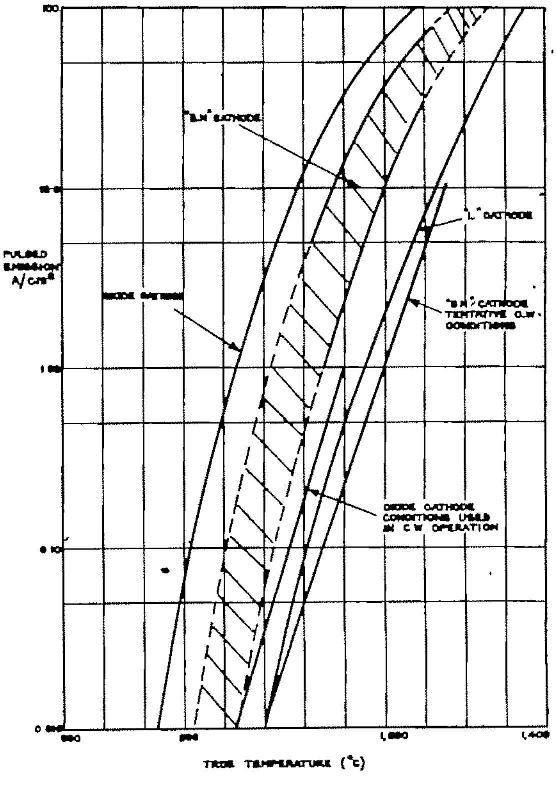

Fig. 1. Curves of emission as a function of temperature for oxide, *L* and *BN* cathodes

bombardment and have been very satisfactorily used in demountable vacuum apparatus.

Measurements of work function by the usual saturation emission method lead to a value for φ_e about 1·8 eV. Retarding field values of φ lead to a value of about 2·8 eV. We interpret these results as meaning that the emission originates from an incomplete monolayer of barium ions, with about 70 per cent surface coverage. The temperature coefficient of the work function is about $1 \cdot 4 \times 10^{-4}$ eV. per deg. K.

A paper describing this work in more detail was read at the recent Congrès International du Cinquentenaire de la Cathode à Oxydes and will be published in the Proceedings of that Congress to appear in *Le Vide*.

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Thermal Expansion of Grey Tin

No work appears to have been reported on the thermal expansion of grey tin and it may be of interest, therefore, to give some X-ray measurements that we have made on this material at temperatures between room temperature and − 130° C. These are shown in Fig. 1, from which it will be seen that the coefficient of expansion is sensibly constant within the range quoted. The value actually works out to be $4 \cdot 7 \times 10^{-6}$ per degree C. The measurements were made with a 'Unicam' 19-cm. powder camera modified as described in a note to be published by us elsewhere. Unfiltered copper *K*-radiation was used.

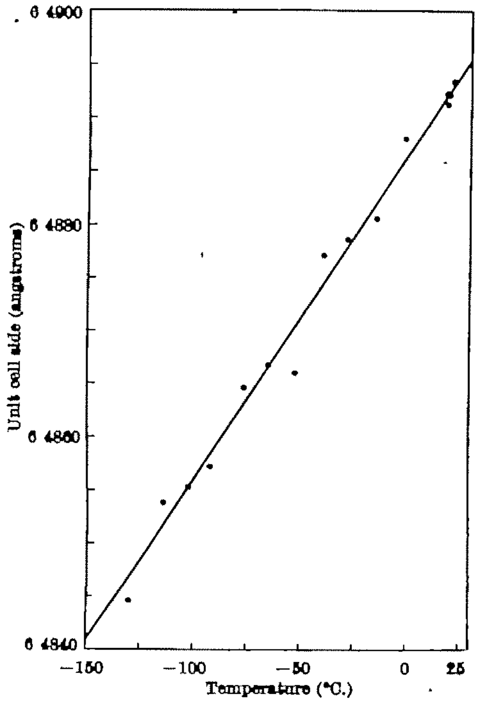

Fig. 1. Thermal expansion of grey tin

The value of the unit-cell side, 6·4892 ± 0·0001 A. at 20° C. (assuming 1·54050 A. for the wave-length of copper $K\alpha_1$), is significantly less than that reported by Brownlee[1], namely, 6·4912 ± 0·0005 A. However, the nature of our curve and the measurements actually made at room temperature (on two different specimens) suggest that our results are substantially correct, especially as the values of the lattice parameters of other materials obtained with the same camera under similar conditions are found to agree with the accepted values for these parameters within the experimental error claimed. We are informed by the Tin Research Institute, to which body we should like to express our thanks for supplying the tin, that the purity of the material we examined was 99·99 per cent, the main impurities being lead and antimony. These impurities would account at most for an error of about the same magnitude as our experimental error, and therefore the discrepancy is left unexplained.

Mr. J. T. Kendall, who supplied the tin used by Brownlee, has informed us that his sample was also very pure, being prepared from Johnson–Matthey's 'spectroscopically pure' material.

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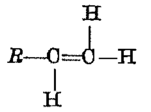
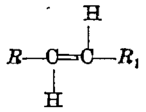
Infra-Red Assignments of Unsaturation in the Region 900–1,000 cm.$^{-1}$

The region 900–1,000 cm.$^{-1}$ of the infra-red spectrum of organic molecules is useful for characterizing the type of unsaturation that may be present. This region is associated with the bending frequencies of hydrogen attached to an olefinic carbon. Thus the groups



$$R-\underset{H}{C}=\overset{H}{C}-H$$

and



$$R-\underset{H}{C}=\overset{H}{C}-R_1$$

give rise to characteristic bands at 909–916 cm.$^{-1}$ and 964–979 cm.$^{-1}$ respectively[1].

Recent work by Jackson *et al.*[2] and Privett *et al.*[3] on the linoleates has enabled further assignments to be made in this region. *Trans-trans* conjugation is characterized by an absorption band at 988 cm.$^{-1}$, whereas *cis-trans* conjugation is characterized by absorption bands at 948 and 982 cm.$^{-1}$. However, when the spectrum of all *trans* vitamin A (which has five conjugated double bonds) is examined, there is one very strong band in the region 900–1,000 cm.$^{-1}$, but this lies at 968 cm.$^{-1}$, a position which is normally held to characterize only an isolated *trans* unsaturated bond. This is illustrated in Fig. 1, which shows the infra-red absorption spectrum of vitamin A palmitate, the 968 cm.$^{-1}$ band being characteristic of both the free alcohol and of its esters. The spectrum of β-carotene, which is a precursor of vitamin A and contains eight conjugated double bonds, is also similar in this respect.

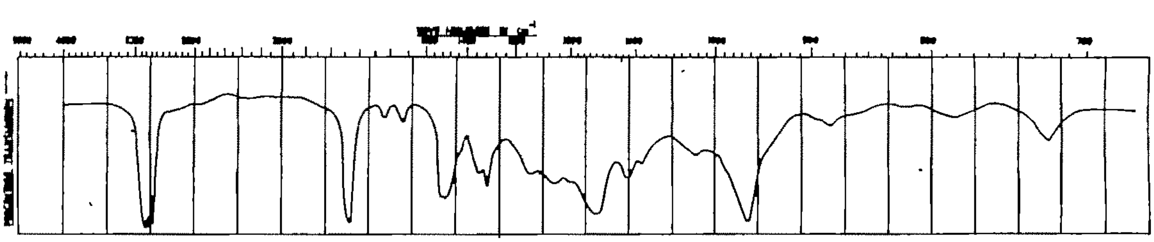
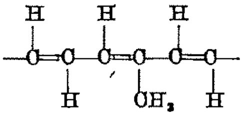


Fig. 1. Infra-red absorption spectrum of vitamin A palmitate

The molecular structures of these compounds show a branched methyl group on alternate double bonds thus:



$$—\overset{H}{C}=\underset{H}{C}—\overset{H}{C}=\underset{CH_3}{C}—\overset{H}{C}=\underset{H}{C}—$$

and since the hydrogen bending vibration in the $CHR_1 = CHR_2$ (*trans*) group appears to behave as though isolated and unaffected by this type of conjugation, it is to be expected that a band arising from the hydrogen bending vibration in the group $CR_1R_2 = CHR_3$ would occur in the region 803–833 cm.$^{-1}$. In fact, however, only a very weak band near 825 cm.$^{-1}$ occurs in the vitamin A spectrum.

In the C = C stretching region, if the $CHR_1 = CHR_2$ (*trans*) and $CR_1R_2 = CHR_3$ groups behaved as isolated non-conjugated groups, two bands would be expected[4] to occur near 1,670 cm.$^{-1}$; in fact, however, two bands at 1,623 cm.$^{-1}$ and 1,565 cm.$^{-1}$ are observed (Fig. 1), showing that the conjugation does affect the C = C stretching vibration.

From the practical point of infra-red analysis of unknown materials, although the 968 cm.$^{-1}$ band is generally assigned to isolated (non-conjugated) *trans* unsaturated bonds, it follows from the above that this is not always correct.

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Iodometric Assay of Penicillinase

The series of iodometric methods[1] for assaying penicillinase reported here permits enzyme activity to be measured easily over wide ranges of *p*H and temperature, with higher speed, accuracy or sensitivity than were previously attainable[2]. Although designed for the penicillinase of *B. cereus* NRRL-569, it appears likely that they may be equally suitable in principle for penicillinase from other sources. 'Unit rate of penicillin destruction' is used here to mean a destruction-rate of 1 µmol./hr. Since the amount of a penicillinase which will give unit rate of destruction depends on the nature of the enzyme and the conditions to which it is exposed, a 'unit dose' (U.D.) of *B. cereus* NRRL-569 penicillinase is here defined as that amount of the enzyme which gives unit rate of destruction when exposed to 0·005 *M* sodium benzyl penicillin in 0·2 *M* potassium phosphate buffer at *p*H 6·5 and 30° C. The commercial crystalline sodium penicillin *G* of Glaxo, Ltd., is used in the following assays; its potency is stated to be 1,650 I.U./mgm.

Before performing an accurate assay it is necessary to know the approximate activity of the enzyme sample, which is determined in the following manner. To 50 ml. of 0·0014 *M* penicillin in 0·02 *M* phosphate buffer, *p*H 6·5, is added 2 ml. of 2 per cent sodium starch glycollate[3] and 0·01 *N* iodine, dropwise, until a faint blue colour persists for 3 min.: a further 6 ml. of iodine is then added. This deep-blue reagent, freshly prepared, is mixed in a test-tube in the proportion of 2·5 ml. to 0·5 ml. of enzyme, and the time-interval until decolorization is noted. At a room temperature of about 22° C. the product, *P*, of activity and time is constant within ± 10 per cent, for purified enzyme samples, over a time-range of about 0·5–15 min., which corresponds to an activity range of between 60 and 2 U.D. of enzyme. If crude preparations of enzyme with a high non-specific iodine uptake do not give a constant value for *P*, standards of known activity are included in each run. Two operators can assay about fifty samples an hour by this method.

The accurate version of the assay is carried out as follows. A stoppered 60-ml. reagent bottle containing 5 ml. of an ice-cold 0·007 *M* solution of penicillin in 0·2 *M* phosphate buffer, *p*H 6·5, is mounted so that it can be gently shaken in a water-bath at 30° C. The enzyme for assay, pre-warmed to 30° C., is added after 10 min.: it should consist of not more than 20 U.D. of activity in not more than 2 ml. of solution containing 0·5 per cent gelatin[4]. After a further 30 min., shaking is stopped, and the enzyme reaction arrested by adding 10 ml. of an iodine reagent also prewarmed to 30° C.; this reagent is 0·0166 *N* iodine, 0·06 *M* potassium iodide and 1·75 *M* sodium acetate buffer, *p*H 4·00. Ten minutes later, the bottle is removed from the bath and titrated with 0·0166 *N* thiosulphate: if the titration is less than 4·5 ml., the assay is repeated with diluted enzyme. Under these conditions, 1 ml. 0·0166 *N* iodine is equivalent to 2 µmol. of penicillin destroyed. Corrections for spontaneous decay of penicillin and the iodine uptake of crude enzyme samples are determined from suitable controls. By starting assays at 3-min. intervals, two operators can perform ten in an hour. Accuracy of the method is within the limits of good volumetric technique: sensitivity is 0·04 U.D. of enzyme, but may be increased ten-fold by lengthening the reaction-time to 5 hr.

This accurate assay may be modified to work over a wide range of conditions providing certain properties of the system are taken into account: (*a*) the K_m of *B. cereus* NRRL-569 penicillinase is about 7×10^{-5} *M*; the influence of *p*H and temperature on its effective rate of destruction of penicillin under certain conditions is shown in Figs. 1 and 2 (these properties

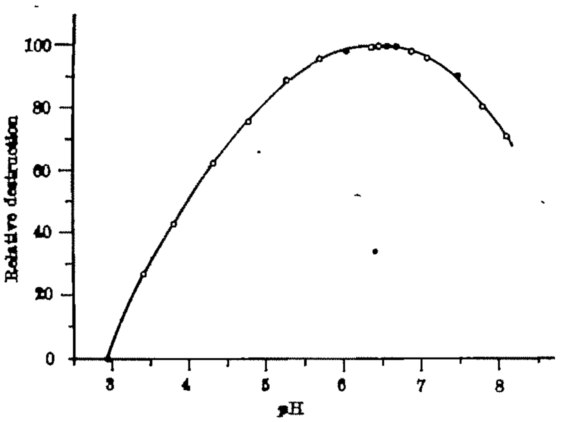

Fig. 1. Penicillin destroyed by a constant initial amount of enzyme at various pH's, expressed as percentage of penicillin destroyed at pH 6·5. Time 30 min.; temperature 30° C.; phosphate-citrate buffer. Each point is the mean of two determinations

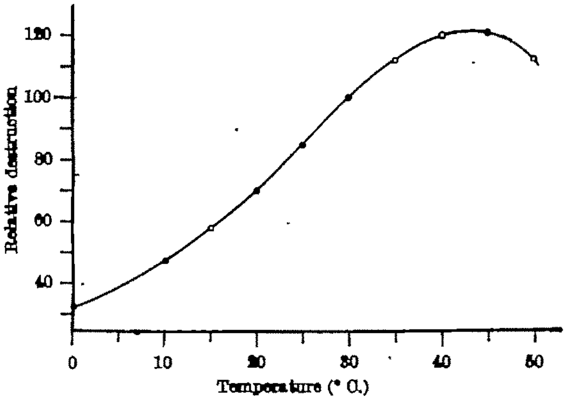

Fig. 2. Penicillin destroyed by a constant initial amount of enzyme at various temperatures, expressed as percentage of penicillin destroyed at 30° C. Time 30 min.; pH 6·5; phosphate buffer. Each point is the mean of three determinations

were determined by iodometric methods and differ slightly from those previously reported[3]); (*b*) a residual iodine concentration of at least 0·0045 *N* at the beginning of the titration seems desirable; (*c*) under the conditions described, the degradation products of 1 molecule of penicillin reduce 8·3 atoms of iodine: under other conditions, that particular relationship will probably not apply[1], and the iodine equivalence must be re-determined using the product of complete enzymic degradation of a known amount of penicillin.

A very sensitive means of detecting penicillinase exploits the widely different partition coefficients of iodine and iodide between carbon tetrachloride and water. If penicillin partially degraded by penicillinase is shaken with a solution of iodine labelled with iodine-131 in carbon tetrachloride, the aqueous phase acquires an amount of radioactivity, in the form of iodide, which is a function of the amount of penicillin destroyed. With highly purified enzyme, 2×10^{-4} *M* penicillin and 5×10^{-4} *N* iodine containing 10 μc. iodine-131/ml., it has proved possible to detect 3×10^{-4} U.D. of penicillinase (about 4×10^{-19} mol. of enzyme if its molecular activity[5] is $1 \cdot 3 \times 10^{5}$). Unfortunately, the conditions for attaining such sensitivity are so rigorous that further refinement of the method seems useless.

The iodine – penicilloic acid reaction can also be used for identifying colonies of penicillinase-producing bacteria in solid media. The indicator is incorporated in the medium; after incubation, the plate is flooded with 0·1 *M* penicillin and left for 15 min. or more at 2° C. The penicillin is then replaced by iodine of suitable strength (depending on the nature of the medium and the activity of enzyme present). Colonies of penicillinase-producers are surrounded by colourless zones which increase in area with time.

These methods and their experimental justification will be reported elsewhere in detail. I am grateful to Miss Daphne Towler and Miss Audrey Hearle for expert technical assistance.

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Utilization of Formate-^{14}C for Synthesis of Deoxyribonucleic Acid by Human Bone Marrow Cells *in vitro*

Previous publications[1,2] have reported on the incorporation of adenine-^{14}C into ribonucleic acid and deoxyribonucleic acid by human bone marrow cells *in vitro*. Using a high-resolution autoradiography technique[3], the grain counts over the individual cells before and after hydrolysis with *N* hydrochloric acid at 60° C. for 6½ min. indicated a slightly larger amount of adenine-^{14}C incorporated into ribonucleic acid than into deoxyribonucleic acid, in 24-hr. cultures (see Fig. 1).

Similar experiments were performed using 0·75 μc./ml. sodium formate-^{14}C in the culture medium. Isomolar (0·75 millimolar) concentrations of formate-^{14}C and adenine-^{14}C were used, these concentrations being in excess of those permitting maximum

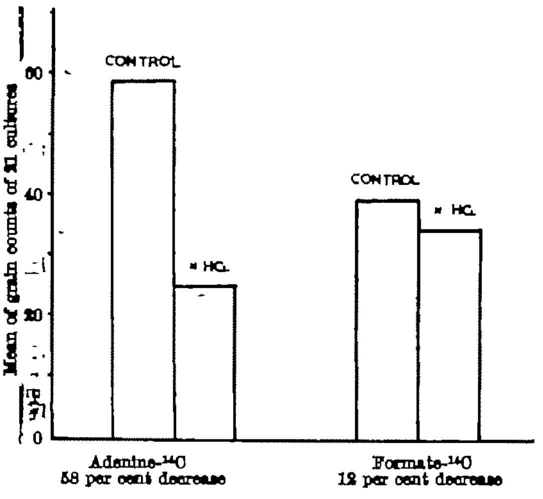

Fig. 1. Effect of *N* hydrochloric acid at 60° C. for 6½ min. on the carbon-14 content of cells

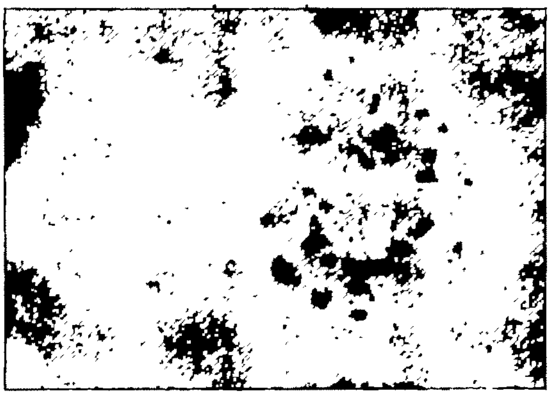

Fig. 2. Formate-^{14}C uptake by human bone marrow cells *in vitro* in 24-hr. culture with 0·75 μc./ml. formate-^{14}C medium. Smear alcohol fixed, not acid hydrolysed. Stained autoradiograph, × 2,000. Note the localization of the isotope in the chromosomes

uptake by the cells. The difference in the specific activities (1·04 mc./m*M* for formate-^{14}C, and 1·56 mc./m*M* for adenine-^{14}C) was compensated for in the exposure times of the autoradiographs, namely, ten days for adenine-^{14}C slides and seventeen days for formate-^{14}C slides. The grain counts on the acid-hydrolysed slides indicated a similar amount of carbon-14 uptake in both cases, the average maximum uptake being of the order of 1·2 × 10^7 atoms of deoxyribonucleic acid-^{14}C.

However, the comparison of the non-hydrolysed and acid-hydrolysed preparations from the formate-^{14}C cultures indicated scarcely any change in the average maximum grain counts after hydrolysis (see Fig. 1). The failure of acid hydrolysis to remove appreciable amounts of carbon-14 from the cells, together with the predominantly nuclear (and chromosomal) localization of the isotope on the non-hydrolysed preparations (Fig. 2), indicated that, as opposed to adenine-^{14}C, most of the formate-^{14}C taken up by human bone marrow cells *in vitro* is incorporated into deoxyribonucleic acid, and only a very small fraction is incorporated into other compounds (for example, ribonucleic acid).

These findings are at variance with those obtained in rat liver with formate-^{14}C [4,5]; but the cause of the difference may lie in the different rates of synthesis of deoxyribonucleic acid in bone marrow and resting liver. There is evidence that in chick bone marrow slices more than 70 per cent of the formate-^{14}C in deoxyribonucleic acid is found in the methyl group of thymine[6], and preliminary experiments in our laboratory also indicate that probably most of the formate-^{14}C administered to human bone marrow cells *in vitro* is incorporated into thymine in deoxyribonucleic acid.

This work is part of an investigation carried out under a full grant from the British Empire Cancer Campaign.

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Cocarboxylasic Activity of Thiamine Phosphoric Esters

AFTER the chemical synthesis of thiamine phosphoric esters was achieved[1–4], reports were published on their cocarboxylasic activity[5–7]. Investigations have shown that monophosphothiamine has no cocarboxylasic activity, but different values have been found for the activity of triphosphothiamine. The discrepancies may be accounted for by the facts that: (*a*) chemical synthesis provides mixtures of three esters (mono-, di- and tri-phosphoric) which are very difficult to separate; (*b*) diphosphothiamine is very active; and therefore quantities as small as 0·1 γ/ml. occurring as impurities with the other esters invalidate the results; (*c*) washed yeast, which has usually been employed as apoenzyme, makes it difficult to reproduce results.

We have separated the esters by paper chromatography[7], employing Whatman No. 1 paper and *n*-propanol – water – 1 *M* acetate buffer, *p*H 5 (70 : 20 : 10), as the solvent.

The position of each ester was established by developing duplicate spots in parallel and spraying one of the series. Fragments of strips not sprayed were placed in Warburg flasks and compared with known amounts of chromatographically pure diphosphothiamine under identical experimental conditions.

As apoenzyme we have used purified apocarboxylase according to Green *et al.*[8]. Each flask contained: an amount of apoenzyme which in the presence of excess (80 γ) of diphosphothiamine produces carbon dioxide at 4·0 × 10^3 μl./hr.; 0·27 mgm. of magnesium ions and 0·19 mgm. of manganese ions; in the side bulb, 0·4 ml. of 1·09 *M* sodium pyruvate; 0·04 *M* citrate buffer, *p*H 6·0, making up the volume to 3·0 ml.; temperature, 30° C.; atmosphere, air; shaking, 160–170 oscillations/min. The rate of evolution of carbon dioxide was determined by a graphical method[9]. The manometers were read every 2 min. after allowing 15 min. for the establishment of equilibrium. The quantities of each ester were established by colorimetric determination of phosphorus[10].

The following results were obtained: (1) monophosphothiamine at concentrations of 0·025–0·13 μmol./ml. did not manifest any cocarboxylasic activity; (2) diphosphothiamine at a concentration of 0·04 μmol./ml. liberated carbon dioxide at the rate of 2·3 × 10^3 μl./hr.; (3) triphosphothiamine at concentrations of 0·005–0·020 μmol./ml. did not manifest any cocarboxylasic activity.

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A Further Serological Distinction between the Hæmagglutinins of *Dolichos biflorus* and *Phaseolus lunatus*

SEED hæmagglutinins have recently been investigated in considerable detail. Many botanical species contain non-specific agglutinins for human erythrocytes and some contain agglutinins which are relatively or absolutely specific[1-4].

Krupe[4] has demonstrated the presence of incomplete antibodies in various seeds. The action of seed agglutinins on enzyme-treated cells is now being investigated in our laboratories. The enzyme used is papain and the technique that described by Stratton[5]. Detailed results will be published in due course.

Bird[6] has directed attention to the fact that there is a difference in the serological reactions of extracts of two *A*-specific seeds, *Dolichos biflorus* and *Phaseolus lunatus*. The former act strongly on A_1 and A_1B cells and relatively weakly on A_2 and A_2B, whereas the latter act more uniformly on these sub-groups.

The present communication reports a more marked serological distinction between the two agglutinins. *Phaseolus lunatus* extracts act upon papainized erythrocytes of groups *B* and *O*, whereas *Dolichos biflorus* extracts retain their specificity for *A* cells when tested under identical conditions (see table).

TITRES OF UNTREATED AND PAPAINIZED CELLS AGAINST *A*-SPECIFIC SEED EXTRACTS

	Untreated cells Group			Papainized cells Group		
	A	*B*	*O*	*A*	*B*	*O*
Dolichos biflorus	1,024	0	0	32,768	0	0
Phaseolus lunatus	2,048	0	0	65,536	8	8

These observations are in keeping with the fact that extracts of some varieties of *Phaseolus lunatus* act weakly on *B* and *O* cells[2], and the observation that these extracts act strongly on panagglutinating (infected) cell suspensions irrespective of their *ABO* group (unpublished results). On the other hand, *Dolichos biflorus* extracts are not known to act on *B* and *O* cells, and do not lose their specificity when tested with panagglutinating cell suspensions (unpublished results).

It appears that *Dolichos biflorus* agglutinins have a greater degree of specificity for the agglutinogen *A* than was originally appreciated.

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Mechanism of Hypotensive Action of Reserpine, an Alkaloid of *Rauwolfia serpentina*

STUDIES on the pharmacology of extracts of *Rauwolfia serpentina* have been reported by Chopra, Gupta and Mukherjee[1], Ray *et al.*[2] and Dasgupta *et al.*[3]. Chopra, Gupta and Mukherjee[1] reported that the alkaloid with which they were working had a marked hypotensive effect which was in part due to depression of central nervous mechanisms, since it was less marked in decerebrate animals, but appeared also to result in part from a direct inhibitory effect on the musculature of the blood vessels. They demonstrated also a fall in the output of the isolated heart. Most subsequent work has suggested that the hypotensive effect of *Rauwolfia* alkaloids is mediated solely via central nervous mechanisms.

A new alkaloid, now named reserpine, was isolated by Müller, Schlittler and Bein[4], and pharmacological studies on the action of this alkaloid have been published by Bein *et al.*[5], Bein[6], and Trapold *et al.*[7]. Their results were in conformity with those of other workers on *Rauwolfia*, who reported it to act via the central nervous system, and they emphasized particularly its capacity to inhibit reflex pressor responses.

Our own studies have confirmed that reserpine diminished reflex vasomotor responses, but have also demonstrated a direct effect on the peripheral vessels independent of its nervous activity. This action is most clearly seen in the rabbit; we employed the preparation devised by Gallagher[8], in which the innervated but otherwise isolated hind-limb is perfused with a blood–dextran medium at constant rate. Changes in vasomotor tone in the limb are indicated by alterations in perfusion pressure. We have found that injections of reserpine into the systemic circulation of the rabbit produce an immediate fall in systemic blood pressure. This is accompanied by an immediate rise in limb perfusion pressure instead of a fall, as would have been expected were the fall of blood pressure mediated through the nervous system. Furthermore, injection of reserpine directly into the artery of the perfused hind-limb causes immediate diminution in vasomotor tone. Reserpine has also been shown to have a depressant effect on the action of vasopressor substances injected into the isolated rat hindquarter preparation and on the response to nervous stimuli of isolated portions of rat diaphragm. A feature of all these reactions is their remarkably prolonged duration, suggesting binding of the drug by the musculature.

We have also obtained evidence that such a direct peripheral effect may play some part in the hypotensive action of reserpine in man. We have found that the blood pressure in the supine position can be brought to a lower level by the combined action of reserpine and large doses of hexamethonium bromide than by hexamethonium alone.

Papers embodying the results of these studies are being prepared and will be published elsewhere.

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A Centrifuging Method for Root Sterilization

In isolating mycorrhizal fungi present in root tissues, the external surfaces must be sterilized without damaging the hyphæ within. Existing techniques involving chemical sterilization or removal of the epidermis under aseptic conditions were found to be unsatisfactory in *Calluna vulgaris* and *Vaccinium myrtillus*, as they involved loss of hyphæ in the epidermis where the hyphæ were concentrated. Accordingly, a centrifuging technique was devised which obviated these difficulties.

The apparatus consists of a small glass tube, fitted into a 'Pyrex' centrifuge tube. A piece of fine muslin is stretched across the top of the inner tube and secured by waterproof adhesive tape. The base of the inner tube is wrapped in cotton wool. This is essential for even distribution of pressure during centrifuging. Sufficient sterile water is added to cover the muslin.

The roots to be surface-sterilized are thoroughly washed in detergent before being placed on the muslin of the inner tube. They are then centrifuged for three to four minutes at 7,500 rev./min., removed and shaken vigorously in two tubes of sterile water to dislodge contaminants still attached to the root surface. Prior to each centrifuging, 50 per cent alcohol is used to sterilize the apparatus. Three times in the centrifuge, each time followed by agitation in two tubes of sterile water, except after the last, when four tubes are used, results in a high proportion of surface-sterile root sections 3–5 mm. in length.

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Environmental Determination of the Sex Ratio of a Plant Parasitic Nematode

The sex ratio of the potato root eelworm *Heterodera rostochiensis* Wollenweber has been under investigation in this laboratory since 1950. From the first it appeared that the ratio is very variable; it is now clear (*a*) that the ratio can be different on primary and lateral roots, and (*b*) that it varies with the intensity of infection.

Plants were raised in pots and grown either on a laboratory window bench or in the field: either they were grown in soil containing eelworm cysts or in sterile sand to which larvæ were added afterwards. As earlier stages are difficult to identify with reasonable ease and certainty, all plants were lifted when the males were adult but still 'encysted'; at this stage females are swollen but still within the root tissues. But as the males leave the roots soon after, care was taken to lift the plants in time. The roots were then carefully washed, treated with lactophenol-acid fuchsin in the standard way[1], and the number of adult males and females counted with the aid of a dissecting microscope; no attempt was made to sex early stages, but the total number of worms was noted. Although most of the worms are readily visible, it was nevertheless necessary more or less to dissect the root system to ensure that all worms were found; and, in the case of the field-grown plants where the root system was particularly extensive, sometimes only a sample of the root system was examined. I am most grateful to Mrs. E. Capstick for the care with which she carried out these examinations.

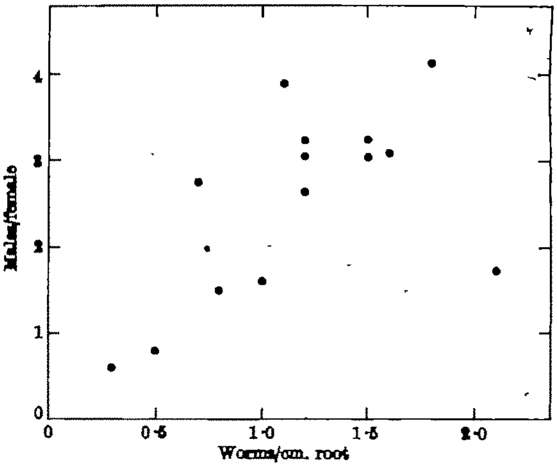

Fig. 1. Increasing proportion of males with increasing intensity of attack

The results for fourteen plants, part of a typical experiment with a number of potato varieties, are shown in Fig. 1; the different plants are compared on the basis of the length of primary roots of the root system examined. The sex ratio (males per female) is plotted against intensity of attack; it will be seen that, as the intensity increases, a higher proportion of males is found, the sex ratio changing from about 1 : 2, at the lower levels, to about four males to one female at the upper end; and higher values have frequently been found. 'Intensity of attack' was estimated from the number of worms of all stages per cm. of primary root, although, of course, worms in both primary and lateral roots are included. The method is not beyond criticism; indeed, an investigation of alternatives, such as the exclusion of juveniles, may itself help to clarify the situation. But other standards do not alter the general trend: the higher the intensity of attack, the higher the proportion of males, or the lower the reproductive rate.

Clearly, the phenomenon may help to explain the puzzling manner in which soil populations of the potato[2,3] and the closely related beet eelworm (*H. schachtii*)[4] increase; for the rate of multiplication decreases with the number of eelworm eggs in the soil.

A fully developed female with her many hundreds of eggs must be a considerable drain on the host plant. Whatever the mechanism, therefore, a reduction in the relative number of females with intensity of attack is a remarkable adaptation. There appear to be two possibilities: either the change in sex ratio is achieved as a result of a differential death-rate; or it is due to environmental influence on the process of sex determination.

A differential death-rate could operate by eliminating a progressively higher proportion of females before they reach the host plant; alternatively, progressively more females might fail to reach maturity within the plant. Careful examination of a number

Table 1. Distribution of Sexes on Primary and Lateral Roots. Figures are mean values per plant for young plants grown in pots to each of which 900 larvæ were added

	Adult male	Adult female	Male/female	Unclassified
Primary	38·3	23·8	1·61	24·9
Lateral	172·9	20·7	8·35	45·1

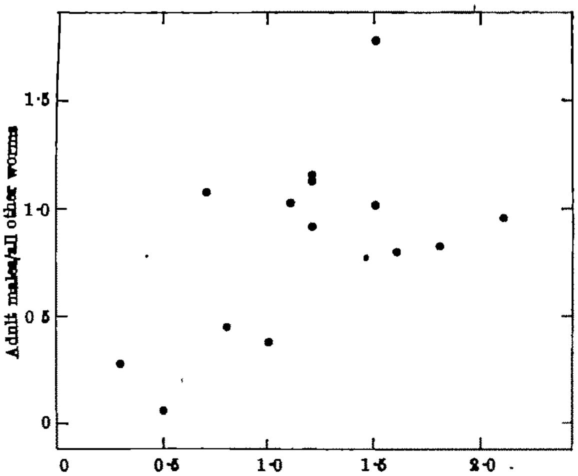

Fig. 2. For this diagram, all worms, other than adult males, have been assumed to be potential females. The increase in the proportion of males, with increasing intensity of attack, is therefore not due to a higher death-rate of females within the host plant

of plants grown in sterile sand to which larvæ were afterwards added showed in every case that the proportion of males to females was very much higher on the lateral roots than the primary roots from which they arose. The mean values are shown in Table 1; there are roughly five times more males per female on the lateral roots than on the primaries. The figures for the unclassified worms show that the difference cannot be due to any difference in rate of development, for the proportion of unclassified worms is rather higher on the primaries. This difference between primary and lateral roots would appear to eliminate the possibility of differential soil death-rate—unless it were also associated with a male preference for lateral roots.

We are confident that the worms counted as neither adult nor female were in fact juveniles and not corpses. Nevertheless, although they show no obvious signs of degeneration, it must be admitted that it may not be easy to distinguish between an eelworm which has died of natural causes and one which has been freshly killed by the fixative. Accordingly, all worms were counted as female which were not adult male; that is, all previously unclassified worms were added to the female total. The recalculated and heavily weighted 'sex-ratios' have been plotted against intensity of attack in Fig. 2; even in such unfavourable circumstances, they still show a very strong trend, the proportion of males increasing with increasing intensity of attack. This is decisive evidence against a differential death-rate in the host as the cause of the trend. Clearly, the process of sex determination is under environmental influence.

This work forms part of a programme supported by grants from the Agricultural Research Council. I am also grateful for a personal grant from the Nuffield Foundation in 1953.

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Eradication of *Venturia inaequalis* (Cooke) Wint.

The control of apple scab or black spot, caused by *Venturia inaequalis*, using protective and eradicant-protective spray programmes during the parasitic phase of fungal activity has reached a stage beyond which further substantial improvement is unlikely. With modern machinery and modern chemicals, good control of the disease can be achieved in normal seasons in New South Wales, but the cost of the control programme is very high and heavy losses still occur under extreme infection conditions.

In 1937, Keitt and Palmiter[1] reported failure to eradicate the disease by attempting to break the cycle of fungal development with autumn foliage sprays of copper – lime – arsenite mixtures and with a late-winter ground spray of ammonium sulphate. Since then many attempts have been made to break the cycle during the saprophytic phase, using eradicant ground sprays. These attempts to kill the maturing perithecia have failed to eradicate the disease, due to the impossibility of hitting all fallen leaves with the chemical and to the incompletely eradicant action of some of the chemicals used.

The use of eradicants in the pre-leaf-fall period to prevent the fungus entering the saprophytic phase has received much less attention, and consequently a re-investigation of this aspect was undertaken using some new eradicant fungicides. Of these, phenyl mercuric chloride appeared most promising. In numerous reports, such as those of Fitzgibbon[2] and of Marsh[3], its outstanding fungicidal ability and low phytotoxicity at low concentration have been stressed. In 1952, Byrde *et al.*[4] reported the successful use of this chemical at high concentration as an autumn spray in preventing sporulation of *Nectria galligena* Bres. on apple trees, thereby demonstrating its extreme eradicant action and non-phytotoxicity.

In late autumn (May) 1953 at Orange, New South Wales, sprays of phenyl mercuric chloride (0·3 per cent), sodium pentachlorophenate (0·5 per cent) and sodium dinitro-*o*-cresylate (0·5 per cent) were applied to Delicious apple trees heavily infected with black spot. The latter chemical caused much leaf burning and leaf rolling, but did not damage bark or buds. The other two materials caused no injury.

Two weeks after spraying, when the foliage was falling freely, samples of leaves from each treatment and unsprayed leaves were collected and allowed to over-winter under orchard conditions at Orange. From the end of September sub-samples from each were examined at weekly intervals for the presence of perithecia and for perithecial maturity as determined by intensity of ascospore discharge in the laboratory.

In the unsprayed leaves perithecia were abundant, ascospore discharge commenced in late September, rose to maximum intensity in early November, fell away quickly at first and then gradually, until it ceased at the end of January.

In the leaves sprayed with phenyl mercuric chloride, no mature perithecium was observed and from these leaves no ascospore of *Venturia inaequalis* was discharged during the testing period (October 2–December 31). Both discrete and diffuse scab lesions were observed on most of the leaves, and the absence of perithecia suggests that the fungus was killed in the sub-cuticular stromatic layer before the initiation of the saprophytic phase.

Sodium dinitro-*o*-cresylate caused a considerable reduction in effective perithecial development, and this was reflected in a low rate of discharge of ascospores.

Perithecia were plentiful in the leaves sprayed with sodium pentachlorophenate and were more advanced in maturity than those in the unsprayed leaves, ascospore discharge reaching peak intensity in mid-October. The rate of ascospore discharge was greater than from the leaves sprayed with sodium dinitro-*o*-cresylate but much less than that from the unsprayed leaves.

Further investigations have been undertaken this autumn (March–May) to determine the minimum concentration of phenyl mercuric chloride for eradication of *Venturia inaequalis* from infected apple leaves, and to test the possibility of eradicating apple scab from heavily infected isolated orchards using phenyl mercuric chloride at high concentration immediately after the completion of harvesting. It is hoped that this eradication measure will also eliminate the fungus from infected bud-scales, a source of inoculum demonstrated by Cass Smith *et al.*[5] to be important in the disease cycle.

Full details of the techniques employed and results obtained in these investigations will be published elsewhere.

I wish to thank the field horticulturists of the N.S.W. Department of Agriculture who are assisting with these investigations, and Mr. E. C. Whittaker, fruit officer at Orange, in particular, whose co-operation in applying the sprays and forwarding sub-samples of leaves made possible the initial investigation.

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Concentration of Potato Root Diffusate by Vacuum Distillation

POTATO root diffusate, which is the liquid obtained by leaching growing potatoes with water, has long been known[1] to contain an active factor which causes the larvæ to emerge from eggs contained within cysts of the potato root eelworm, *Heterodera rostochiensis*. Since the War, considerable research has been carried out in an attempt to ascertain the chemical constitution of the active factor[2]. At normal room temperature potato root diffusate is extremely unstable; hence the diffusate is stored in refrigerators, where it remains relatively stable for a considerable time.

Some method of concentrating the diffusate was imperative because it was becoming increasingly difficult to store bulk quantities of diffusate in refrigerators. The convenience of storage was the main reason for concentrating the diffusates, but other factors are also of importance.

Dilutions of the concentrate could be used for a large number of assays at the same time, hence ensuring that each experiment received the same hatching stimulus and thus removing one difficulty normally encountered in eelworm assay. Moreover, the gradual decomposition of a sample of root diffusate can be corrected by concentration and subsequent redilution. There is no reason for supposing that concentrated root diffusates differ from ordinary samples in their rate of decomposition, so that while tests are being carried out on their relative stability, the concentrates are kept at 3–4° C.

It was decided to prepare the concentrate by vacuum distillation at 5° C. and a pressure of 1 mm. mercury; the water which distilled was collected at $-20°$ C., until the volume remaining in the still was between 1 and 4 per cent of the original. In some samples further concentration was effected by freeze drying. Afterwards, dilutions were prepared for biological assay so that concentrations lay on a logarithmic scale[3].

Results showed that 90–95 per cent of the active principle remained undecomposed after vacuum distillation when comparing the diluted concentrate against the original sample. A rather greater loss, of 30 per cent, occurred with the freeze-dried material.

For all samples investigated an optimum hatch was observed (Table 1), confirming the suggestion by Calam *et al.*[2]. For concentrations higher than that which produce the optimum hatch, fewer larvæ emerged from the cysts. Thus two widely spaced concentrations of the hatching stimulant produce similar hatches, and this introduces complications into the bioassay of this substance, for which no chemical assay is as yet available.

Table 1. PERCENTAGE HATCH OF LARVÆ FROM CYST

Exp.	Dilution of root diffusate							
	$\frac{1}{1}$	$\frac{1}{4}$	$\frac{1}{16}$	$\frac{1}{64}$	$\frac{1}{256}$	$\frac{1}{1024}$	$\frac{1}{4096}$	Original sample
A	20	33	40	88	18	12·5	7·6	44
B	78	79	84	78	65	43	19	87
C	4	33	62	29	17	16	7	41

It is not yet certain whether the reduced hatch at higher concentrations is due to inhibition by soil nutrient salts or to the root diffusate factor itself. Recent experiments in which the potatoes, grown in silver sand, are leached with distilled water, suggest that the inhibition is associated with enhanced concentrations of the hatching factor.

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Augmentation of Wool-growth by l-Thyroxine and Tri-iodo-thyronine in Sheep

THE photoperiodic response giving increased wool-growth in sheep[1] having been demonstrated, we are now endeavouring to trace the mode and function of this response. One section of a series of experiments designed to cover this aspect involved the use of hormone-replacement therapy. This required the acceptance as a working hypothesis that the pituitary gland is stimulated by the photoperiodic treatment so as to increase the output of the various hormones known to be associated with it, resulting finally in an increased rate of wool-growth. The availability of hormones restricted the number which could be used to three.

Ten mature Corriedale ewes were randomized on a live-weight basis into four groups. They were housed in four adjacent pens of the same shed, each pen containing a complete group. Exactly the same standard maintenance ration of concentrates and chaffed lucerne hay was fed daily to all groups throughout the experiment. This resulted in maintaining the body-weight of the control group fairly constant until shearing in mid-October, when, as would be expected, the weight of all groups fell by the weight of wool removed, that of the control group remaining constant thereafter.

The three hormones used were: (*a*) 1-thyroxine injected subcutaneously as an aqueous solution totalling 92 mgm. per ewe over the period; (*b*) tri-iodo-thyronine injected subcutaneously as an aqueous solution totalling 30 mgm. per ewe over the period; (*c*) anterior lobe pituitary extract administered orally in pill form, totalling 92½ grains of desiccated substance over the period.

The method was to use a dose-level above the physiological range to some extent indicated by Maqsood's use of thyro-active iodinated casein[2], until definite biological activity had been established by a sharp loss of live weight amounting to about 8 lb. per ewe. The succeeding doses were then spaced so as not to bring about a further alteration in live weight during the period.

Every month the wool was clipped from similar areas of skin on each sheep, clean scoured and weighed dry. The dry weight of wool clipped from each ewe in any one month was then expressed as a ratio of the same ewe's monthly production from the same area of skin during the previous December–January–February period, when nutritional conditions were identical for all sheep. Thus for each ewe the wool-growth curve at its maximum[3], is used as a standard to which subsequent production can be related. The group means have been plotted in this manner in Fig. 1, which in addition shows the period when the hormones were administered relative to the responses obtained.

During the period, the increases in wool-growth obtained from the thyroxine and tri-iodo-thyronine groups are substantial and statistically significant. It will be further noted that cessation of the injections resulted in a return to the normal curve of the controls, with which wool-growth conformed thereafter.

The obvious failure of the anterior pituitary extract to produce any effect on wool-growth may be explainable in two ways: (*a*) it has not yet been possible to trace the source from which the extract was manufactured; if this was, as appears likely, ox pituitaries, then it could be possible for the sheep injected with this substance to produce an immunity, thus preventing any biological action taking place, or (*b*) the dose-level was not high enough to cover the inefficiencies of oral administration.

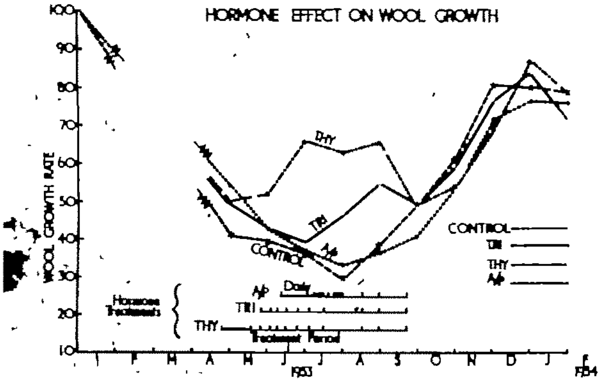

Fig. 1

These experiments are being continued and will be reported more fully elsewhere.

Thanks are due to the University of New Zealand for financial assistance and to Glaxo Laboratories, Ltd., for their active interest and co-operation in supplying the 1-thyroxine and tri-iodo-thyronine used.

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Sulphydryl Groups in Wool

A method for the estimation of sulphydryl groups in hair and other insoluble proteins by means of the specific sulphydryl reagent, 1-(4-chloromercuriphenylazo)-naphthol-2, has recently been reported by Scott and Flesch[1]. In this method, the hair is pulverized, treated with water at 100° or an aqueous solution of a swelling agent at 40° and shaken with a solution of the reagent in amyl acetate, the decrease in concentration of the reagent in the amyl acetate layer being measured colorimetrically.

A modification of this method is in use in this laboratory to detect and estimate sulphydryl groups in wool. The colour reagent is dissolved in formamide, which swells the fibres sufficiently to allow penetration and thus avoids the necessity of grinding up the wool. Sulphydryl groups may therefore be detected by the orange colour of the fibres after washing out excess reagent, and an approximate measure of the concentration of these groups may be obtained by observing the decrease in intensity of colour of a standard solution of the reagent in contact with a known amount of wool. In practice, a sample of 50 mgm. of wool of known moisture content is shaken mechanically at 30° with an appropriate volume of a formamide solution of the reagent containing 4 mgm. per 100 c.c. The rate of reaction is rapid at first, but slows down considerably until after four days it has reached a small, although finite, value. The figures quoted below refer to a reaction time of four days and thus probably represent minimal values. All the untreated wool samples tested so far have become an orange colour, indicating that they contain sulphydryl groups, although samples pretreated with a mercuric chloride solution to block sulphydryl groups do not absorb the reagent.

To standardize the colour reagent, an amyl acetate solution was allowed to react with a known amount of glutathione[2,3]. The solution in formamide could not be used because the coloured derivative of glutathione is soluble in this solvent.

It has been found that, for a typical South African merino wool, the average concentration of sulphydryl groups is 7 micromoles per gm. of dry wool. There do not appear to be any reliable values for the concentration of sulphydryl groups in wool that can be used for comparison (see Park and Speakman[4]).

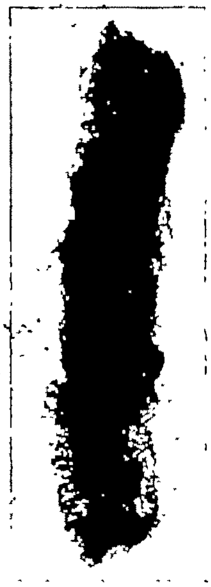

Fig. 1. Light-coloured root section at bottom

The distribution of sulphydryl groups in wool from copper-deficient sheep has been studied by this method. A number of sheep, after having been reared on copper-deficient pasture, were fed a diet adequately supplemented by copper sulphate, as in earlier experiments[2]. Samples of wool were thus available from these sheep with an easily recognizable 'copper-deficient' section and a 'normal' section near the root. Fig. 1 shows such a staple of merino wool after purifying and treating with a formamide solution of the colour reagent for three days. The 'copper-deficient' section has an intense orange colour which tends to decrease towards the tip, possibly owing to the effect of weathering on the sulphydryl groups, and a clear line of demarcation separates this section from the 'normal' section, which has a faint orange colour. The rather short length of the 'normal' section in Fig. 1 was due to felting of this section in formamide.

The average concentration of sulphydryl groups was found to be 26 micromoles per gm. in 'copper-deficient' wool, excluding the damaged tips, and 10 micromoles per gm. in 'normal' wool from the same staple. It is known from the nitroprusside test for sulphydryl groups that the region of intense staining in the wool follicle is of a much greater length in copper-deficient sheep than in normal sheep, although this test gives a barely perceptible colour for 'copper-deficient' wool that has emerged from the follicle[3]. It now appears that the conversion of sulphydryl groups to cystine linkages is less complete in 'copper-deficient' than in 'normal' wool, and this may help to explain the relative weakness of this wool (cf. the results of Palmer[6] on wool hydrolysates).

Experiments aimed at increasing the rate and degree of penetration of the colour reagent into wool fibres are now in progress. It has been found that penetration is complete in a few hours if the fibres are first supercontracted in hot aqueous phenol[7]. In this case, however, about twice as many sulphydryl groups are detected, the origin of which is under investigation.

I wish to thank Dr. P. C. Carman for advice in this work, and the South African Wool Board for a fellowship. This communication is published with the permission of the South African Council for Scientific and Industrial Research.

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Pelvic Relaxation in Sheep

Pelvic relaxation in pregnant females has been studied for several species of small animals and for primates[1]. Experimental investigations on the hormonal control of this process in mice and guinea pigs are encountered frequently in the current literature. Less attention has been given to this aspect of reproductive physiology in farm animals. Work is at present in progress at Ruakura on pelvic relaxation in sheep. Study of the factors involved are important in the understanding of parturition problems such as dystocia and vaginal prolapse.

To obtain a clear picture of the physical changes which take place in the pelvic region of the pregnant ewe, sixty animals have been slaughtered. Dissected ewes were examined at monthly intervals during gestation and after parturition. Physical methods were devised to measure objectively changes in the joints and appropriate soft tissues. In these ewes there was no relaxation in the pubic symphysis at any stage. Loosening of the sacro-iliac joints and of the sacro-sciatic ligaments began between the second and third months, reaching a maximum value at, or immediately after, parturition. Regression of these joint changes was incomplete in some cases even three months after lambing. For a total of twenty-five non-pregnant ewes killed just before the breeding season, movement of the sacro-iliac joints was barely perceptible. No loosening of these joints was found in œstrous ewes. It was also found that the sacro-lumbar joint became more flexible with advancing pregnancy. Soft tissues such as those attaching the reproductive tract to the birth canal, and the muscles and ligaments of the perineum, also progressively become 'relaxed', though regression after parturition was much more rapid than in the case of the bone changes. Ewes with vaginal prolapse were generally more relaxed than normal ewes at the same stage of gestation, both in the sacro-iliac joints and soft tissues.

The dissected pelves of two full-term cows and one sow showed relaxation only of the sacro-iliac joints.

In a preliminary experiment on the hormonal control of pelvic relaxation in sheep, four spayed ewes (spayed two years previously) were injected with 10 mgm. of diethylstilbœstrol daily for five days. Two of these ewes were then injected, on the sixth day, with 650 G.P.U. of 'Releasin' (relaxin) (kindly supplied by Dr. Robert L. Kroc, Warner Chilcott Research Laboratories, Morris Plains, New Jersey). All animals, including one untreated spayed ewe, were killed and dissected twenty-four hours later, on the seventh day. In the four treated ewes quite marked loosening of the sacro-iliac joints and the sacro-sciatic ligaments occurred, equivalent to that found in ewes four months in lamb. The joints of the relaxin-treated ewes were no looser than those injected with stilbœstrol alone. No measurable changes took place in the soft tissues.

Investigations have shown that œstrogen and androgen can first be detected in the urine between the twelfth and fifteenth weeks of gestation[2], providing indirect evidence that hormones are closely involved in pelvic relaxation in the ewe.

In the experiment on spayed ewes described above, loosening of the sacro-iliac joints was caused by œstrogenic stimulation alone. However, further work is necessary to study the role of the relaxin hormone. Preliminary experiments have shown that a substance with relaxin-like activity is present in pregnant ewes' ovaries, and in very low concentrations in the blood serum. Interaction of oestrogen and relaxin may be necessary to effect marked changes in soft tissues at different dose-levels than those used here.

The mode of action of relaxin appears to vary markedly between different species. There is room for extensive study of the comparative physiology of this hormone.

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Tolerance to the Maize Rust *Puccinia polysora* Underw.

THE maize rust disease *Puccinia polysora* Underw was observed in Nyasaland again in the 1953–54 growing season, its first appearance in the country having been in the 1952–53 season. At the Agricultural Research Station, Lilongwe, a replicated trial was carried out in which the use of a fungicide spray 'Blitane' (zinc ethylene *bis* dithiocarbamate) reduced the incidence of the fungus on the maize on sprayed plots as compared with those which were unsprayed. All plots were split into three varieties: (*a*) an imported hybrid; (*b*) a locally selected open-pollinated variety; (*c*) an unselected local native maize.

Scores were made for the number of open uredosori, the total possible for a severely infected plant being 9. Spraying did not prevent the incidence of the rust, but reduced the score for the sprayed plots by about one half as compared with those unsprayed. The unsprayed hybrid was given an average score of 3·5 per plant, and those of the local selected and unselected maize were 1·9 and 1·6 respectively. However, the yield of the hybrid was reduced by 17 per cent, whereas that of the local varieties was completely unaffected. Thus there are clear indications of differences in varietal susceptibility and of tolerance, although all three types have given the fully susceptible reaction to the method of testing for juvenile resistance in the greenhouse.

The tolerance of the local varieties—which yielded much less than the hybrid even when the latter was fully attacked by the rust—may be an indication that they do not express in the yield of their grain the full capabilities of their metabolism. This would allow for a reservoir which absorbs the inroads of disease, and until it is exhausted no loss in yield would be encountered. Native maize of this same type has been inbred, and hybrids produced, which will be grown here next season. If the foregoing hypothesis is correct, it may be expected that these, being more highly selected and yielding more nearly to their true capacity, will suffer greater loss in yield from the presence of the disease.

R. T. ELLIS

Agricultural Research Station,
Lilongwe,
Nyasaland.
July 30.

A Method of rearing Individual Trombiculid Mites in the Field

THE taxonomy of the Acarina Trombiculidae requires stabilizing by the study of the non-parasitic post-larval stages. Fewer than sixty nymphs and adults are known out of more than five hundred species, and of these only very few can be identified with absolute certainty. Techniques for rearing nymphs from engorged larvæ are widely known and practised, but a single host often carries several or many species of chiggers, and taxonomic studies make it necessary to identify each nymph by reference to the cast larval pelt. Although this is practicable in the laboratory, it is extremely difficult to do in the field especially when moving from place to place, because nymphs may take several weeks to emerge.

The following simple method was designed to allow the rearing of identifiable nymphs from chiggers collected during expeditions in Borneo and Malaya. It has also been used for rearing nymphs of related families of mites. It is worth noting that the larval pelts obtained are frequently complete except for disarrangement and some loss of body setæ; and because they show no deterioration with age after mounting they are often of more permanent value than mounts of actual larvæ themselves.

Collection of engorged larvæ. Techniques must be modified for every occasion to suit local conditions and requirements, such as the need to preserve skins of hosts intact. It is economical to allow chiggers to become detached naturally rather than to pick them off individually. Scrapings, or better, fragments of infested skin, are placed in water in cavity blocks, or are pinned to the corks of 2 in. × 1 in. tubes, and left overnight for larvæ to become detached. Engorged larvæ are then selected for rearing. Full engorgement is not always necessary to allow development of the nymph. If time and space allow (for example, in the laboratory), chiggers may be placed on water in cavity blocks or Syracuse dishes and the emergence of nymphs awaited—the nymph usually sinks while the larval pelt remains floating.

Rearing in tubes. Use stout round-bottomed tubes, or simple lengths of tubing corked at both ends, and soft rubber corks; a good size is about 35 mm. × 8 mm. Cut cigarette paper into strips to fit the tubes, say, 25 mm. × 6 mm. When planting larvæ, mark a small circle in pencil near one end of a strip, at the same time entering identification data and date. Place in a tube with the circle near the mouth and wet thoroughly. Plant a selected larva in the marked circle: it is usually held there by surface tension, and the optimum degree of wetness is soon learnt by experience. Flooding will allow the larva to move within the water film; if the size of the paper and the amount of water added is too small in relation to the volume of the tube, the paper will tend to dry out and the larva be released. Most papers have too rough a surface and hold too thick a film of water to be suitable. If conditions of work allow, it is better to allow batches of larvæ to remain floating in water in cavity blocks for a few days and then to plant out the larvæ which become akinetic. The corked tubes are inspected at intervals. When a nymph has emerged, it should be preserved in 50 per cent spirit together with identification data. The larval pelt is usually left stuck down by the water film in the circle on the paper slip; it can be floated off gently at leisure and mounted. It can nearly always be identified without trouble, but it helps to have mounted a batch of larvæ from the same host. If fungal growth proves troublesome, it may be kept down by a trace of merthiolate. This is preferably introduced after the larva has become akinetic. It, or a trace of formalin or spirit, may be introduced as a routine to the tube after removing the nymph if the larval pelts are to be kept indefinitely awaiting an opportunity to mount and study them. The comments of other workers who use this technique would be greatly appreciated.

J. R. AUDY
M. NADCHATRAM

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Malaya.
Oct. 13.

Presence of a Peritrophic Membrane in Diplopods

The presence of a peritrophic membrane has been reported in the midgut of the following classes of mandibulate Arthropoda: Onycophora, Crustacea, Insecta and Chilopoda[1]. It has not been reported in the Diplopoda, although Randow[2] stated that the brush border of the midgut epithelial cells may slough off. We have dissected tubular membranes giving a positive chitosan reaction[3] from the midguts of the following British millipedes: *Tachypodoiulus niger*, *Ophyiulus pilosus*, *Iulus scandinavius*, *Cylindroiulus punctatus* (Iulidae), *Glomeris marginata* (Glomeridae), *Polydesmus angustus* (Polydesmidae), *Polymicrodon polydesmoides* (Craspedosomidae) and *Choneiulus palmatus* (Blaniulidae). The presence of a similar membrane has been inferred from paraffin sections of the midgut of *Polyxenus lagurus* (Polyxenidae). In none of these is there an œsophageal valve; it is therefore inferred that the peritrophic membrane arises by delamination of the brush border from the midgut epithelial cells. A delaminating brush border has been observed in *O. pilosus*, *C. punctatus*, *G. marginata*, *P. polydesmoides* and *C. palmatus*. Furthermore, in *G. marginata*, *P. angustus*, *T. niger*, *I. scandinavius*, *C. punctatus* and *P. polydesmoides* concentric peritrophic membranes were seen in sections, a phenomenon often observed when membranes are formed by delamination[4].

We wish to thank Mr. J. G. Blower for his help with identifications.

BETTY MASON
OWEN GILBERT

Merlewood Research Station,
Nature Conservancy,
Grange-over-Sands, Lancashire.
Aug. 27.

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[1] Waterhouse, D. F., *Nature*, 172, 676 (1953).

[2] Randow, K., *Z. wiss. Zool.*, 122, 534 (1924).

[3] Campbell, F. L., *Ann. Ent. Soc. Amer.*, 22, 401 (1929).

[4] Wigglesworth, V. B., "The Principles of Insect Physiology" (Methuen, London, 1950).

Acceleration of Flowering in Non-vernalized Chrysanthemums by the Removal of Apical Sections of the Stem

Vince and Mason[1] have reported recently that unvernalized plants of *Chrysanthemum morifolium* var. Sunbeam can be induced to produce flowering lateral shoots by decapitation of the main shoot. Under the stated conditions the main apex did not bud for a further four to six weeks. They suggest that inhibitory effects from the main apex are responsible for the failure of unvernalized plants to bud.

However, in variety Sunbeam it is in fact quite unnecessary for the main apex to be removed in order to obtain budded laterals. This observation was briefly mentioned in the paper referred to by Vince and Mason[2].

Flowering laterals in the presence of a vegetative main apex frequently appear on plants that have received a slight degree of vernalization. In a recent experiment, four out of four slightly vernalized plants, and twelve out of twenty-four incompletely devernalized plants which failed to bud with their main apices, produced flowering lateral shoots. The entirely unvernalized controls remained vegetative at lateral as well as main apices. A photograph of such plants accompanies a manuscript awaiting publication in the *Journal of Experimental Botany* dealing with the de-vernalization of the chrysanthemum.

As regards the theoretical interpretation of Vince and Mason's results, it may be mentioned that no evidence has been found for translocation of either positive or negative effects in grafting experiments between vernalized and unvernalized partners[3].

W. W. SCHWABE

Research Institute of Plant Physiology,
Imperial College of Science and Technology,
London, S.W.7.
Nov. 4.

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[1] Vince, D., and Mason, D. T., *Nature*, 174, 842 (1954).

[2] Schwabe, W. W., *J. Exp. Bot.*, 1, 329 (1950).

[3] Schwabe, W. W., *J. Exp. Bot.* (in the press).

Zoological Nomenclature

NOTICE is hereby given that, as from April 22, 1955, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purpose specified against each entry. (1) Renier [1804] *Prospetto*; question of validation of four generic names (*Discoides*; *Cerebratulus*; *Polycitor*; *Scolizedon*) published in; (2) Renier [1807] *Tavola*; question of validation of six generic names (*Aglaja*; *Alcyonaria*; *Cystia*; *Rodens*; *Tuba*; *Tubulanus*) published in; (3) names (generic and specific) given to aptychi of Ammonites, suppression of; (4) *Notropis* Rafinesque, 1818 (Cl. Osteichthyes), determination of gender as masculine; (5) *Cheloniceras* Hyatt, 1903 (Cl. Cephalopoda, Order Ammonoidea), designation of type species for; (6) *Argus* Bohadsch, 1761 (Cl. Gastropoda), retention of status for the purposes of the law of homonymy, to preserve *Lysandra* Hemming, 1933, from falling as a synonym of *Argus* Boisduval, 1832; (7) *minimus* Miller (J. S.), 1826 (*Belemnites*) (Cl. Cephalopoda, Order Dibranchia), validation of. A proposal for a 'Declaration' banning names based on aptychi of ammonites is also being made.

Full particulars of these cases appear in Part 9 of Volume 9 of the *Bulletin of Zoological Nomenclature*.

Comments on the above cases should be sent to me as soon as possible.

FRANCIS HEMMING
(Secretary)

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London, N.W.1.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 29

British Society for the History of Science (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. G. J. Whitrow: "Ancient and Mediaeval Hindu Mathematics and Astronomy".

Tuesday, November 30

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. B. A. Rowley: "Psychology and Literary Criticism".*

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. D. Holland: "Prestressed Units for Short-Span Highway Bridges".

Royal Institute of Chemistry, London Section (joint meeting with the Sir John Cass College Chemical Society, at Sir John Cass College, Jewry Street, London, E.C.3), at 6.30 p.m.—Dr. M. A. Phillips: "Synthetic Organic Chemicals in Agriculture".

Society for Analytical Chemistry, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Tenth Annual General Meeting, followed by a discussion on "Possibilities in the Establishment of Standard Samples for the Determination of Some Trace Elements".

Wednesday, December 1

University of London (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. J. N. Davidson: "Recent Developments in the Biochemistry of the Nucleic Acids".

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. J. N. Dean: "The Insulation of Submarine Telephone Cable" (Llewelyn B. Atkinson Memorial Lecture).

Institution of Electrical Engineers, Radio Section (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. H. Page and Mr. G. D. Monteath: "The Vertical Radiation Patterns of Medium-Wave Broadcasting Aerials".

Society for Analytical Chemistry (joint meeting with the Oils and Fats Group of the Society of Chemical Industry, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Meeting on "Methods for the Chemical Determination of Vitamin A".

Society of Visiting Scientists Limited (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion Meeting on "Recent Research on Speech". Chairman: Sir Archibald Gill; Speakers: Dr. D. B. Fry, Dr. E. C. Cherry and Prof. R. C. Oldfield.

Wednesday, December 1—Thursday, December 2

Iron and Steel Institute (in association with the Institute of Metals, at Church House, Westminster, London, S.W.1)—Symposium on "Powder Metallurgy".

Wednesday, December 1

At 9.45 a.m.—Discussion on Papers in Group 1: "Manufacture, Properties and Testing of Powders".

At 2.15 p.m.—Discussion on Papers in Group 2: "Principles and Control of Compacting and Sintering".

Thursday, December 2

At 9.30 a.m.—Discussion on Papers in Group 3: "Manufacture and Properties of Structural Engineering Components".

At 2 p.m. Discussion on Papers in Group 4: "Powder Metallurgy of High-Melting-Point Materials".

Thursday, December 2

University College, London (in the Anatomy Theatre, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "The Magical Statuettes of Ancient Egypt".*

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. J. Grenfell Williams: "Broadcasting in the Colonies".

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. Rosalind Pitt-Rivers: "Thyroid Hormones". (From a series of lectures on "The Scientific Basis of Medicine".)*

Society of Chemical Industry, Road and Building Materials Group (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. D. C. Broome: "The Physico-Chemical Properties of Bitumens as used in Mastic Asphalt".

Institute of Metals (joint meeting with the Chemical Engineering Group of the Society of Chemical Industry, at the University Chemical Department, Woodland Road, Bristol), at 6.30 p.m.—Dr. A. R. Harding: "Thermochemistry of Alloys".

Institute of Physics and the Chemical Society (joint meeting of the Manchester Branches, in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. P. J. Flory (Cornell University): "The Configuration and Properties of Polymer Molecules in Dilute Solution".

British Glaciological Society (at Bedford College, Regent's Park, London, N.W.1), at 7.30 p.m.—Mr. H. Lister: "The Glaciological Work of the British North Greenland Expedition".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, December 3

British Society for the History of Science, Philosophy of Science Group—Northern Branch (in Staff House, The University, Manchester), at 7 p.m.—Dr. W. H. Thorpe, F.R.S.: "The Study of Animal Behaviour and Some of its Implications".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Christopher Hinton, F.R.S.: "Industrial Power from Nuclear Energy".

Saturday, December 4

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. Eric Simms: "A Study in Sound of Some Highland Birds".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer or Assistant Lecturer in Clinical Parasitology in the Veterinary School—The Registrar and Secretary, The University, Bristol (November 30).

Assistant Experimental Officer to work in the Bee Department on bee behaviour—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (December 1).

Research Assistant in the Department of Physics, for duties which will involve general assistance in radio research investigation—The Registrar, University College, Singleton Park, Swansea (December 1).

General Assistant Engineers (2), (with a university degree or equivalent qualifications in electrical engineering or in physics) at the Research Laboratories, British Electricity Authority, Leatherhead, for duties which include research on electrostatic precipitation and allied problems—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting NAT/541 (December 3).

Pathologist (with veterinary or medical qualifications) at the Poultry Research Centre, Edinburgh, to develop a programme of original research using the fowl as experimental material—The Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1 (December 3).

Biochemist, basic grade (with a B.Sc. degree with honours in biochemistry or chemistry, or equivalent qualification)—The House Governor, The General Hospital, Birmingham 4 (December 4).

Head (with a good honours degree, teaching and industrial experience, and preferably with research experience) of the Engineering Department—The Principal, Kingston Technical College, Fassett Road, Kingston-upon-Thames (December 4).

Principal (with a degree in agriculture and sound practical farming knowledge, experience of teaching and administrative ability) of the Brooksby Hall Farm Institute—The Director of Education, County Offices, Grey Friars, Leicester (December 4).

Research Student (graduate in physics or electrical engineering) in Physics—The Registrar, The University, Sheffield (December 6).

Scientific Officer (honours graduate) to carry out ecological and population studies of soil pests as affected by insecticides—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (December 8).

Lecturer or Senior Lecturer (with an appropriate honours degree and preferably with teaching experience) in Mathematics, and Physics and Mechanics, at the R.N. College, Dartmouth—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting 4397/54 (December 10).

Physicist (with H.S.C. (science) or equivalent) in the Ministry of Supply, to assist in environmental physiological research in Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.325/54A (December 11).

Professor (with high academic qualifications and practical works experience in ferrous metallurgy) of Chemistry and Metallurgy, at the Royal Naval College, Greenwich, London, S.E.10—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting 4396/54 (December 14).

Assistant (graduate in science, preferably biochemistry or organic chemistry, and with research and literary experience) to the Chairman of the Editorial Board—Dr. A. Neuberger, F.R.S., *Biochemical Journal*, National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7 (December 18).

Research Officer (Bacteriologist) (with an honours degree in science or agricultural science with bacteriology, chemistry or biochemistry as a major subject, and with postgraduate research experience) in the Division of Food Preservation and Transport, Commonwealth Scientific and Industrial Research Organization, Homebush, N.S.W., Australia, for investigations in the field of microbial physiology; initially studying the effects of freeze-drying—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 300/150 (December 18).

Senior Research Fellow (with experience in wind-tunnel work) in the Department of Aeronautical Engineering, to design new high-speed laboratory equipment and take a leading part in the research work of the Department—The Secretary and Registrar, The University, Southampton (December 31).

Chair of Pharmaceutical Chemistry—The Registrar, The University, Nottingham (January 8).

CHAIR OF PHYSICAL METALLURGY—The Registrar, The University, Sheffield 10 (January 8).

I.C.I. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, ENGINEERING, PHARMACOLOGY or PHYSICS—The Secretary of University Court, The University, Glasgow (February 26).

ASSISTANT, Grade B (graduate of a British university, and with good teaching and/or industrial experience) to teach chemistry in relation to the cocoa, chocolate and sugar confectionery industry; and an ASSISTANT, Grade B (graduate of a British university, and with good teaching and/or industrial experience) to teach biology up to general certificate of education advanced level—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

ASSISTANT (Scientific) IN THE METROPOLITAN POLICE LABORATORY—The Secretary, Room 139, New Scotland Yard, London, S.W.1.

BIOCHEMIST, CHEMIST or PHYSICIST (interested in research in biophysics), to join a small team studying the structure of plant viruses—The Secretary, Birkbeck College, Malet Street, London, W.C.1.

CHEMIST (with considerable experience in the analysis of biological materials, and, in particular, the use of modern techniques, and able to assist in equipping and organizing a new laboratory unit) to take charge of the Analytical Department—The Secretary, Grassland Research Institute, Hurley, near Maidenhead, Berks.

ELECTRICAL ENGINEER/PHYSICIST, Senior Experimental Officer grade (with at least H.S.C. (science) and preferably with a good basic understanding of electronics and practical experience of the generation of high voltage pulses and the measurement of very short time intervals) at Fort Halstead, Kent, to assist in research and development on problems associated with high voltage, high energy electrical discharges—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 290/WGH/2.

ENTOMOLOGIST, PLANT BREEDERS (2), and a SOIL CHEMIST (with an appropriate honours degree, and fully literate in either Arabic or English) in the Research Division of the Ministry of Agriculture, Sudan Government—The Sudan Agent, Sudan House, Cleveland Row, London, S.W.1.

ENTOMOLOGIST, to develop a field technique to control biting midges—Dr. S. D. Kettle, Zoology Department, West Mains Road, Edinburgh 9.

EXPERIMENTAL OFFICERS (3) (with at least Higher School Certificate in science subjects or equivalent) IN THE NUCLEAR PHYSICS DIVISION for research in the study of nuclear transmutations—The Establishments Officer, United Kingdom Atomic Energy Authority, Research Group, Harwell, Didcot, Berkshire, quoting 2/103/181.

PHYSICIST/MECHANICAL ENGINEER, Scientific Officer grade (with a first- or second-class honours degree in physics or equivalent qualification) to undertake studies/research on the mechanical effects of stresses applied to atomic weapons (Ref. 109/WGH/2); and a PHYSICIST or METALLURGIST, Scientific Officer grade (with a first- or second-class honours degree in physics or metallurgy) to carry out fundamental and applied research on reactive inorganic compounds (Ref. 251/WGH/2)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree or equivalent in physics, mechanical or electrical engineering, and with considerable research experience) IN THE ROCKET PROPULSION DEPARTMENT, R.A.E., Westcott, Bucks, to lead a small section engaged in research and rocket motor instrumentation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.321/54A.

RESEARCH OFFICER (with a first- or second-class honours degree in biology and at least two years postgraduate experience in animal genetics) IN THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION, for animal genetics studies in the Animal Industry Division—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.196/151/01.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or equivalent qualification) for basic research into the mechanical properties of certain radioactive metals and alloys—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 272/WGH/2.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or mathematics, and an interest in applying mathematics to practical problems) to carry out theoretical work in connexion with the design of nuclear reactors—United Kingdom Atomic Energy Authority, Research Group, Harwell, Didcot, Berks.

SENIOR BIOCHEMIST (science graduate)—The Medical Superintendent, County Hospital, Stonehouse, Lanarkshire.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics with subsidiary mathematics, and for the post of Senior Scientific Officer at least three years appropriate postgraduate research experience) at Fort Halstead, Kent, to undertake experimental small-scale work on fundamental problems in connexion with the study of phenomena associated with explosions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 209/WGH/2.

TECHNICIAN (preferably with experience in a pharmacological or physiological laboratory) IN THE DEPARTMENT OF PHARMACOLOGY—The Secretary, University College, Gower Street, London, W.C.1, quoting Pharmacology/5.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Aero Research Technical Notes. Bulletin No. 140, August, 1954: "Araldite" in the Napier Surface Heater De-icing Equipment. Pp. 6. (Duxford: Aero Research Limited, 1954.) [249

The Chemical Pathology of Animal Pigments—a Symposium held at the London School of Hygiene and Tropical Medicine on 20 February 1954. Organized and Edited by R. T. Williams. (Biochemical Society Symposia—No. 12.) Pp. v+84. (Cambridge: At the University Press, 1954.) 12s. 6d. net. [249

Privy Council. Medical Research Council Special Report Series No. 284: Intracranial Gliomata—Some Clinical, Radiological and Therapeutic Aspects of 298 Cases. By John Pennman and Marion C. Smith. Pp. v+70. (London: H.M. Stationery Office, 1954.) 5s. net. [249

Report of the Technical Colleges and Industry Conference. (Organized by the F.B.I. Education Committee, and held at Ashorne Hill, Leamington Spa, Warwickshire, 5–7 May, 1954.) Pp. viii+88. (London: Federation of British Industries, 1954.) 4s. 6d. [249

Scottish Home Department. Marine Research, 1954—No. 2: The Food of the Whiting, and a comparison with that of the Haddock. By R. Jones. Pp. 34. (Edinburgh: H.M. Stationery Office, 1954.) 7s. net. [249

Department of Scientific and Industrial Research. Geological Survey and Museum. British Regional Geology. The Pennines and Adjacent Areas. By W. Edwards and F. M. Trotter. Based on previous editions by Dr. D. A. Wray. Third edition. Pp. v+86+12 plates. (London: H.M. Stationery Office, 1954.) 5s. net. [249

Department of Scientific and Industrial Research. Selenium: a Short Review of its Production and Utilization, with reference to the current shortage. By R. Ashton, R. G. Hill and D. Neville-Jones. Pp. iv+30. (London: H.M. Stationery Office, 1954.) 1s. 6d. net. [249

A Critical Review of the World Literature on the Lepidopterous Stalk Borers of Tropical Graminaceous Crops. By Dr. W. F. Jepson. Pp. vi+127. (London: Commonwealth Institute of Entomology, 1954.) 15s. [249

Aluminium Development Association. List of Films, Film Strips and Wall Charts. Pp. 20. List of Publications. Pp. 26. (London: Aluminium Development Association, 1954.) [249

Other Countries

Indian Council of Agricultural Research. Bulletin No. 74: Bibliography of Soil Science and Fertilizers with reference to India. Compiled by K. K. Guha Roy. Pp. iv+131. (Delhi: Manager of Publications, 1954.) 6 rupees, 2 annas; 9s. 6d. [249

Union of South Africa: Department of Agriculture. Science Bulletin No. 338 (Chemistry Series No. 193): Fertilizer Experiments at the Vaalharts Agricultural Research Station 1946–1950. By D. G. Wessels and T. P. Pretorius. Pp. 76. 1s. Science Bulletin No. 350 (Agricultural Education and Research Series No. 11): Agronomy Experiments at the Vaalharts Agricultural Research Station 1946–1950. By W. Van der Merwe, D. G. Wessels and T. P. Pretorius. Pp. 70. 1s. (Pretoria: Government Printer, 1954.) [249

Discours prononcés à la Manifestation d'Hommage à Victor van Straelen—Directeur de l'Institut Royal des Sciences Naturelles de Belgique, 1925–1954. Pp. 39. (Bruxelles: l'Institut Royal des Sciences Naturelles de Belgique, 1954.) [249

Sudan Government: Ministry of Agriculture. Bulletin No. 10: Commercial Horticulture in the Sudan. 1: Citrus Cultivation. By J. Robbie and F. W. Fisher. Pp. ii+56+8 plates. (Khartoum: Agricultural Publications Committee, 1954.) 20 p.t. [249

Smithsonian Institution. Bureau of American Ethnology. Bulletin 152: Index to Schoolcraft's "Indian Tribes of the United States". Compiled by Frances S. Nichols. Pp. vi+257. 1.25 dollars. Seventieth Annual Report of the Bureau of American Ethnology, 1952–53. Pp. ii+33. (Washington, D.C.: Government Printing Office, 1954.) [249

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THE UNIVERSITIES AND THE COMMUNITY

In recent months there have been many discussions, lectures and even books on the purpose and function of universities. These institutions, many of them of venerable age and with long traditions, have had to meet changing conditions, and are indeed successfully adapting themselves to the needs of the times. In that process, however, they need all the support which an enlightened public opinion can give them.

A recent book in this field, Dr. Robert M. Hutchins's "The University of Utopia", is particularly interesting and has already been mentioned in these columns. Dealing with the hazards to education arising from industrialization, Dr. Hutchins makes it clear how serious may be the consequences of any narrow view of education, even at the technical, let alone the university, level. He fully recognizes the difficulty of making work significant in an industrial, mechanized economy. None the less, he maintains, like Mill, that the true strength of a democratic society lies in the character of its citizens. Indeed, there is much in his book that is relevant to the debate on university entrance requirements raised by the pamphlet recently issued by the Joint Matriculation Board. That pamphlet, affirming a belief in the value of the broad-based entry, argues that without the protection which such an examination affords, the schools, and especially the smaller ones, would be exposed to the narrowing influences of vocational demands, which could not easily be resisted.

There is much support for this argument; but whatever the decisions as to where the basis of education is to be broadened, it should not be taken without a clear conception of what is involved. Like the Utopians described by Dr. Hutchins, we should first ask ourselves what it is we are trying to do, and have regard not merely to the vocational demands but also to the implications of education for leisure and the purpose of university education, before we prescribe its content. We must, as Sir Charles Morris emphasized last spring in his Joseph Payne Memorial Lectures on "The Idea of University Education" (published in the *Universities Quarterly* of August and November 1954), recognize that there are limits to what a university can give in the short span of a student's life at a university. Moreover, if for the reasons which Dr. Hutchins, A. N. Whitehead, Sir Charles Morris, Sir Hector Hetherington and others agree in giving, a university is not concerned to impart a stock of information or of tricks of some specialized trade, we must be quite clear as to what a university should seek to give its students by way of preparation for their future careers.

It is by the influence that it exerts upon the subsequent lives of action of its graduates that university education will be mainly judged, as Sir Charles Morris rightly remarks; and the answer he gives to the question what can the university do to encourage the development of the faculties and capacities by which young people will be able to make the judgments necessary for their actions and decisions if they are to serve their generation as rational, educated men and women, is first and foremost that it should impart a sturdy faith in the power of reason in human affairs. It may be taken for granted that personal contact between teachers and taught, as well as between students—which not only makes for education in living but also contributes to the ability to communicate with others—is no less important than the grasp of fundamental ideas. Further, the faith in the power of reason and the ability to communicate with others are not only the essentials of an educated man or woman; they are equally the conditions for the survival of democratic society.

It follows, therefore, that if the universities put first things first and are really carrying out their educational responsibility, they are once again making their protest against the isolation of man from man of which John Richard Green wrote, and they will at the same time renew that contact with the world outside which Mansbridge stressed as so important when he was writing of the older universities. In serving this ideal, the variation in method between university and university in the pursuit and exposition of knowledge for its own intrinsic sake may be quite immaterial. Indeed, as Sir Ernest Barker has commented, poor accommodation may often be a spur to good education; at least it is no obstacle in inculcating the habit of learning.

But it must be remembered that a university is also a home of learning, a place where our inheritance of knowledge is increased and kept alive—a place, in Whitehead's words, for the imaginative acquisition of knowledge. Sir Charles Morris, pointing to the achievements of recent years, remarks that imagination cannot have been entirely atrophied in the specialist of to-day in his youth; but none the less, he wonders whether specialized success is to some extent being bought at the cost of starvation of the imagination and of *élan*. Certainly that is a danger to which the university teacher could easily be exposed, both through outside pressure and a general failure to understand the purpose of a university, and through confusion as to the proper place of research in the work of a university.

While, however, the vigorous quest for new knowledge is necessary to maintain the vitality of university teaching, it is less certain that the dedicated research worker benefits by giving up some of his energy in teaching; and there can be no doubt at all that many students who are induced to undertake research neither profit by it themselves nor obtain results of high importance in their investigations. Without restricting entry to a university to anything like the extent which characterizes the University of Utopia described by Dr. Hutchins, or transferring to other institutions, such as the colleges of technology, much of the vocational education or training at present given in British universities, it would still seem worth while to reconsider the place of research in university work. While ensuring full opportunity for research for the university teacher, it might be wise not to encourage the undergraduate and postgraduate student to take up research, unless he shows distinct promise of contributing to knowledge or benefiting significantly by such activities. Even for the university teacher, it is as well to remember Dr. Hutchins's caution as to the importance of reflective thinking. What a university teacher or student needs above all is time for reflexion: when other activities, no matter what they are, leave the teacher or student no time for serious thinking, the university is missing its mark.

Here, as in discussing the educational function of the university, Dr. Hutchins's message for the British reader is a warning of the importance of maintaining standards. There is little reason for thinking that British universities are in any grave danger of making excessive concessions to vocational training, though the warning is one to be kept in mind, particularly in planning the expansion of technological and of technical education. Narrowness of mind, inability to take broad views and obtuseness in handling other men are more likely to arise from over-specialization in school, and the preoccupations caused by extra-mural pressures may well limit the ability of the university to correct such defects or tendencies within the span of three academic years. None the less, the warning is timely, and the way in which Dr. Hutchins sets his University of Utopia, not merely at the apex of the educational system but also against the social background, reminds us that the success with which the universities pursue and impart learning with imagination, breadth and vision depends not on themselves alone, but on the co-operation of the schools and the understanding and support of public opinion. Where support is withheld, and lack of understanding circumscribes the activities of the university and infringes its freedom of investigation and discussion, the lighted torch burns dim. It can only be handed on flaming strongly when the purpose and functions of the university are clearly understood and strongly upheld by the community of which the university is part.

DESIGN OF STEEL BUILDING FRAMES

The Steel Skeleton

By Prof. J. F. Baker. Vol. 1: Elastic Behaviour and Design. Pp. xi+206+4 plates. (Cambridge: At the University Press, 1954.) 42s. net.

THIS is the first volume of a new two-volume work by Prof. J. F. Baker on the scientific study and logical design of the steel building frame. The second volume, yet to appear, will deal with the plastic behaviour of the structure and will, without doubt, be the more eagerly awaited part of the work. The present volume is largely historical in its content. It shows, step by step, how the logical attack on the problem developed, and what stage has now been reached in the study of the elastic behaviour of the steel frame. The first nine chapters describe the activities of the Steel Structures Research Committee in its seven years of active investigation (1929–36) of stresses in building frames. The necessity of such repetition of published work might well be questioned, but justification lies in the fact that, after the bombing of the Second World War, relatively few of these reports were in existence.

The Committee, of which Prof. Baker was technical secretary, found the conventional, simple method of design to be irrational and inexact. As a result of many tests on existing buildings, on a specially constructed frame, and on laboratory specimens, a new and rational method of design was devised. This method is, once more, described by Prof. Baker. In 1936 when it was first put forward as a solution to the problem of the steel frame, designers found it complex and time-consuming, and discovered also that there was no significant economy in the amount of material used. The semi-rigid steel skeleton was also sensitive to settlement and to variations in workmanship and materials, and the new recommendations were ignored.

Perhaps Chapter 14, "The Reception of the Recommendation", with its closely argued and critical review of the attempts made to guide the designer of steel frame, is the part of the book which carries the most vital lesson for the engineer. The first publication of the Steel Structures Research Committee (1931) comprised a "Code of Practice for the Use of Structural Steel in Building". This was meant to be of temporary assistance to engineers until the results of research could be made public. It was based, as all codes of practice tend to be, on current practice. It looked back while the Committee looked forward. In spite of that, its terms were embodied in London County Council regulations and in British Standards Specification 449, and it controlled the design of steel frames in Britain until 1948.

After the tacit rejection of the Committee's research by the disregard paid to its recommendations, a further attempt was made by a joint committee of the Institution of Civil Engineers and the Institution of Structural Engineers to draw up a revised code of practice which would be more acceptable to the profession and yet embody much of the new knowledge as yet unused. A war-time Steel Structures Committee supported this revised code of practice.

Coming nearer the present day, Prof. Baker describes the new British Standard 449 of 1948. The new Standard describes both semi-rigid and fully-rigid design methods—the first official encouragement for the rational methods reported in 1936. The revision, however, does not constitute a real acceptance of the ideas of the Steel Structures Research Committee, and Prof. Baker sees in B.S. 449–1948 a potential if not a present danger. The B.S.S. 449 of the 1930's showed the current practice; the Committee pointed the way to the future. B.S. 449–1948 is neither based on long-established practice nor firmly on the Committee's findings. It has taken a step in an unknown direction. When this Standard comes up for revision, Prof. Baker fears a further step 'over the edge'.

We are now approaching the nineteenth year since the behaviour of the steel skeleton in the elastic field was first defined, and logical answers given to design problems. At the Building Research Congress in 1951 there were signs that the designer is still searching for an answer to these problems and perhaps inclined to look at the views of the Steel Structures Research Committee. This volume, with its wealth of scientific results and deductions and its history of a rather unhappy and confused chapter in the history of structural engineering, comes as a salutary lesson. Prof. Baker, perhaps unnecessarily kind to the reader, makes the confusion of codes and recommendations less confused by omitting all reference to Code of Practice 113 which appeared at about the same time as B.S. 449–1948, and conflicted with it in a way which did no credit to the co-ordinating ability of engineers. The designer can learn much from this book—much of technical value in his work and much of the gulf which still exists between the scientific research worker pushing ahead in new fields and the so-called 'practical' man, too often afraid to adventure where the man of science has trod.

As a minor criticism it should be noted that the British Standards Institution abandoned the use of the word "Specification" some years ago. Its publications are "British Standards". Finally, why should this volume be 10¼ in. high? It will be a physical embarrassment to shelves adjusted to other 'structural' publications. W. FISHER CASSIE

HONEYBEES AND THEIR ACTIVITIES

The World of the Honeybee

By Dr. Colin G. Butler. (The New Naturalist: a Survey of British Natural History.) Pp. xiv + 226 + 42 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 21*s.* net.

RECENTLY a church window has been dedicated to the Rev. Charles Butler, whose famous book the "Feminine Monarchie" appeared a little less than 350 years ago (in 1609). It is a pleasure to review a contemporary book by his namesake, and one is tempted to begin with a comparison between the two books, which encompass modern progress in our knowledge of the ways of the honeybees. Thus the older Butler's discovery that not the queen but the drone is the male bee is now generally accepted, but his assumption that drones and workers mate and the latter lay eggs has been refuted. His opinion that the workers "by this sense [of smell] find out any strange bee, which is not otherwise to be known from his own company", has after several decades of disbelief been verified and amplified by recent experiments. Altogether, it appears that progress was made by controlled experiments rather than by observation alone.

Dr. Butler's comparative and evolutionary approaches to such subjects as social organization in general and to more special topics like swarming and communication are, of course, modern features.

The author's recently published discovery of a 'queen substance' and of some of its properties form the book's most original part. This somewhat fugitive substance may be a part of the waxy covering of the queen's body, or more probably of the volatile solvent in which the wax is believed to be secreted. A small number of the workers of a colony obtain queen substance by licking the body, particularly the abdomen, of their queen and then offer food to other members of their colony, thus widely distributing some of the substance. So long as sufficient queen substance is in circulation, the bees of a colony are as a rule in a state of organized activity. But when the queen is lost or becomes enfeebled, disorganized restlessness ensues, sometimes after a few minutes, and regulatory processes like the building of emergency queen cells, the transplantation of young larvæ or supersedure are observed after a few hours or days. On the other hand, supernumerary queen cells or young virgin queens, which are ordinarily destroyed, are then tolerated. A large colony of bees needs more queen substance than a small colony, and it is probably the relative scarcity of this substance which results in the production and toleration of the young queen and thus in swarming.

The work of other bee-workers which Dr. Butler has incorporated in the text is necessarily restricted, but the emerging picture is on the whole correct and well balanced. An error concerning the sun orientation of bees occurs on p. 199; experiments by Wolf apparently demonstrating that bees trained to a feeding place in sunny weather and afterwards caged and kept there for an hour return in a wrong direction, as the sun had moved on, are probably wrong. More recent experiments by Meder, referred to by v. Frisch in 1952, indicate that captive bees—like any other bees, but unlike ants—take the daily movement of the sun into account when they use it for orientation.

The author is to be congratulated on the exquisite photographs—eighty-seven in black-and-white and two in colour. For readers whose appetite has been whetted, a list of books is furnished where references to the original literature and the description of research techniques can be found. There are author and subject indexes. H. KALMUS

LOGARITHMETICA BRITANNICA

Logarithmetica Britannica

Being a Standard Table of Logarithms to Twenty Decimal Places of the Numbers 10,000 to 100,000. By Dr. Alexander John Thompson. Vol. 1: Numbers 10,000 to 50,000, together with a general introduction. Pp. xcviii + Tables. Vol. 2: Numbers 50,000 to 100,000. Pp. iv + Tables. (Issued by the Department of Statistics, University College, London, to commemorate the tercentenary of Henry Briggs' publication of the *Arithmetica Logarithmica*, 1624.) (Cambridge: At the University Press, 1952.) £8 8*s*. net the set.

THE invention of logarithms by John Napier and the introduction of the number 10 as base by Henry Briggs have led to tables which have been of inestimable benefit to computers for three centuries. Many hands and very many years were needed, however, before tables known to be completely accurate became available. During this period, also, tables were given to fewer and fewer decimals, culminating in the familiar tables to four, five or six decimals that are in everyday use. This is, in fact, one of the means by which accuracy was ensured—by concentrating on fewer figures.

It is true that the growing use of calculating machines has diminished the need for logarithms among professional computers, but many remain who use them for preference or because other equipment is inaccessible; these workers mainly need relatively few figures.

The logarithm also has other users among computers, for it remains a function in its own right, and has applications quite apart from its employment as a method for converting multiplication to addition, and easing other calculations. Certainly, as a function in analysis it is the natural logarithm, to base e, which arises alongside exponential, circular and hyperbolic functions; but the relation between the two is simple, and evaluation for an arbitrary argument is rather more easily carried out with common logarithms. There exists, then, a need for a fundamental table of logarithms, which shall be definitive, in that it should be completely accurate, and should have a number of figures adequate for all needs which may be reasonably expected, and should, moreover, be easy to interpolate.

In the tables under review, A. J. Thompson meets this requirement for a definitive table in a remarkable manner. The only other tables of comparable extent—giving the logarithms of a hundred thousand numbers or more—whether to base e or base 10, have fifteen decimals only, and none of these makes full provision for interpolation by differences. Thompson, in his tables, gives twenty-decimal logarithms of all integers to 100,000, together with second and fourth differences—all that are needed for interpolation. The introduction discusses very fully the various ways in which interpolation can be effected, and is a mine of information. It is not stated there that δ^4 can be dispensed with from about 23,000 onwards, by replacing δ^2 by $\delta^2_m = \delta^2 - 0{\cdot}184\delta^4$, the "modified difference" of Comrie; but it is only fair to mention that Thompson has a strong dislike of *ad hoc* methods of this nature.

To the initiated there is little need to defend the twenty-decimal accuracy in a fundamental table, but it may be worth while to state reasons for welcoming such a choice. Makers of fundamental tables have to carry out exploratory calculations in preparing tables to eight- or ten-figure accuracy which will later form a basis for accurate tables to fewer figures. In these exploratory calculations it is very common to meet a quantity as the difference of two others which may agree to three, five or even ten figures. This is certainly a challenge to the mathematician to find an expression for the difference directly; but, while devising this, he does not want to be held up by being unable to get a value at all in the meantime. Again, in step-by-step processes, errors may accumulate rapidly, or even grow exponentially—another challenge, but often avoided by using extra figures when to accept the challenge involves side-tracking; the use of the recurrence formula for the Bessel function $J_n(x)$ provides an example of this. These two reasons alone, occurring week by week over centuries, provide an adequate justification for tables like the present one.

This table was conceived originally as a tribute to the memory of Henry Briggs and the first part was published in 1924, the tercentenary of the publication of Briggs's "Arithmetica Logarithmica". The ninth and last part to be published appeared in 1952, and the whole work is a monument, which will last, to the effort and perseverance of one man. Thompson set out to explore the possibility of preparing a table which could be interpolated by means of even central differences with Everett's formula. He found that he needed to design a calculating machine, illustrated opposite p. lv of Vol. 1, to make reasonably possible the computation of logarithms by summation from fourth differences. When he had prepared the manuscript, and subjected it to checks of a most exacting nature, the problem of publication had to be faced.

A. Fletcher, in Art. 6.1 of the "Index of Mathematical Tables", lists fundamental tables of logarithms, and gives ten substantial tables to twelve decimals or more. Of these, three only have been published: Thompson's table to twenty decimals;

Briggs's table (in 1624) to fourteen decimals; and the table of Spenceley, Spenceley and Epperson (in 1952, by the Smithsonian Institution) which gives twenty-three decimals, but has only ten thousand arguments. The difficulties of publication are clear, and the remarkable achievement of Thompson in purchasing a Monotype keyboard and setting up the whole table himself is thereby enhanced. A single-handed effort of this nature deserves publicity: Thompson, virtually single-handed, has computed, checked, set up in type and proof-read the whole of the tabular material of more than nine hundred pages, and the checks and proof-reading have been as thorough as the most exacting of table-makers—that is, Thompson himself—could desire.

The tables are accompanied by interesting and valuable introductory matter on interpolation and on the construction of the tables, and include several auxiliary tables of logarithms and antilogarithms to twenty-one decimals. A translation by J. T. Foxell of "The Life of Henry Briggs", by Thomas Smith (1707), is also included. This is a book to last for centuries and should be in all computing libraries.

J. C. P. MILLER

VIBRATION IN ENGINEERING STRUCTURES

Introduction to a Study of Mechanical Vibration

By G. W. Van Santen. (Philips' Technical Library.) Pp. xvi+296. (Eindhoven: N. V. Philips' Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd., 1953.) 35*s*.

THE author of this book regards sinusoidal strains as the *bête noire* of the engineer, and in consequence his main concern is with the measurement, origin and elimination of mechanical vibration in engineering structures. The earlier chapters develop in a readable and competent manner the standard theory of the behaviour of simple mechanical systems, both idealized and of engineering importance, vibrating at or near a natural frequency.

Chapter 9, on vibration propagation, raises the question of the degree of over-simplification which is allowable in a volume which professes to be an introduction. The section here on the velocity of transverse waves in a bar achieves excessive over-simplification by assuming that the lateral displacements arise entirely from shear strains. The propagation of shear waves is best illustrated by the torsional case, given later, which lends itself quite simply to an exact analysis. The transverse wave is more complex, but could be introduced with profit in an alternative over-simplified form by assuming that bending strains are predominant. This would lead to a logical introduction of dispersion, which is only vaguely hinted at in the book. A similar question of over-simplification is presented in the rather naïve discussion of fatigue; for example, the statement that fatigue failures "are not accompanied by any distortion of the part" is misleading without further qualification.

The chapters on vibration measurement and its associated pitfalls constitute the most valuable part of the book, in which the author clearly enters his special field. The reader hoping to acquaint himself with a representative selection of measuring instruments may be a little disappointed to find the examples drawn almost exclusively from those marketed by the author's company; but the range turns out to be sufficiently extensive to form the basis for adequate discussion.

The book is well produced at a price which represents fair value for money by present standards, but this edition would be improved by more diligent proof-reading. The translation from the Dutch is good, but in parts the ideas do not flow so sweetly as they might. The volume can be strongly commended to the attention of those concerned with the experimental analysis of vibration in engineering structures. The most serious student who seeks a sound basis from which to attack the more advanced theoretical aspects would do well to peruse den Hartog first, for in the book under review he will miss the fascinating examples which are a sure means of providing a grasp of the fundamental principles.

K. M. ENTWISTLE

Rh BLOOD GROUP

Rh–Hr Blood Types

Applications in Clinical and Legal Medicine and Anthropology. Selected Articles in Immunohematology. By Prof. Alexander S. Wiener. Pp. xii+764. (New York: Grune and Stratton, Inc., 1954.) 11.50 dollars.

An *Rh–Hr* Syllabus

The Types and Their Applications. By Prof. Alexander S. Wiener. (Modern Medical Monographs—No. 9.) Pp. xii+82. (New York: Grune and Stratton, Inc., 1954.) 3.75 dollars.

IT was in 1940 that Landsteiner and Wiener described the *Rh* blood group, and since then research into this particular group has been continuously carried out by workers all over the world. It has become the most complicated human blood group and is now known to be of clinical importance; the studies that have been made have added considerably to our knowledge of human genetics.

Prof. A. S. Wiener has made very many contributions to this work, and the first of these two books, "*Rh–Hr* Blood Types", consists of a selection of the author's papers bound together. Research workers will have read most of Prof. Wiener's papers, but in any event this is a book for the specialist and it may be useful to have a number of selected reprints bound together, since it makes reference to points of detail much easier.

The other work, "An *Rh–Hr* Syllabus", is a little monograph about the *Rh* blood group, its relationship to disease and anthropological and medico-legal applications. I liked this little book and found it pleasant and readable; persons with no special knowledge of blood groups will find it useful and helpful.

One of the difficulties about the *Rh* factor is that there are two separate systems of notation depending upon the theory one holds about this blood group. Prof. Wiener puts forward his theory of multiple allelic genes and his *Rh–Hr* notation and dismisses the Fisher–Race notation used by most British workers. It is a pity, too, that Prof. Wiener has extended the difference in notation by using anti-F and anti-J for what are known to most British workers as anti-Fy^a and anti-Jk^a antibodies. It is to be hoped that the notation difficulties in this field will be resolved satisfactorily in the course of time.

F. STRATTON

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS BY DR E. D. ADRIAN, O.M., P.R.S.*

AWARD OF MEDALS, 1954

Copley Medal: Sir Edmund Whittaker, F.R.S.

WHITTAKER is probably the best-known British mathematician by reason of the numerous, varied and important contributions which he has made and the high offices which he has held. For many years he was the head of the flourishing mathematical school at Edinburgh which owes its whole being to his activity.

His work shows extraordinary versatility. He has written five outstanding books, on entirely different subjects, and some fifty to sixty papers which touch on almost every branch of pure and applied mathematics. Of his books, perhaps the most important is "A History of the Theories of Aether and Electricity", which he has just completely rewritten in a second edition of two volumes. This great work gives a critical appreciation of the development of physical theory up to the year 1925. All his writings show, besides their more technical qualities, powers of arrangement and exposition of a most unusual order; and his treatises of dynamics and analysis have had a considerable influence on mathematical thought both in Great Britain and abroad.

It is only possible to mention a few of Whittaker's original contributions to knowledge (beyond the considerable number absorbed in his books). He has made important additions to the theory of the solution of differential equations, ordinary and partial, by definite integrals; to the theory of Lamé and Mathieu functions, the functions of the elliptic and parabolic cylinders, and the integral equations associated with them; to the theory of interpolation; and to the theory of the solution of dynamical problems by trigonometrical series. He has also, in recent years, made a number of interesting contributions to the pure mathematics of relativity, electromagnetism and quantum theory. The astonishing quantity and quality of his work are probably unparalleled in modern mathematics, and it is most appropriate that the Royal Society should confer on Whittaker its most distinguished award.

Rumford Medal: Dr. C. R. Burch, F.R.S.

Dr. Burch has made outstanding contributions in the development of new techniques for the production of high vacua. Using a molecular still of his own design, he produced a range of oils, greases and waxes having very low vapour pressures. He developed modified diffusion pumps suited to these low vapour-pressure oils which in very many cases have made the use of refrigerants unnecessary and have superseded the mercury diffusion pump. With these pumps and various other devices he pioneered high-vacuum engineering as we know it to-day. Some of its products—continuously evacuated valves, high-voltage tubes, X-ray crystallographic tubes, aluminizing tanks, etc.—he also designed in the early period. These developments have formed an essential part of the design of the high-vacuum devices used in the production of high-speed particles.

Many of the joints in Burch's original pieces of apparatus involved the use of flat surfaces, and he became interested in the science of optics necessary for the study of the production of surfaces to very accurate shapes, and devised a technique for making microscopic phase-retarding disks needed for testing them by phase contrast.

This was one of the techniques used in his next achievement—the perfection of the reflecting microscope. Although the principle of the instrument has long been known, Burch has been responsible for making it practically useful. His theoretical consideration of the problem showed for the first time the conditions under which good results can be expected and the limitations which must be faced.

The introduction of reflecting microscopes may well produce revolutionary changes in many aspects of microscopy, including microbiology. Since the system is wholly achromatic, it remains at the same focus for all wave-lengths. Identification of substances by plotting the absorption curve in the ultra-violet can now be made by the use of a reflecting microscope and a continuous spectrum, and the possibilities of microscopy in the infra-red are greatly extended.

Royal Medal (A): Sir John Cockcroft, K.C.B., C.B.E., F.R.S.

Sir John Cockcroft turned to physics after an early training as an engineer. In conjunction with Dr. E. T. S. Walton he was the first to transmute elements by purely artificial means, setting the crown on Rutherford's work which had proved that bombardment by α-particles from radioactive substances could transmute many of the lighter elements. Cockcroft's work in this field is outstanding both for its scientific consequences and as a discovery in technique. The original experiments of Cockcroft and Walton are the seed from which has grown the whole new science of nuclear chemistry, in which artificially accelerated particles are the reagents which produce varied changes in the nuclei of elements which they bombard. Indeed, a large fraction of the researches now being carried out in the physics laboratories in Great Britain and in the United States arise directly from his work.

Shortly before the Second World War began, Cockcroft had realized the great importance of radar methods of aircraft detection for the defence of Britain, and his influence at the Cavendish Laboratory and later at Malvern was of decisive importance in the development of radar.

In 1944 Cockcroft returned to nuclear physics and was in charge of a large group of British, French and Canadian scientists working on plutonium production, first in Montreal and then at the newly developed

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* Delivered at the Royal Society on November 30.

Canadian research establishment at Chalk River. When, after the War, the Atomic Energy Research Establishment was set up at Harwell, Cockcroft became its director. Under his guidance it expanded rapidly, and at the same time provided much of the basic information needed for the large-scale production of plutonium in Britain. He has maintained a balance between pure and applied research which has built up in the Establishment a fruitful research atmosphere and has led to important new developments in the use of atomic energy.

Royal Medal (B): Prof. H. A. Krebs, F.R.S.

Prof. H. A. Krebs has made unique contributions to our understanding of the intermediary metabolism of nitrogenous substances and of carbohydrates in living cells, and in his recent work he has helped to bridge the gap which exists between our understanding of the chemical activities of cells and of the way in which these activities help to maintain ionic gradients within the living organism. In the course of these researches he has devised many valuable new methods for the study of cell metabolism.

The main advances for which he has been responsible are numerous and varied. In the realm of nitrogenous metabolism he was able to demonstrate the catalytic function of ornithine in the conversion of ammonia and carbon dioxide to urea by liver tissue. In his work on amino-acid metabolism he showed that kidney and liver tissues contain the system which oxidizes L-amino-acids, while kidney extracts have an active D-amino-acid oxidase; these important enzyme systems attack amino-acids to form ammonia and the corresponding keto-acids.

He discovered the metabolic reaction by which proline can be converted into glutamine, and he has shown the basic significance of glutamine in the inter-related metabolism of amino-acids and carbohydrates, and also in the transport of ions across cell membranes.

His greatest discovery is the tricarboxylic acid cycle, commonly referred to as the Krebs citric acid cycle. This is now accepted as one of the principal means of biological oxidation. Its basic significance in cellular metabolism scarcely needs emphasizing, for it accounts for the complete oxidation to carbon dioxide and water of the two-carbon fragments which arise in the intermediate metabolism of most kinds of foodstuffs.

In his recent work he has helped to clarify the means by which ions and small molecules are transported within the cell.

In 1953 Krebs was awarded the Nobel Prize for Medicine, jointly with Fritz Lipmann, and the award is an indication of the great value of his discoveries to the advance of biochemistry.

Davy Medal: Dr. J. W. Cook, F.R.S.

Cook is distinguished mainly for his contributions to our knowledge of the polycyclic aromatic compounds, the carcinogenic hydrocarbons and the tropolones, including the alkaloid colchicine.

During the period 1920–28 he carried out an extensive series of investigations on derivatives of anthracenes and related complex hydrocarbons, in the course of which a new type of molecular rearrangement was discovered. He then turned to the chemistry of carcinogenic hydrocarbons and synthesized many homologues and derivatives of 1:2-benzanthracene which were found to be carcinogenic; from these and other studies, indications of the nature of the chief carcinogenic agent in coal tar pitch were deduced. Further, Cook was able to enunciate certain broad generalizations regarding the structural conditions necessary for carcinogenic action within this group of compounds. By fractionating 2 tons of coal tar pitch he isolated the pure potent crystalline carcinogen, and with the aid of fluorescent spectroscopy this agent was shown to be 3:4-benzopyrene, identical with a synthetical specimen. Thus Cook was able to demonstrate for the first time the nature of tar and certain mineral oil carcinogenic agents, results which have proved invaluable in studies of certain aspects of the cancer problem.

During the period 1939–54 Cook made outstanding contributions to our knowledge of the alkaloid colchicine and to the chemistry and synthesis of the tropolones. The novel and now accepted structure for colchicine is based almost entirely on Cook's early studies, which stimulated activity in a number of other laboratories.

More recently Cook has extended his studies to the examination of the structure of metabolic products of the carcinogen, 3:4-benzopyrene, and to the oxidation of benzenoid hydrocarbons by novel methods.

In these original studies Cook has tackled a series of extremely difficult and complicated problems with an exceptional knowledge of general organic chemistry coupled with great experimental ability. In the course of his purely chemical studies, Cook has been quick to detect the biological significance of his results, and his findings have provided weapons of attack, if not the keys, to a number of problems in the biological field. Of the results which Cook has achieved, it can be said that they have fundamental importance either to general organic chemistry or to biology or to both.

Darwin Medal: Dr. E. B. Ford, F.R.S.

Dr. E. B. Ford, reader in genetics in the University of Oxford, has made important contributions to all departments of genetics; and, in particular, he has extended and enriched Darwinian thought in two crucial ways: first, the reformulation of Darwinism in terms of the Mendelian theory of inheritance, and second, the extension of Darwinian theory to natural populations.

Ford is the foremost authority on the genetics of Lepidoptera. In studies of a single natural population of moths continued over many years, he was able to show that the genetic diversity of the population varied with its size. Rapid increase of numbers was accompanied by an outburst of variation; in leaner years the individual members of the population were highly uniform. Ford used wing coloration in moths of the genus *Abraxas* to demonstrate the fundamental truth that the 'dominance' of a gene is profoundly influenced by the action of other genes, and therefore by natural selection; with the effect that a factor intermediate in its expression in the heterozygous state could be caused to become dominant or recessive at will. More recent work on Lepidoptera has shown up with particular clarity the sensitivity of the response of even small natural populations to the influence of selection: in altering the genetical structure of such a population, natural selection has proved to be a more potent influence than the vagaries of random mating and random survival. As a corollary, Ford has shown that genetical variants which a superficial and subjective judgment have dismissed as being 'trivial' or of no adaptive significance cannot in reality be so regarded. This work, much of it carried out in collaboration with Sir Ronald Fisher, has clarified and strengthened Darwinian theory in a most important degree.

A complete understanding of Darwinian theory must in the long run turn upon a knowledge of how genetical factors exercise their effects in development. In this field, too, Ford has made important contributions. In collaboration with Dr. J. S. Huxley he showed that one important means by which different genes produce their several effects is by influencing the rate rather than the nature of chemical reactions. More recent work on the genetical basis of wing-coloration in Lepidoptera has been distinguished by the way in which Ford has bent chemical methods to the solution of biological problems.

A single example may be given of Ford's wider influence on genetical thought. At a time when many geneticists were still preoccupied with the analysis of single-character differences and their rules of segregation, Ford was particularly insistent on the need for appreciating the concerted and harmonious action of the assembly of genes considered as a whole, and his concept of the 'gene complex' has had an important effect on the general background of genetical thought.

Dr. Ford's work thus very evidently merits the Society's award for work "of acknowledged distinction in the field in which Charles Darwin laboured".

Hughes Medal: M. Ryle, F.R.S.

Martin Ryle is the leader in the recent developments in radio-astronomy in England. By adapting war-time techniques, he developed a radio analogue of the Michelson stellar interferometer, and he showed how it could be used to detect localized sources of radiation against a continuous background.

With these new and powerful methods he has been able to demonstrate that the solar radiation comes roughly from the area of the visible disk, and that sunspot radiation comes roughly from an area the size of the spot and is often circularly polarized. He showed that there are a large number of radio-stars, and he has detected and roughly located about a thousand of these. He measured the position of a few of them with such accuracy that the optical astronomers have been able to identify them with visible objects. He developed a Fourier analysis method for measuring the distribution of emission across the solar disk and has used it to show that this distribution is unsymmetrical and varies with time. He has used the occultation of a radio-star by the solar corona to investigate the scattering of waves by the corona. He showed that the scintillations of radio-stars were produced by scattering in the ionosphere, and he has used the observations to investigate ionospheric irregularities and their movements.

Ryle has always been very productive of theoretical ideas to account for his observations, and he has pointed out their interesting consequences for cosmological theory.

He has shown that he can pass on his ideas and his enthusiasm to others, and he is the leader of a small and able team which is making major advances in this new field.

THE DIVERSITY OF SCIENTIFIC ADVANCES

When he admits new Fellows to the Royal Society and when he presents the medals at the annual meeting, the President performs his two most pleasant and most important duties. And the range of natural science is now so vast that he need not feel embarrassed by his lack of understanding of the work which he rewards. One hundred, or even fifty, years ago there was far less to understand: we can well believe that there were many Fellows of the Society who knew at least the vocabulary and the general content of every branch of natural science. We still have a few who can survey the whole field—and perhaps we never had more than a few—but certainly it becomes every day more difficult to find scientists whose interests are wide enough to assist the advance by helping the specialists to understand one another.

There is in the Library of Trinity College, Cambridge, a collection of letters illustrating the value of such help. They were written between the years 1830 and 1860 by two Fellows of the Royal Society, Michael Faraday and William Whewell, the great discoverer seeking advice from the most learned scholar of his day. The correspondence reminds us how far we have gone in these hundred years, though it is not surprising that Whewell could assist Faraday, for both of them were exceptional people. Whewell was the Master of Trinity of whom it was said that there was no subject on which he did not speak with authority. His two books on the inductive sciences can still be read with admiration and he had made important contributions to the study of architecture, law and theology. Faraday was in difficulties with his experiments on electrolysis. He needed new terms to describe what he was doing and, having called the two poles 'electrodes', he was uncertain how to differentiate them and how to name the products of current flow. As he was anxious to avoid theoretical implications, he thought of calling the electrodes 'Voltode' and 'Galvanode' or even 'Alphode' and 'Betode'. Whewell makes no reference to this suggestion but, in a letter dated May 5, 1834, he strongly advises the terms 'Anode' and 'Cathode'. The letter continues:

> "If you take *Anode* and *Cathode* I would prefer for the two elements resulting from electrolysis the terms *Anion* and *Cation*, which are neuter participles signifying *that which goes up* and *that which goes down*; and for the two together you might use the term *ions* instead of *Zetodes* or *Stechions*."

And Faraday replies ten days later to say that he has taken Whewell's advice and ends his letter:

> "I am quite delighted with the facility of expression which the new terms give me and I shall ever be your debtor for the kind assistance you have given me."

Whewell's assistance did not end there. In 1836 he suggested the term 'dielectric', and there is a letter written about 1850 which begins:

> "My dear Sir,
> I am always glad to hear of your wanting new words, because the want shows that you are pursuing new thoughts and your new thoughts are worth something."

This time the new word he has to suggest is 'paramagnetic'.

In these days when Faraday was still pursuing new thoughts and Clerk Maxwell was still an undergraduate, it would not have been so difficult to select the most important scientific advance of the year and to point out its significance in the general store of knowledge. But now the store expands so rapidly that it is much more difficult to see where the advance has been greatest. We are farther into the mighty maze and have split up into groups, all of them too deeply engaged to consider the plan. Many of these groups, indeed, are now in territory so far from the entrance that only the grey beards can tell you how they came there—the young pioneers have learnt the dialect of the district and all their interest lies ahead.

We must face the fact that scientists to-day are hard put to it to keep in touch with one another, and that they seldom trouble to signal their position to headquarters. We need not take this too seriously. Parts of the maze may be left unexplored or may be explored twice over, but no permanent harm will come of it. Yet the different groups ought not to be left entirely alone. Though they would resent advice or patronage from those who cannot appreciate their problems, they will go more cheerfully if they are encouraged from time to time by the approval of the scientific world.

It is part of the function of the Royal Society to show this approval. We can still hope to do it effectively by the award of medals, for the achievements which they crown are of a kind which we can all appreciate, though as individuals we may not understand their full content. But the approval of the Royal Society would soon become valueless if we lost either our corporate view of the general enterprise or the close contact of our Fellows with its many special divisions. If we are to retain both, it is more than ever necessary for us to keep our programme and our whole organization under constant review. The position changes rapidly and already great care is needed to see that we are not guided too much by memories of what it was twenty, or even ten, years ago. There are fresh growing-points to demand attention, and we must be ready to accept their claims and if necessary to revise our estimates of the relative importance of established branches. No one likes to think that the special branch which he cultivates is now less fruitful than it was; but we must be careful that our approval is not spread too thin to give much encouragement to the new growths.

An Experiment in Lamarckianism

Having emphasized the need for looking forward rather than backward, I can turn with a clearer conscience to an experiment which has just been concluded and is none the less interesting for having started twenty-two years ago. It is an investigation of the late Prof. W. McDougall's claim to have demonstrated the inheritance of a reaction produced by training, an inheritance which could only be explained on the lines of Lamarck's theory. The report which has just been published is the fourth of a series by a team headed by the late W. E. Agar and more recently by Prof. O. W. Tiegs. I have a special reason for mentioning it, for to physiologists of my generation it will bring back a vivid picture of a meeting in Edinburgh thirty-one years ago. It was at the Eleventh International Congress of Physiology, and we had come to hear a lecture prepared by Pavlov and delivered in English by his son, dealing with recent developments in his work on conditioned reflexes. No one who knew Pavlov will be surprised that our attention was sometimes diverted from the substance of the lecture to the spectacle of its author listening intently to the English version, for Pavlov, like Rutherford, had a vigour of mind and body which could not escape notice. But the lecture ended with an account of some preliminary results on a new problem, that of the inheritance of conditioned reflexes, and these compelled attention because, although they were not yet conclusive, they seemed to show a positive effect. Rats which had formed a conditioned reflex to the sound of a bell bore litters which needed less training to establish the same reflex in them. It looked as though Lamarck might be right after all, that a modification acquired by the individual in consequence of its efforts to adapt itself to its environment might be transmitted in some degree to its descendants.

Pavlov returned to Leningrad, and not long after we learnt that further work had revealed a source of error and that, in fact, he could find no good evidence of the inheritance of reactions set up by training. But William McDougall, a Fellow of our Society and a distinguished psychologist, had been working on similar lines, and his experiments showed a positive effect small enough to need careful assessment but too large to set aside. McDougall gave his rats the choice of escaping from a water tank by swimming towards a light or a dark exit. They could escape in comfort by the dark exit but received a mild electric shock if they chose the light, and before long they never made the mistake of doing so. The amount of training needed to establish the habit was averaged from the performance of large numbers of rats bred from a standard stock, and it was found that with successive generations the training needed became progressively less; and that after the thirty-fifth generation the rats showed a distinct preference for the dark exit from the first time that they were placed in the tank.

McDougall continued his experiments until 1937 (he died in 1938) and replied vigorously to his critics. The most important criticism was that of F. A. E. Crew, who conducted a similar training experiment lasting over eighteen generations and found no evidence of improvement. Agar and Tiegs began their work in 1932. It has been extended over fifty generations and has involved the training of 4,654 rats; its results agree with Crew's in showing no evidence that the training of one generation makes the next need less training to acquire the same certainty of response. Their experiments confirmed McDougall's to the extent that they too obtained long-duration trends of improvement in learning-rate, but they found that they were shown equally by a control series of rats of untrained ancestry and that the effect was not sustained. It seemed to be correlated with general changes in the health and vigour of the laboratory colony, changes which had nothing to do with the training process.

The problems of inheritance cannot be studied without experiments running on from one generation to another, and the results are bound to come slowly if the organism is not one which reproduces itself in a very short time. Certainly an experiment which may last twenty years is not to be undertaken lightly, for in that time so much may happen to threaten its survival. But this one has survived all the hazards of our time, and its authors will not need to be congratulated on having achieved their purpose.

Their purpose was to examine McDougall's case for a Lamarckian type of inheritance, and they have found that the evidence is against it. Most of us would have been rudely surprised if the result had been positive instead of negative; but if their experiment had not been made, we should have had an uneasy feeling that McDougall's conclusion might after all be justified, although Crew's experiments gave it no support.

The same cause for uneasiness may arise whenever a laborious and difficult investigation has given results which seem to contradict prevailing theories but are not decisive enough to be taken without confirmation. We realize that the experiments must be repeated and that it may be a wearisome business demanding great dexterity, constant attention and the building up of elaborate apparatus. There will be little scope for originality except in the devising of further controls, for the new experiments must not differ appreciably from those they are intended to check. Most of us start with a bias in favour of the orthodox view, and as we know that the pitfalls increase with the length and complexity of the experiment, we shall be surprised if the outcome is not the expected negative. When it turns out that way, we shall be grateful to those who have cleared up our uneasiness, but glad that we could think of adequate reasons for spending our time on something else.

No doubt we shall not have spent our time more profitably. The new experiments usually reveal some unsuspected factor which made the original result misleading, and this factor may be an important clue in different problems. But work of this sort rarely meets with the recognition it deserves, and this is a good opportunity for pointing out that our general advance could not go on without it.

The advance of science must depend on the initiative of those in the front line of research. It must be the aim of each special branch to explore the alleys it has opened up, including those which are most probably blind; but as long as the branches are not controlled from headquarters, their members will decide how this is to be done. Control by headquarters is sometimes necessary: we cannot demand that we should always be left to choose our own problems, for there are periods when we must all do as we are told, periods of emergency when we are threatened by war or famine or disease and must all join in a concerted attack. In fact, as scientists we have a double responsibility, for our general aim is to advance our understanding of Nature, but we are now the members of a profession which has special responsibilities because of the way in which it can affect the whole structure of civilized life. The immediate claims of society have to be met, and for this we must be willing to do more or less as we are told. For the long-term objectives we can still do better when we are allowed our independence, but only because there are some of us who will face the laborious work when there is no other way of resolving a doubt.

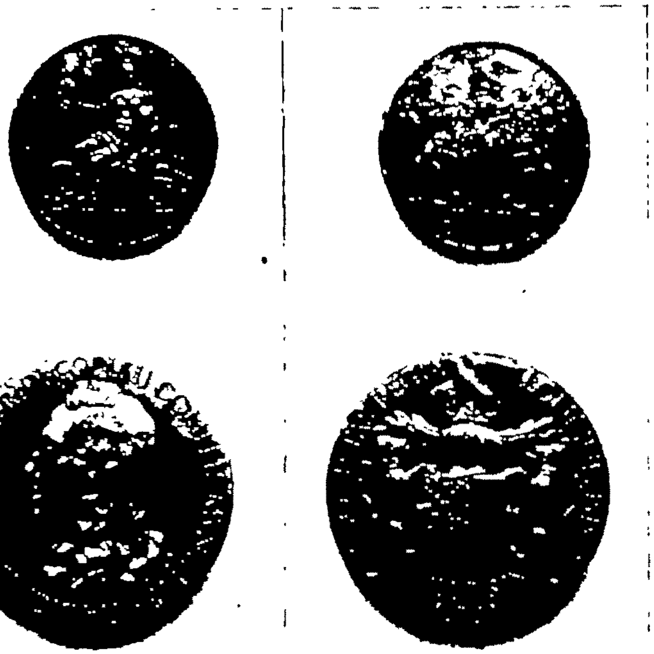
THE COPLEY MEDAL AND ITS FOUNDER

By Engineer-Captain EDGAR C. SMITH, O.B.E., R.N.(Retd.)

When in 1773 Sir John Pringle, president of the Royal Society, presented the Copley Medal to Priestley for his "Many Curious and Useful Experiments on Different Kinds of Air", he referred to it as "the palm and laurel of this community". An earlier president, Martin Folkes, when handing the Medal to John Harrison, of chronometer fame, had spoken of it as "this small but faithful token of their regard and esteem". Later, Davy called it "the ancient olive crown of the Royal Society", while Cuvier in his *éloge* of Priestley wrote: "La Société Royale lui décerna la médaille de Copley, que l'Angleterre considère comme le prix le plus noble auquel on puisse arriver dans les sciences. L'Académie de Paris lui accorda un prix non moins noble, l'une de ces huits places d'associés étrangers". In the eighteenth century there were few scientific societies and still fewer prizes, but to-day, in spite of the great increase in the number of scientific institutions and awards, some of the latter of which are accompanied by large sums of money, the Copley Medal with its honorarium remains what it was to Pringle, Folkes, Davy and Cuvier, although in the press of public affairs its significance is to-day often overlooked.

While this is true, it is fairly certain that few readers know much of its history or of its founder. Ever since 1736 when the first Copley Medal was struck, it has, with some exceptions, been awarded annually, and the long lists of recipients, especially those of the past and present centuries, include the names of many of the greatest men of science who ever lived, no matter what their nationality. A brief account of the founding of the Medal is given in Weld's work, "A History of the Royal Society with Memoirs of the Presidents compiled from Authentic Documents", published in 1848; but Weld knew little of Copley, and neither did the writer of the notice of him in the "Dictionary of National Biography". Thanks, however, to the researches of Prof. W. H. G. Armytage, of the University of Sheffield, much relating to Copley and his activities has been brought to light, and some of the results are to be found in Prof. Armytage's article entitled "Sir Godfrey Copley, F.R.S., 1653–1709. Some Tercentenary Glimpses through Letters to his Friends", published in *Notes and Records of the Royal Society of London* (11, No. 1; January 1954). From this it is seen that Copley was a public-spirited man of varied interests and a faithful friend and correspondent.

The exact date of Copley's birth is not known, though evidence points to the year 1653; but it appears certain that he died in Red Lion Square, London, on April 9, 1709, and was buried in the parish church of Sprotborough, about three miles from Doncaster, Yorkshire. He thus lived through the reigns of Charles II, James II and William and Mary, and a part of that of Queen Anne. His father, the first Sir Godfrey, had been made a baronet soon after the restoration by Charles II, and when he died about 1684 his son succeeded to his title and estate, including Sprotborough Hall, then one of the stately homes of England, but now no longer standing. Of Copley's education and upbringing little is known, though he was admitted to Lincoln's Inn in 1674. Following in his father's footsteps, he served as member of Parliament, first for the little town of Aldborough and then for Thirsk, and was High



By courtesy of the Royal Society

THE COPLEY MEDAL

ABOVE. Replica of the gold medal awarded to Sir Charles Lyell in 1858
Athena, seated amidst emblems of her own attributes, and of the arts and sciences, holds out in the right hand a wreath; in her left arm is the Ephesian Artemis; on her breast the head of Medusa; near her the armorial shield of Sir Godfrey Copley. *Leg* G. COPLEY BART. DIGNISSIMO. Below, T (John Sigismund Tanner).
Rev The armorial shield of the Royal Society, with crest and supporters. *Leg* SOCIETAS REG. LONDINI. *Ex* On a band the motto NULLIUS IN VERBA.
Diameter 1 7 in.; bronze (replica).

BELOW. New die, first used for the medal awarded in 1941.
Bust of Copley, left, in curly wig. *Leg.* GODEFRIDI COPLEII COMITIS MVNIFICENTIA DIGNISSIMO. On truncation, M. GILLICK
Rev. The arms of the Royal Society, with supporters, crest, and motto. *Leg* SOCIETATIS REGIA LONDINENSIS
Diameter 2 25 in, bronze (replica)

Sheriff of Yorkshire. He was twice married, first to Catherine, daughter of John Purcell, of Nantriba, Montgomeryshire, by whom he had an only daughter, Catherine, and secondly, to Gertrude, daughter of Sir John Carew, of Antony, Cornwall. His daughter became the wife of Joseph Moyle, whose descendants in 1768 assumed the name of Copley and in whose favour the baronetcy was revived ten years later. The present representative of the family is Robert Godfrey Wolseley Bewicke-Copley, Baron Cromwell.

As a politician, Copley was assiduous in his attendance at Parliament, and outspoken in his views, as can be seen by his speech against the bill of attainder brought in at the time of the conspiracy of Sir John Fenwick and others: "It is the Custom and Law of our Nation", he declared, "to require two positive witnesses to prove Treason. . . . I look upon it as a fundamental Breach of those Rules, for an accusation to be given in against any Man behind his Back, by he knows not whom, or by any with whom he is not confronted, and brought Face to Face. . . . If this method of Proceeding be warranted by an English Parliament, there is an end to the Defence of any Man living, be he ever so innocent". He was much concerned with the urgent problem of the reform of the currency, a matter which led to Newton's appointment to the Mint, and during the early campaigns of Marlborough he was Comptroller of Army Accounts. Had he lived longer, the world would have heard more of him.

Devoted as he was to his public duties, Copley was no less interested in his native county, embellishing his mansion, improving his gardens and corresponding with and visiting other Yorkshire worthies such as Ralph Thoresby and Thomas Kirke. He tried to improve the navigation of the River Don, was interested in pumping plant, water supply and fountains, and at Sprotborough Hall constructed what was probably the first indoor swimming bath. In a letter to Hans Sloane, he described the bath as being about 34 ft. long, 16 ft. wide, 6 ft. deep and lined with lead. It could be filled to a depth of 4½ ft. by his water engine in five hours. "Two or three faggots," he added, "and a sack of Coales doth warm it equall to ye heat of your body. . . . My wife and some Ladys of her acquaintance have gone in it together & are much delighted with it. I am sure this fancy of mine will be followed by some one who perhaps may be willing to outdo me in making one 3 times as large."

Copley's closest friend in London was Hans Sloane, who was seven years his junior and who outlived him forty-four years. Sloane was admitted a Fellow of the Royal Society in 1684, was secretary of the Society during 1693–1713, and in 1727 succeeded Newton as president. Copley was admitted a Fellow in 1691 and six years later was elected a member of Council. He often enjoyed the company of his fellows at one of the coffee houses or at "Pontack's", and his letters contain references to his mathematical books, prints and instruments, to lodestones, air pumps, Napier's Bones, surveying wheels and the voyages of Halley and Middleton. Up to the time of his death, the Royal Society was meeting in the somewhat dilapidated Gresham College, Bishopsgate Street, in the City of London, once the mansion of Sir Thomas Gresham, and it was here the brilliant and versatile Hooke was for long curator and demonstrator. In old age, however, he became penurious and in one letter Copley wrote: "Dr. Hooke is very crazy; much concerned for fear he should outlive his estate. He hath starved one old woman already and I believe he will endanger himself to save sixpence for anything he wants . . ."; and on March 4, 1702–3, he wrote again: "Your old *Philosopher* is gone at last, to try experiments with his ancestors. He is dead, they say, without a will: had only a poor girl with him, who, seeing him ill, went to call somebody; and he was quite gone before they came". In another letter he wrote: "The *poor Corporation* of *London* stand in need to make some profit of the ground of *Gresham College*. I wonder old Dr. Hooke did not choose rather to leave his 12,000 l. to continue what he had promoted and studied all the days of his life (I mean mathematical experiments) than to have it go to those whom he never saw or cared for. It is rare that

Virtuosos die rich, and it is a pity they should if they were like him . . .".

It was in the year following Hooke's death that, on October 14, 1704, Copley made the will in which he bequeathed to Hans Sloane and Abraham Hill (1635–1721), F.R.S., the sum of "one hundred pounds, in Trust for The Royal Society of London for improving natural knowledge, to be laid out in experiments, or otherwise, for the benefit thereof, as they shall direct and appoint". Sloane and Hill accordingly dealt with the bequest until Hill's death, after which Sloane was entirely responsible; and not until he died in 1753 did the Council make the awards. It is thus seen that the early history of the bequest belongs to the time when the Royal Society was meeting in its new quarters in Crane Court, Fleet Street, under the successive presidencies of Newton, Sloane and Folkes.

Though from a letter of Franklin's it appears that the interest on Copley's bequest was being used as early as 1717, the first definite record is a minute of a Council meeting in 1731 which ran: "To Mr. Stephen Gray. For his 'new Electrical Experiments' —as an encouragement to him for the readiness he has always shown in obliging the Society with his discoveries and improvements in this part of Natural Knowledge". A second award was made to Gray in 1732, but in neither case was the amount stated. Gray was a Kentish man who had devoted himself to astronomy and other subjects, but who in 1719 had become a Brother in the ancient Charterhouse, London, the buildings of which are now being restored after being severely damaged during the Second World War. He was then about sixty-six years of age, and it was within the walls of the Charterhouse, and at the home of his friend, the Rev. Granville Wheler (1701–70), F.R.S., Otterden Place, near Faversham, Kent, that he made that long series of experiments with feathers, hair, silk, wool, soap bubbles, resin and threads which mark an epoch in the early history of electricity. Gray died in 1736, when about eighty-three years of age, and it was later in that year that, at the suggestion of Folkes, the Copley Medal was founded. Made of fine gold and weighing one ounce two pennyweights, it was first presented to the Rev. John Theophilus Desaguliers (1683–1744), whose services as curator and demonstrator to the Society were as valuable as those of Hooke. All subsequent medals were made of gold until 1941, when the medal was redesigned by Mrs. M. Gillick and changed to silver gilt. Of the medals presented in the eighteenth century, the Royal Society possesses that given to Priestley, while the British Museum has those given to Gowin Knight in 1747 and to Sir William Hamilton in 1770.

There are features in the early history of the Medal before it had attained an international status that are absent in its later story. Altogether, between 1736 and 1800, fifty-nine awards were made; no awards were made on eleven occasions, but duplicate medals were given in 1783 and 1791, while in 1766 no fewer than three were given. It was awarded twice to Desaguliers and twice to Canton, and one of the recipients in 1783 was the nineteen-year-old Yorkshire boy, John Goodricke (1764–86), who in the previous year had discovered the "Period of the Variation of Light in the Star *Algol*". Among other recipients of the Medal in the eighteenth century were the Rev. Stephen Hales, who lies beneath the tower of Teddington Church, which he restored; Benjamin Robins, the gunnery expert, who died in India; the Greenwich astronomers, Bradley and Maskelyne; Smeaton; Benjamin Franklin; the wealthy Clapham recluse, Henry Cavendish; Peter Woulfe, "the last true believer in alchemy", whose rooms were as full of furnaces and crucibles as the laboratory of Paracelsus; Captain Cook; John Hunter; William Herschel; Rumford; and Volta, who held the chair of physics at Pavia.

With the award of the Medal to Volta in 1794, a new chapter in its history opens, for previously all the recipients had been British citizens, if not of British birth. It was, however, not until 1820, when the Medal was given to the Danish physicist, J. C. Oersted, that the name of another foreigner is found in the list of Medallists. There probably would have been others had it not been for the unfortunate effects of the French Revolution and the Napoleonic Wars. Not long before the signing of the Treaty of Amiens in 1802, the Paris Academy of Sciences elected Banks, Maskelyne, Cavendish, Herschel, Priestley and Rumford foreign members, but there was no reciprocal action by the Royal Society. The nineteenth century fortunately saw much of the national animosity die away, and in 1825 Arago became the first Frenchman to receive the Medal, in 1836 Berzelius the first Swedish man of science, and in 1838 Gauss the first German. By then the Rumford and Royal Medals had been founded, and some awarded to foreigners, the Royal Society recognizing with impartiality the debt to Continental investigators and teachers, to whose laboratories and lecture rooms British students began to flock in increasing numbers.

By the middle of the nineteenth century the Copley Medal had become recognized all the world over as the "palm and laurel" of science, and under the successive presidencies of Sabine, Airy, Hooker, Huxley, Spottiswoode, Stokes and Kelvin, the Society again and again acknowledged the work of other nations. It is thus found that, of the fifty awards made during 1851–1900, no fewer than thirty-two were made to foreigners, the list for the decade 1870–79, for example, including Mayer, Wöhler, Helmholtz, Pasteur, Hofmann, Claude Bernard, J. D. Dana, Boussingault and Clausius. Among the British names found in that half-century are Owen, Darwin, Lyell, Joule, Stokes, Kelvin (then Sir William Thomson) and Lord Rayleigh. To this period also belongs the generous gift in 1881 by the then Sir Joseph Copley of a sum in Consols sufficient to provide an honorarium of £50 for each medallist. The value of this investment diminishing gradually, the Council of the Society last year made provision for increasing it to £100.

The present century opened with nothing to disturb the relations of men of science of either Europe or America, and under the presidency of Sir William Huggins, himself a Copley medallist, the Medal was awarded in turn to Willard Gibbs of America, Lord Lister, the Austrian geologist Suess, Sir William Crookes and the Russian chemist Mendeléeff. Next in the list come the names of Metchnikoff, Michelson, A. R. Wallace, G. W. Hill, Galton, Sir George Darwin, Prof. Klein of Göttingen, Ray Lankester and Sir J. J. Thomson, to whom it was given in 1914. With the outbreak of war and the upheavals of the past forty years, the Royal Society was faced with difficulties similar to those of the days of Napoleon, and once again British names appear with greater frequency, as can be seen from the following table:

Copley Medallists, 1915–54

1915	I. P. Pavlov
1916	Sir James Dewar
1917	Émile Roux
1918	H. A. Lorentz
1919	W. M. Bayliss
1920	H. T. Brown
1921	Sir Joseph Larmor
1922	Lord Rutherford
1923	Sir Horace Lamb
1924	Sir Edward Sharpey-Schafer
1925	A. Einstein
1926	Sir Frederick Gowland Hopkins
1927	Sir Charles Sherrington
1928	Sir Charles Parsons
1929	Prof. Max Planck
1930	Sir William Bragg
1931	Sir Arthur Schuster
1932	Dr. G. E. Hale
1933	Prof. T. Smith
1934	Prof. J. S. Haldane
1935	Prof. C. T. R. Wilson
1936	Sir Arthur Evans
1937	Sir Henry Dale
1938	Prof. Niels Bohr
1939	Prof. T. H. Morgan
1940	Prof. P. Langevin
1941	Sir Thomas Lewis
1942	Sir Robert Robinson
1943	Sir Joseph Bancroft
1944	Sir Geoffrey Taylor
1945	Dr. O. T. Avery
1946	Dr. E. D. Adrian
1947	Prof. G. H. Hardy
1948	Prof. A. V. Hill
1949	Prof. G. O. de Hevesy
1950	Sir James Chadwick
1951	Prof. D. Keilin
1952	Prof. P. A. M. Dirac
1953	Prof. A. J. Kluyver
1954	Sir Edmund Whittaker

Whatever the conclusions of a reader may be, it is, however, well to remember the lines,

> "This world is not for aye ; nor 'tis not strange
> That even our love should with our fortunes change . . ."

and in spite of contending political systems and of national prejudices, no man of science will dispute the remark of Davy's that "Science like Nature, to which it belongs is neither limited by time or space. It belongs to the world and is of no country and no age".

OBITUARIES

Prof. A. F. Blakeslee

Prof. Albert Francis Blakeslee, of Smith College, Northampton, Massachusetts, died on November 16 at the age of eighty. Blakeslee will perhaps be remembered as a man who made more varied discoveries than any biologist of his time. Fifty years ago he observed that sexual reproduction in fungi was restricted by a genetic incompatibility, a principle which is now known to limit and direct sexual reproduction in plants and in the lower organisms generally. Thirty years ago in a large series of collaborative studies on *Datura* he began to show a whole unexpected range of chromosome changes (polyploidy, interchange, etc.) underlying the variation of the species. He pursued this work with unremitting zeal throughout his life. But concurrently he was showing how polyploidy could be induced in innumerable plants with the help of colchicine and he was investigating the genetics of the faculties of taste and smell in man as well as of fragrance in the plant itself. At the age of seventy-six, still a guest professor at Smith College, he attended the Stockholm Botanical Congress and gave papers on the chromosomes of species hybrids in *Datura*, on the use of chimæras in elucidating the germ layers of plants, on the culture of excised embryos as a means of growing inviable hybrids, and on the development of *Rudbeckia hirta* by selection from a wild species to a garden plant.

These were only the more successful inquiries that Blakeslee undertook. His energy and curiosity took him into many less productive fields. Two things strike one about his work. One is that he never made any serious mistake of observation. The other is that he never ventured far into interpretation or prediction after his early studies in fungi. Here his interpretation was unfortunate in that he tied the word sex to the property of incompatibility and thereby led his successors astray right down to the present day. In a sense the style of his work is best represented by his diagrams of *Datura* chromosomes as packets. These diagrams were useful in a popular sense so long as one did not take them too seriously. Unfortunately, it seems that Blakeslee did take them seriously. To him they were the real and final thing.

By his alertness and ingenuity and his practical sense in organizing the Station for Experimental Evolution at Cold Spring Harbor (where he worked for thirty years, until his retirement in 1942), Blakeslee kept the botanical world of his day in a state of constant stimulation. C. D. Darlington

Dr. Neville Jones, O.B.E.

Neville Jones, whose death on October 24 has been reported from Bulawayo, was a pioneer in Rhodesian prehistory, and during the years 1913–47 worked out the complete succession of Stone Age cultures in the western part of Southern Rhodesia.

Born in London in 1880, he was educated at Dulwich College and, after working in various capacities, including an appointment as geologist to an expedition to Madagascar in 1906–7, he went to Southern Rhodesia as a missionary in 1912. On retiring from mission work at the age of fifty-five, he at once commenced a new profession and became the first keeper of prehistory at the National Museum of Southern Rhodesia in Bulawayo. Here he was able to devote his whole time to prehistory, and his best scientific work was done during the twelve years in which he held his Museum post.

Important as was his work on the Stone Age, it was by no means his only interest. As a missionary among the Matabele, he saw much of these people and published anthropological notes as well as a valuable historical study, "My Friend Kumalo" (1945). With one very important exception, his field-studies related to the Stone Age; but the exception, the excavation of Mapungubwe in the Northern Transvaal in 1934, shows that Stone Age studies were not all-absorbing for him. His work at this site is incorporated in Prof. Fouche's "Mapungubwe" (1937). Besides his archæological work, he was a botanist and entomologist of no mean calibre, being especially interested in the collection and culture of South African xerophytic plants.

Jones was the moving spirit in the foundation of the Commission for the Preservation of Natural and Historical Monuments and Relics in Southern Rhodesia and was successively its secretary and its chairman.

His lack of formal academic qualifications never greatly worried him, for his wide correspondence enabled him to keep in touch with current thought in his subject; nevertheless, the honorary doctorate conferred upon him by the University of the Witwatersrand during the last year of his life was the most highly prized of his honours.

Jones's work for prehistory will provide a basis which other workers, who knew him not, will accept or, perchance, reject; to his colleagues throughout Southern Africa he has, however, left a personal legacy in his example of quiet, careful and unselfish work for which they are all the richer.

R. Summers

NEWS and VIEWS

Chief of the Royal Naval Scientific Service: Dr. H. F. Willis

DR. H. F. WILLIS, superintendent of the Admiralty Research Laboratory, Teddington, has been appointed chief of the Royal Naval Scientific Service, in succession to Mr. W. R. J. Cook (*see Nature*, 166, 135; 1950), who has become deputy director of the Atomic Weapons Research Establishment, Aldermaston. Dr. Willis, who is forty-five, is a graduate of University College, Cardiff, where he obtained first-class honours in mathematics in 1930 and physics in 1931. In the following year he gained the M.Sc. degree for research on relativity, and he became a Fellow of the University of Wales in 1933. He spent the next two years at Trinity College, Cambridge, engaged on experimental research into the optical properties of molecules, and for this work was awarded the Ph.D. degree. In 1935 he joined the British Cotton Industry Research Association and carried out fundamental research on the diffusion of dye-stuffs into cellulose fibres. These early researches were described in papers published in the *Philosophical Magazine* and in the *Proceedings* of the Royal Society and of the Faraday Society. Dr. Willis entered Admiralty service in 1938, and until 1945 was engaged on underwater acoustics research in the anti-submarine experimental group, where he served with notable success. He was then transferred to the Admiralty Research Laboratory, and until 1953 was leader of the group concerned with problems in electromagnetics and underwater ballistics. He was promoted to the rank of deputy chief scientific officer in January 1950, and became superintendent of the Admiralty Research Laboratory in 1953. The versatility and originality displayed by Dr. Willis in his own researches, and the skill which he has since shown in organizing and directing the work of a large establishment, augurs well for the Royal Naval Scientific Service in the increasingly important part which it is being called upon to play in naval affairs.

The French Canadian Association for the Advancement of Science: Dr. L. Marion, M.B.E.

DR. LÉO MARION, director of the Division of Pure Chemistry of the National Research Council of Canada, has been elected president for 1954–55 of the French Canadian Association for the Advancement of Science. He has also been awarded an honorary D.Sc. by Laval University, Quebec. Dr. Marion, who is fifty-five, is a graduate of Queen's University, Kingston, and a Ph.D. of McGill University, Montreal. Joining the National Research Council in 1929, he became head of the Organic Chemistry Section in 1943, and four years later he took on the added responsibilities of editor-in-chief of the *Canadian Journal of Research*, a post which he still holds. In 1952 he became director of the Division of Pure Chemistry. Dr. Marion's research work has been concentrated on the alkaloids, and for his contributions in this field he was awarded in 1948 the gold Médaille Léo Pariseau of the French Canadian Association for the Advancement of Science. He was elected to the Royal Society of Canada in 1942 and was made an M.B.E. in 1946.

British Participation in an International Atomic Energy Agency

IN reply to a question in the House of Commons on November 16, Sir Winston Churchill stated that during the past seven years the United Kingdom had exported to forty-six countries more than sixteen thousand consignments of isotopes and, at the present rate of seven thousand consignments a year, is the world's largest exporter of isotopes. Both Canada and the United States are also important exporters. The Isotopes Advisory Service offers advice and assistance, and foreign students are accepted at the Isotopes Training School at Harwell. Sir Winston agreed that the United States has given a fine lead towards establishing an international atomic energy agency and that it will have a great effect on the international situation if the Soviet Union can see its way to co-operate fully along these lines. On the same day, the Minister of State, Mr. A. Nutting, told the United Nations Political Committee in New York that, following the allocation by the United States the previous day of 100 kgm. of fissionable material, the British Government is prepared to hold available as required 20 kgm. of fissionable material for use in atomic research reactors abroad. Mr. Nutting added that the British Government has not changed its views as to the objectives of the agency: these are to encourage world-wide research and development of peaceful uses of atomic energy; to arrange for nuclear materials to meet the needs of research, development and practical applications to medicine and other peaceful activities, including the eventual production of power; to foster the interchange of unclassified information; and to prepare for a time when the use of atomic energy for peace becomes the predominant and perhaps the exclusive use of atomic energy.

Sucrose Synthesis in Tobacco Leaves

THE synthesis of radioactive sucrose by tobacco leaves from glucose and glucose-1-phosphate uniformly labelled with carbon-14 has been described by P. V. Vittorio, G. Krotkov and G. B. Reed (*Canadian J. Bot.*, 32, No. 3, 369; 1954). The petioles of detached tobacco leaves were placed for six hours in solutions of labelled glucose and glucose-1-phosphate, and at the end of this time the leaves were extracted with boiling 80 per cent ethanol and the activities of their various carbohydrate fractions determined. The specific activities of both the glucose and fructose moieties of sucrose were found to be high and very close to one another, while that of the free fructose was low. From this the authors have concluded that the fructose component of sucrose is derived from the glucose introduced and not from the free fructose present in leaves. Low activity in starch observed in photosynthesizing leaves indicates preferential transformation of the glucose introduced into sucrose and not into starch. Moreover, respiration of labelled glucose ought to produce labelled carbon dioxide and, after a period of photosynthesis, labelled starch. The isolated starch contained only a small amount of activity, indicating that, in light, sugars were not utilized in respiration to any great extent. In darkness, however, sugars were so utilized, the carbon dioxide evolved being very radioactive. The authors conclude that the mechanism of sucrose synthesis in tobacco leaves must be different from that reported for *Pseudomonas saccharophila*.

Proceedings of the Botanical Society of the British Isles

IT has been decided to replace the "Yearbook" of the Botanical Society of the British Isles by a new publication—the *Proceedings*, which is to appear twice a year, edited by D. H. Kent (1, Part 1; pp. 117). The first number contains such familiar features as plant notes, plant records and abstracts from literature. Each number will also contain papers of general interest on the British flora and, at times, reports of officers, excursions and exhibition meetings, as well as book reviews and obituaries. The present part includes papers on recent work on the Manx flora and the flora of Caldey Island, Pembrokeshire.

Abstracts of Theses for Cambridge Research Degrees

ABSTRACTS of the theses which were approved for the degrees of Ph.D., M.Sc. and M.Litt. in the University of Cambridge during the academic year 1951–52 have been published by the Cambridge University Press (pp. xvii+243; 1954). These abstracts, which vary in length from about 120 to 500 words each, are arranged in the alphabetical order of the faculties under the degree committees of which the research students worked and, within these main divisions, by departments. Sixteen faculties are represented, and two hundred dissertations are reported. These include twenty-six in the Faculty of Mathematics, and in the Faculty of Physics and Chemistry twenty on subjects in organic and inorganic chemistry, ten in physical chemistry and thirty-one in physics. The Faculties of Classics and Divinity are represented by only one each. An index of authors' names is given at the end of the volume, and it is stated that a copy of each dissertation is deposited in the University Library and may only be consulted there. It is to be expected that the substance of the more important dissertations will be published in due course in the appropriate journals; but as it is essential that details of work done, particularly in science, should be made available as soon as possible to those interested, it is a pity that this handy reference volume to research work performed at the University of Cambridge during 1951–52 was not published more promptly, and further that the copies of the dissertations are not available for loan except perhaps from the individual authors.

American Association for the Advancement of Science: Meeting in Berkeley

THE one hundred and twenty-first meeting of the American Association for the Advancement of Science will be held in the University of California, Berkeley, during December 26–31. In addition to the programmes of the Association and its eighteen sections, fifty-nine societies and other scientific organizations have arranged more than three hundred sessions, and another thirty societies are co-sponsoring appropriate symposia. Besides the address of the retiring president of the Association, Dr. E. U. Condon, to be given on December 28, the Association will hold three general symposia as follows: natural resources—power, metals, food; population problems; and the impact of science on society. As in previous years, the main work of the meeting will be divided between the various Sections of the Association, which are as follows: (*A*) mathematics; (*B*) physics; (*C*) chemistry; (*D*) astronomy; (*E*) geology and geography; (*F*) zoological sciences; (*FG*) biological sciences; (*G*) botanical sciences; (*H*) anthropology; (*I*) psychology; (*K*) social and economic sciences; (*L*) history and philosophy of science; (*M*) engineering; (*N*) medical sciences; (*O*) agriculture; (*P*) industrial sciences; (*Q*) education; (*X*) science in general. Among the other meetings to be held in Berkeley at the same time are: the third Berkeley symposium on mathematical statistics and probability; a four-day international conference on animal venoms; a meeting of the International Union for the Study of Social Insects; the annual Academy conference, made up of delegates of the forty-two academies of science affiliated with the Association; and the recurrent conference on scientific editorial problems and the conference on scientific man-power. Further information can be obtained from Sidney S. Negus, Medical College of Virginia, Richmond, Virginia.

Geographical Association: Annual Conference

THE annual conference of the Geographical Association will be held in the London School of Economics, Houghton Street, Aldwych, London, W.C.2, during January 4–7, 1955. The presidential address, by Prof. S. W. Wooldridge, professor of geography, King's College, London, will be on "The Status of Geography and the Role of Fieldwork". In addition to the usual lectures, excursions, etc., there will be a symposium sponsored by the Public and Preparatory Schools Section of the Association, on problems of geography teaching and their relation to preparation for the university. Further information can be obtained from the honorary conference organizer, Prof. W. G. V. Balchin, University College, Swansea.

The spring conference of the Association will be held in York during April 12–16, 1955, and the programme and reservation leaflet for this meeting will be enclosed in the January issue of the Association's journal *Geography*.

Israeli Scientific Papers during 1948–53: Exhibition in London

AN exhibition of scientific papers published by Israeli research workers during 1948–53, covering both pure and applied science, will be held at the Israeli Consulate, 18 Manchester Square, London, W.1, starting on December 7, and will remain open to the public for a fortnight, Saturdays excluded. Sir Francis Simon will open the exhibition and will give an impression of science in Israel during his recent visit to that country. Sir Ben Lockspeiser will also speak, and Sir Robert Robinson will be in the chair. A catalogue will be issued of all the publications concerned, with full names and references, as well as an author index. Further information can be obtained from the Office of the Scientific Attaché of the Embassy of Israel, 2 Palace Green, London, W.8.

University of Glasgow

THE following appointments have recently been made in the University of Glasgow: to the chair of agriculture, Prof. Donald S. Hendrie, principal of the West of Scotland Agricultural College; to lectureships, A. C. MacLean (geology), Dr. E. Gelles (chemistry) and Dr. H. W. Wilson (experimental physics); to Imperial Chemical Industries, Ltd., fellowships, Dr. S. C. Abrahams (senior fellowship) and Dr. H. M. M. Shearer. For the present session, 287 new students (228 men and 59 women) have been admitted to the Science Faculty of the University, compared with 259 in 1953. In the University as a whole, the total number of matriculated students stands almost unchanged at 5,585. The new wing of the Chemistry

Institute (see *Nature*, 173, 119; 1954) is now occupied, and thus once more, after an interval of fourteen years, the whole work of the Department of Chemistry is housed in a single building, which—with a floor space of about 170,000 sq. ft.—is probably the largest chemistry building in Britain; including staff and students, the total population of the Department is well over a thousand.

University of Leeds

The following gifts have recently been received by the University of Leeds: a grant not exceeding £10,000 from the Wellcome Trust to the Department of Pharmacology for the reconstruction and re-equipping of laboratories; £20,000 from Imperial Chemical Industries, Ltd., to the Department of Textile Industries towards the cost of equipping the new man-made fibres building.

Dr. H. E. Nursten has been appointed a lecturer in the Department of Leather Industries of the University.

Christmas Lectures for Young Persons

A number of organizations are holding lectures for young persons during the Christmas school holidays. Among them, the Royal Institution's "course of six lectures adapted to a juvenile auditory" is perhaps the most famous, certainly the most long-standing, and this year the one hundred and twenty-fifth such course will be by Sir Frank Whittle on "The Story of Petroleum"—its uses; geology; exploration, production and transportation; engines and their fuel; refining; and the gas turbine. The lectures will be given at 3 p.m. on Tuesdays, Thursdays and Saturdays during December 28–January 8 at the Royal Institution, 21 Albemarle Street, London, W.1, the fee being, juveniles (10–17 years) £1, adults (non-members) £2. For the first time the Plastics Institute is holding this year a Christmas lecture for young persons, which will be given at 2.30 p.m. on December 30 in the auditorium of the Wellcome Research Institution, 183–193 Euston Road, London, N.W.1, by Dr. J. C. Swallow, chairman of the Plastics Division, Imperial Chemical Industries, Ltd., whose talk, on "The Wonder of Plastics", will be illustrated by a film and supported by practical demonstrations; applications for tickets should be made to the Secretary to the Council, Plastics Institute, Adam Street, London, W.C.2. A Christmas lecture, for persons between twelve and eighteen years old, which the Manchester Federation of Scientific Societies organizes will be given this year by Dr. H. A. Thomas, of Courtaulds, Ltd., his subject being "How Science helps to Clothe us"; the lecture will be given in the Chemistry Lecture Theatre of the University of Manchester at 3 p.m. on January 5 and will be repeated the next day. Applications for tickets should be made through one of the Federation's participating societies.

Announcements

We regret to announce the death of Prof. E. Fermi, For.Mem.R.S., of the Institute for Nuclear Studies, University of Chicago, on November 28, aged fifty-three.

The title of emeritus professor in The Queen's University of Belfast has been conferred on Prof. James Small, professor of botany during 1920–54, and on Prof. J. K. Charlesworth, professor of geology during 1921–54.

The title of professor of biochemistry in the University of London has been conferred on Dr. Henry McIlwain in respect of the post held by him at the Institute of Psychiatry. The title of reader in physiology in the University of London has been conferred on Dr. M. Grace Eggleton in respect of the post held by her at University College.

Prof. John Walton, regius professor of botany in the University of Glasgow, has been elected a corresponding member of the Botanical Society of America.

Prof. F. E. King, Sir Jesse Boot professor of chemistry in the University of Nottingham, has been elected to the board of British Celanese, Ltd. Prof. King will assume a full-time appointment with the company as director in charge of research in September next.

The new Cavendish professor of experimental physics in the University of Cambridge, Prof. N. F. Mott, has invited Prof. H. Bethe, of Cornell University, to spend the academic year 1955–56 in the Cavendish Laboratory as an adviser on the development of nuclear physics in the Laboratory. Prof. Bethe's acceptance of the invitation should prove exceedingly valuable for the future of nuclear physics at Cambridge, since he is particularly well informed about American developments in this field.

Dr. George Porter, until recently assistant director of research in the Physical Chemistry Department, University of Cambridge, has joined the British Rayon Research Association as assistant director and is in charge of fundamental research there. Dr. Porter's research work has been concerned with reaction kinetics and, by means of flash photolysis, with the investigation of the very short-lived intermediates which are to a large extent responsible for chemical change. At the Association he will be continuing his recent work on the absorption of light by aromatic molecules and dyestuffs.

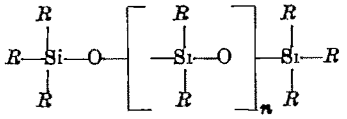
The Massachusetts Institute of Technology is offering a small number of scholarships to university graduates in science, technology and architecture to enable them to work at the Institute during the summer session, June 6–September 24, 1955. Candidates must be British citizens, less than thirty-two years of age, with at least two years experience in postgraduate research, either academic or industrial. Application forms (to be returned by January 3) can be obtained from the Cultural Affairs Officer of the United States Embassy, Room 302, 41 Grosvenor Square, London, W.1.

Under the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and British Colonies to go to the United States for an academic or educational purpose, provided that they have the financial support in dollars for the visit and have been accepted by an American institution of higher learning. The grants cover the cost of direct travel between a candidate's home and America and return, and are available during June 1, 1955–February 1, 1956. Applications must be submitted by March 15, 1955 (for those travelling between June 1 and July 31), or June 1 (for those travelling after August 1). Application forms and further information can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1.

PRODUCTION OF SILICONES

NEW PLANT AT BARRY, GLAMORGAN

PROF. F. S. KIPPING, working in the University of Nottingham at the end of the nineteenth century and early years of the twentieth, carried out many experiments in the field of silicon chemistry. In the course of that research he often obtained polymeric silicon products, which he recognized as containing silicon–oxygen linkages. Such compounds are known as 'silicones', a term which refers to any organo-silicon compound based on a silicon–oxygen structure with hydrocarbon radicals attached to the silicon atoms ; for example :

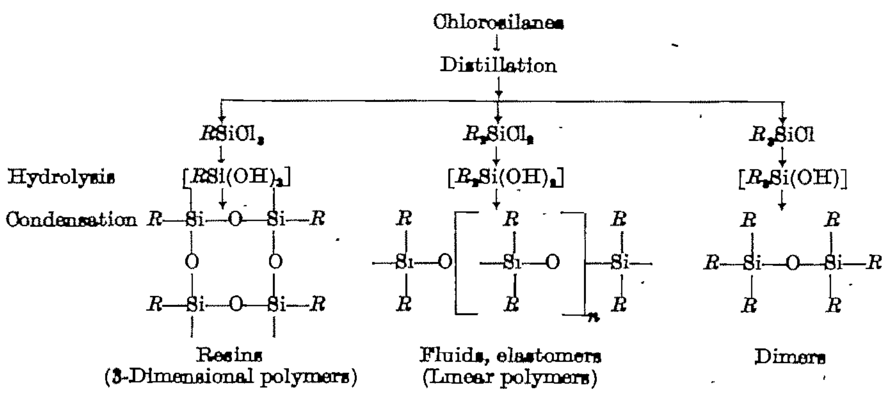


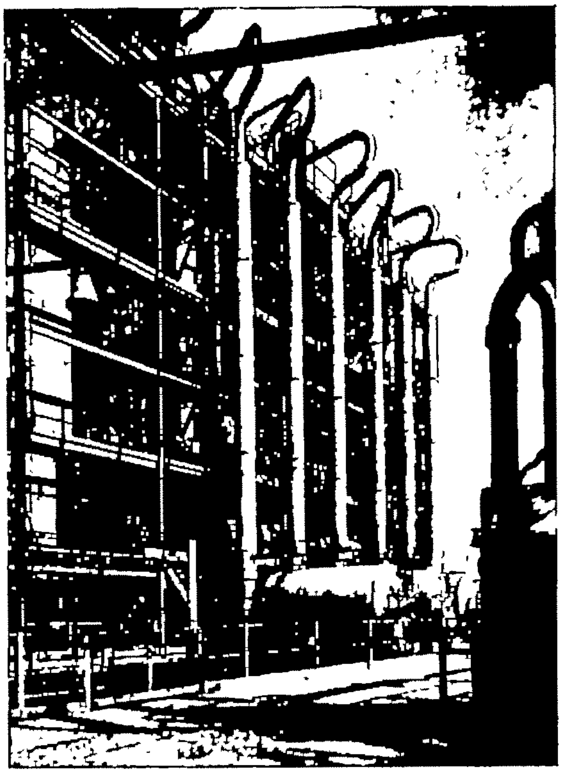
$$R-\overset{R}{\underset{R}{Si}}-O-\left[-\overset{R}{\underset{R}{Si}}-O-\right]_n-\overset{R}{\underset{R}{Si}}-R$$

The group inside the brackets is called 'siloxane'. In the case of the polydimethylsiloxanes (that is, where R is a methyl group), n may vary from zero to several thousands.

The production of silicones in Great Britain is taking place at the Albright and Wilson, Ltd., Silicone Plant at Barry, Glamorgan. Here, on a large scale, with the rigorous exclusion of air and moisture, silicon is treated with methyl chloride at 275–375° C., using copper as a catalyst. The various chlorosilanes, RSiCl$_3$, R_2SiCl$_2$, R_3SiCl, which are so produced, for example, Si + 2RCl → R_2SiCl$_2$, are fractionated into the pure components. This fractionation is difficult because the boiling points of the chlorosilanes are very close together, and fractioning equipment of great efficiency has to be used. The fractionating section is a vital part of the whole plant, and involves fractionating columns of great height and many stages, all controlled automatically. This fractionation gives the mono-, di- and tri-substituted chlorosilanes as pure components. Some of these chlorosilanes are further treated by a Grignard reaction, in order to prepare those types of chlorosilanes which are most needed.

Having obtained pure chlorosilanes, the next step is their hydrolysis by water. The products of hydrolysis condense, and by varying the initial proportions of the different chlorosilanes, a great variety of silicone products can be made ; for example :





Distillation unit showing still pots and batch columns

It can thus be seen that the characteristics of the products are dependent upon the type of chlorosilane or mixture of chlorosilanes used.

The process employed is very complicated, and requires to be carried through many stages with great care in order to produce pure materials in good yield. Since the chlorosilanes are corrosive and toxic, react spontaneously with water, and are highly inflammable, elaborate safety precautions are necessary, and the volatile solvents and intermediate products of the process are stored in buried tanks. The tanks—and indeed all parts of the system—are purged with inert gas to prevent the ingress of air or moisture and to reduce the risk of fire. Incoming solvents are transferred to the storage tanks from the tank cars, in which they are transported, by pumps. On the other hand, methyl chloride, which is also transported by road tanker, is transferred to storage tanks by utilizing its own vapour pressure. All people working in hazardous areas wear protective clothing, including glasses and helmets.

The silicone products so obtained are characterized by good resistance both to water and to extremes of temperature. These are extremely useful properties, and result in silicones being used for such varied purposes as paints for metal surfaces at high temperatures, water-repellent treatment for masonry, concrete, etc., heat-resistant electrical insulation, silicone finishes to fabrics to achieve water repellency and stain resistance, etc. The quality of the products is tested in a technical service laboratory, and the development of new products is also carried out there.

The knowledge and experience of the Dow Corning Corporation in the field of silicone science and technology has been freely available and has been drawn on liberally in the setting up of this plant at Barry.

BIOLOGICAL EVALUATION OF WATER AND EFFLUENTS

On November 3 the Biological Methods Group of the Society for Analytical Chemistry held a symposium in London on "The Biological Evaluation of Water and Effluents". The large attendance and the spirited discussion of the papers gave a good indication of the large number of chemists and biologists now interested—either as consultants or as servants of public authorities or industrial firms—in the assessment and control of pollution.

Dr. B. A. Southgate (Water Pollution Research Laboratory, Stevenage), in introducing the subject, said that, in trying to evaluate the purity either of a surface water or a polluting discharge, chemical and biological methods are usually used in conjunction. Waters to be used as a source of domestic—or sometimes industrial—supply are usually examined bacteriologically; with some surface waters the algal flora is examined frequently, and measures are taken to prevent its interfering with filtration and other methods of treatment of the water. There is a great lack of quantitative information on the distribution of different species of fish in rivers, particularly in rivers polluted by sewage and industrial effluents. Recent work has shown that large numbers of coarse fish enter a channel carrying an undiluted sewage effluent, in which conditions only rarely become lethal; when lethal conditions do occur, it is due principally to depletion of oxygen in solution.

In regulating the discharge of effluents containing oxidizable matter to a stream, a method is urgently required whereby the effect of a given discharge on the oxygen tension in the stream can be predicted. Usually effluents are examined by the test for biochemical oxygen demand or, better, by measuring uptake of oxygen in a respirometer (of which a new modification of an instrument of the Warburg type was described), but it is by no means certain that the rate of oxidation—particularly of ammonia—measured in this way is the same as that which occurs in a stream. In the direct measurement of rate of oxidation in a river, it is necessary to be able to determine the rate of solution of oxygen from the air—known to vary widely with turbulence, surface agitation, and other factors. Dr. Southgate described an attempt to do this by following changes in the oxygen content of air trapped in a light plastic container, open at the bottom, and floating on the surface of the water. Rapid fluctuations may occur in the oxygen tension in polluted streams, and methods of recording the level of oxygenation, continuously or at short intervals, are required. A recently developed apparatus was described in which samples are taken at intervals of ten minutes, the oxygen content being determined automatically, essentially by the method of Winkler; the values obtained are recorded on a chart.

The determination of the toxicity of effluents to fish was then dealt with by Mr. D. W. M. Herbert (Water Pollution Research Laboratory, Stevenage); the object of this work, he said, is to predict, from tests in the laboratory, what effect a given effluent would have on fish when discharged to a river. Laboratory tests under controlled conditions can usually be made only during a period of a few days, though some have been continued for as long as three months; from tests of this kind, one has to try to predict what the effect of a small concentration of a poison, present continuously in a river, would be on a fishery. It is very probable that the toxicity of a river water, containing a fixed concentration of a poison, would in any event fluctuate widely, since the toxicity of most direct poisons which have been examined increases markedly as the oxygen tension of the water containing them is reduced below the air-saturation value. Fluctuations in temperature and *p*H value may also be important; the toxicity of solutions of ammonia, for example, increases rapidly as the *p*H rises and ionization is suppressed.

Dr. J. E. Forrest (Queen Mary College, London) described the effects of polluting discharges on the flora and invertebrate fauna of streams, dividing effluents for this purpose into those containing direct poisons; those, such as sewage effluents, not directly poisonous but containing organic matter; and those which affect a river mainly by raising its temperature. Below a source of serious organic pollution there is a well-marked sequence of changes in the invertebrate fauna and, it was suggested, a study of the fauna in a river might give more reliable information about the state of pollution of the water than would be given by random chemical tests. The relative importance of the level of oxygenation of the water and of the nature of the bottom in influencing the distribution of invertebrates is not yet clear. Normally, of course, if mud and sludge are to be deposited in a river, this will happen in slow-flowing and relatively deep reaches where the oxygen tension of the water is likely to be low, as a result of uptake of oxygen at the mud–water interface, and of the relatively small rate of re-aeration of the water from the air under stagnant conditions. The importance of *Cladophora* (blanket weed) in modifying the character of a stream was stressed; this alga may grow very vigorously in rivers polluted by nitrogenous organic matter.

In a paper on the determination of the safety of water, Dr. E. Windle Taylor (Metropolitan Water Board, London) described the development which has taken place, from about 1880 onwards, of bacteriological methods of examination. Recently, for research purposes, the probable error of bacterial counts, using liquid media, has been considerably reduced by using only two-fold dilutions and examining seven series, each of ten tubes, in each determination; the modern view, however, is that in routine estimations to safeguard the purity of a domestic water supply it is better to increase the number of samples examined rather than to increase the number of tests carried out on each sample. He emphasized that a public water undertaking aims at distributing a safe, but not necessarily a sterile, water; sterilization may be necessary if the water is used in a hospital, and for process water in food industries further treatment may be desirable to improve the keeping qualities of the product. Among the most promising recent developments in methods of examining water are membrane filtration, and the use of synthetic media containing only pure inorganic substances. Dr. Windle Taylor urged—and this was strongly supported in discussion of his paper—that standard bacteriological methods should be used in examining water supplies. Several members also referred to the urgent need for a second edition of "Methods of Chemical Analysis as applied to Sewage and Sewage Effluents", the first edition of which was published by the Ministry of Health as long ago as 1929.

The discussion—a very brisk one—which followed the papers covered a wide range. Opinion seemed to be general that there is a need for a standard method of determining the toxicity of industrial effluents to fish; an attempt is in fact now being made to develop such a method, and the Ministry of Agriculture and Fisheries has announced that it proposes to set up a laboratory in London in which samples submitted will be tested. Several speakers referred to the inadequacy of the widely used test for biochemical oxygen demand of effluents, and it is clear that much further work is required to determine rates of oxidation of pollutants, both under laboratory conditions and in different types of rivers. Only when this information is available will it be possible to predict with confidence the effect of an effluent on the level of oxygenation of a river—a very important matter to a river board proposing to frame by-laws regulating the quality of effluents in its district.

RESEARCH ADMINISTRATION CONFERENCE

THE eighth annual conference on "The Administration of Research" brought together nearly three hundred leaders of industrial, university and government research laboratories at New York University during September 8–10, coinciding with the opening of the centennial celebration of the College of Engineering of that University. The Conference is arranged each year by an informally organized group, mainly administrators of research and development in the physical sciences. Attendance is by invitation and proceedings are published by the host university. The programme for 1954 was designed for discussing specific incidents pertaining to management of the 4,000 million dollar research and development business throughout the United States.

At each half-day symposium a series of four or five brief presentations was followed by lively discussion. The first symposium, "Appraising and Rewarding the Researcher's Output", was opened by Dr. Eric A. Walker, dean of engineering at Pennsylvania State College, where the Conference was founded in 1947. Observing that "we have passed through the stage of random creativeness and entered an age of deliberate creativity", Dr. Walker said it is up to the research man to sketch the course the engineer will follow toward the prophesied increase of 100,000–150,000 million dollars in the gross product of the United States by 1960. Although no objective measure of an individual scientist's productivity has yet been found, the fact that empirical evaluations are becoming more prevalent and systematic was brought out by each speaker.

Mr. Edwin A. Speakman, general manager, Guided Missiles Division, Fairchild Engine and Airplane Corporation, described the semi-annual rating plan of his company. He noted that supervisors and administrators must often evaluate and reward a researcher's potential far in advance, as it may take several years for his efforts to materialize. Dr. Clyde E. Williams, director of the Battelle Memorial Institute, emphasized that scientific integrity, selflessness and ability to work in a team are considered most important for promotion. The National Bureau of Standards, according to its director, Dr. A. V. Astin, favours appraisal and promotion of staff members through the collective judgment of committees at various levels. Although it is possible to promote a scientist to the highest grade without assigning him executive responsibility, such assignments are difficult to avoid, and Dr. Astin suggested that this situation warrants further study.

The Conference speaker from outside the United States was Dr. John J. Green, of the Defence Research Board of Canada, who is science advisor to the Royal Canadian Air Force. He summarized, with individual examples, awards which are available for merit in research; these include sabbatical years, cash awards, royalties from inventions, the Queen's honours lists, and the annual gold medal of the Professional Institute of the Civil Service of Canada.

After a luncheon, addressed by Henry T. Heald, chancellor of New York University, the second symposium dealt with a number of general aspects of "Management in the Research Laboratory". The chairman, Dr. James B. Austin, vice-president of the Research Division, United States Steel, gave some pointers on the "Control of Service Groups". He emphasized the concept of service to the research staff, pointing out that machine-shop backlog must be small enough to accommodate rush-work for scientists. Informal contacts by the scientist with the service technician are encouraged and priority determinations in shops work, for example, are made through weekly conferences. In exploring "The Use of Work Simplification in a Research Laboratory", Mr. Allan H. Mogensen, management consultant, gave examples of how other organizations have been helped by such a programme. He urged that all workers be taught to keep asking 'why', and recommended direct communication, rather than suggestion boxes, as the channel for ideas.

The delicate problem of "Inter-Departmental Relations of Research to Production and Sales" was treated by Mr. Kenneth H. Klipstein, general manager of the Research Division, American Cyanamid Co. Not only individuals but also whole sections of an organization must practise team-work in to-day's industry and government. To have the research director as a part of top management and to use co-ordinating committees for active planning and review are approaches Mr. Klipstein has found most effective. Similar experience was described by Dr. Blaine B. Wescott, executive vice-president, Gulf Research and Development Co. Having research consolidated in one department rather than dispersed among operating departments, he agrees, has more advantages than disadvantages. Qualifications of an engineering manager were discussed by Mr. Howard L. Richardson, vice-president of engineering operations, Sylvania Electric Products, Inc. No stereotyped combination of traits has been found, he pointed out. A technical background is invaluable, but it does not teach such executive arts, as how to sell ideas and how to make decisions based on judgment where facts are sparse.

In the third symposium, "Communication Problems in a Research Operation" were illustrated. The chairman of the session, Dr. Paul R. Beall, consultant to the Deputy Chief of Staff, Development, U.S. Air Force, was also chairman of the Conference Programme Committee. Alluding to the disappointment a company may experience when inadequate communication of a design proposal makes it lose a large contract, Dr. Beall gave some tips, including a dramatized presentation on how to make an effective oral presentation. "How ASTIA Can Help Your Research" was indicated in a series of specific cases by Mr. Leslie E. Neville, director of the Armed Services Technical Information Agency (ASTIA). This Agency is a clearing-house available to the U.S. Defense Department and its prime contractors. A single report, for example, obviated a long-range study of corrosion which saved one company fifty thousand dollars and two years in time.

Dr. Howard G. Vesper, vice-president of the Standard Oil Co. of California, asserted that good external communication with its clientele is at the heart of effective service by a research laboratory. He agreed with the thinking of Dr. Wescott and Mr. Klipstein as regards a separate laboratory organization and its co-ordination through committees. At California Research, Inc., a conscious attempt is made to bring group leaders and even bench workers into study-group discussions, and also to permit them to see their 'brain children' put on the production line. A very specific tool of communication is "The Director's Mimeographed Weekly Bulletin", described by Dr. Helmut E. Landsberg, chief of the Climatological Services Division, U.S. Weather Bureau. It helps to bridge the gap resulting from bigness.

The special problems of "Communication in Classified Research", brought up again and again during the Conference, were given more extensive treatment by one in a position to know, Dr. Norris E. Bradbury, director of the Los Alamos Scientific Laboratory of the Atomic Energy Commission. The solution of internal communication problems, he said, is really a function of how the director and the people with whom he works feel toward one another. No tools or procedures can compare with 'attitudes' when it comes to communication. The 'need to know' is interpreted broadly within Los Alamos, and free discussion among staff develops bright ideas in the most unexpected places. In external communication, security restrictions cause difficulties that Dr. Bradbury does not know how to overcome. He believes there can be more common sense in the sharing of scientific information without endangering national security.

The fourth symposium, on "Physical Facilities for Research", included contributions from Mr. Walter H. Verdier on the planning and construction of the new Applied Physics Laboratory of Johns Hopkins University; from Mr. A. R. Johnson, of Arthur D. Little, Inc., on the building of adequate laboratory structures for less than 12 dollars per sq. ft.; from the architect, Mr. Ralph Walker, who spoke from wide experience on "Designing Buildings for Research"; and from Dr. Clifford F. Rassweiller, vice-president for research and development, Johns Manville Corporation, on "Building for Greater Research Productivity". All agreed that the building is merely a tool for productive research. There were some differences of opinion about the size of the 'modular design' and about how easily transferable the partitions should be. Dr. Rassweiller particularly emphasized thinking in terms of things that will increase research productivity. We should not just ask "How much can we save in building?", he declared, but "How can we build a facility that will give greatest returns on the dollars invested?".

The final symposium, on "Basic Research in an Applied Research Laboratory", elicited stimulating discussion to the very end of the Conference. The chairman of the session, Mr. Earl P. Stevenson, president of Arthur D. Little, Inc., had served this year as general chairman of the Conference Advisory Committee. He strongly favoured the mixing of some basic research along with applied, and explained how his company established the 'office of science director' with no administrative responsibility but with a broad mandate for providing scientific leadership through the informal organization. Dr. Maurice Nelles, director of the Borg-Warner Central Research Laboratory, gave a concrete example of how basic results grew out of applied research on sheet metal work. "We used to be asked", he said, "what have you discovered that is new? Now we are asked, when will you complete that project?" This signifies, Dr. Nelles concluded, that science may have reached the end of progress by analysis and separation—that random hunting has passed its prime—and we must plan deliberate creation and synthesis. "Cortisone—A Product of Joint Academic and Industrial Basic Research" was the title of a vivid description by Dr. Randolph Major, vice-president of Merck and Co., Inc. Without close team-work between applied and basic approaches, the hormone synthesis which resulted in this drug could never have been possible.

Dr. Ralph Bown, vice-president of the Bell Telephone Laboratories, suggested that "Research is simply an effort to understand more about things". The way for an applied laboratory to get a balance which includes some basic research is to employ people who are concerned in understanding the things which interest the company and then to keep them informed of those interests. Bell Laboratories, Dr. Bown said, relies less on committees and more on delegation and co-ordination through the line than seems to be true of some others. When a man has a bright idea, the general policy is that he should pursue it, if it is reasonably applicable to the company's work; as soon as it reaches the stage where it is not, he should publish interim results so that someone else can continue the research.

Mr. Alex Stewart, director of research of the National Lead Co., spoke on "Gold is where you find It", in people as well as in minerals. His company sponsors exploratory and basic research in universities and, when timely, transfers it to the company laboratory. Also, the National Lead Co. has the unique practice of making a research and development team actually demonstrate the salability of a proposed product before it is turned over to the Sales Department.

At the dinner meeting, Major General William M. Creasy, of the Army Chemical Corps, spoke candidly of needs and proposals for strengthening the research and development work as well as general operations of his Corps. He is setting up an advisory committee and has engaged a leading industrial scientist to direct all scientific operations.

Attendance at the Conference was reported to be a little more than half from industry and the remainder divided equally between government and universities. The 1955 Conference will be held at Northwestern University, Evanston, Illinois. Dr. Thomas H. Vaughn, vice-president for research and development of the Colgate-Palmolive Company, is the new chairman of the Advisory Committee, and Dr. Maurice Nelles the new chairman of the Programme Committee.

A. V. ASTIN
IVAN ASAY

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

REPORT FOR THE YEAR 1953–54

THE annual report for 1953–54 of the Indian Association for the Cultivation of Science has recently been published in full*, and although reference has already been made in these columns to the Association's activities during the year (*Nature*, September 11, p. 495) when the acting director, Prof. P. Ray, originally presented the report at the annual general meeting of the Association, held on July 30, a fuller résumé that is now possible, from the published report, is not without interest. Besides the usual appended financial statements and lists of books acquired during the year and serials received on an exchange basis, the account includes, among the departmental reports of research, departmental lists of papers published during the year. Details are given of the five-year plan of development covering the financial years 1954–59, which was prepared at the request of the Finance Committee and the Government of India and finally approved by the Council on March 29, 1954. The plan contemplates non-recurrent grants totalling Rs. 1,138,200 for equipment and Rs. 1,771,393 for land and buildings, of which two-thirds is to be provided by the Government of India and one-third by the Government of West Bengal. Recurrent grants, which are estimated to increase from Rs. 465,630 in 1954–55 to Rs. 777,415 in 1958–59, and to total Rs. 3,237,592 in the quinquennium, will be provided mainly by the Government of India as at present. The Plan does not involve the establishment of any new Department.

In the Department of General Physics, X-Rays and Magnetism, investigations on the transport properties of matter have been started. Results obtained for the conductivity of argon–neon mixtures using Kannuluik's thick-wire method agree with the 12 : 6 power model of the intermolecular potential but not with the inverse power model. B. N. Srivastava has applied the theory of the thermodynamics of irreversible processes in investigating the thermal effusion of substances capable of existing in two isomeric forms. The unit-cell dimensions of fluoranthrene and phthalic acid have been determined from morphological and X-ray studies, and the dimensions of the intermicellar zones of some fibres have been obtained by incrustation of metals like gold and silver in the colloidal form in the fibre framework. The investigation of low-angle X-ray scattering continued as well as X-ray studies of red-coloured silver glass and of the nature of adherent metal films of glass surfaces. Determinations of the magnetic anisotropy of paramagnetic crystals of the elements of the iron group continued, and a new, simple and efficient electrodynamic method of measuring magnetic fields, with an accuracy of about 5 parts in 10,000, has been developed. Experimental and theoretical studies on the electrical, thermal and magnetic properties of graphite crystals also continued.

In the Department of Optics, the ultra-violet absorption spectra of phenetole, *n*-butyl benzoate, α-chloronaphthalene and α-bromonaphthalene have been determined in the liquid and solid states at low temperatures and also those of *o*-, *m*- and *p*-toluidine, while the Raman spectra of *o*- and *p*-chlorotoluene in the solid state at − 180° C. have been compared with those for the liquid state. Studies of the Raman spectra of 1 : 2-dichloroethane and 1 : 1 : 2-trichloroethane in the vapour state indicate a marked change in the ratio of the number of the two types of molecule with the change from liquid to vapour state, attributed to the influence of the strong inter-molecular field in the liquid state. The absorption of radio waves of frequencies in the range 250–920 Mc./s. in benzyl alcohol, benzyl chloride and benzylamine at different temperatures has also been studied, as well as the absorption of 3·3-cm. microwaves in chloroform and ethylene dichloride. The number of events in which a neutral particle in cosmic rays produced in a lead absorber either one charged meson or more neutral ones moving along different paths was determined.

In the Department of Theoretical Physics the equivalence of the Born approximation to the covariant perturbation theory has been demonstrated by considering the scattering of fast electrons by the Coulomb field of the atomic nuclei, and the method of Brinkman and Kramers has been extended to the capture of the electron in arbitrary excited orbits. Theories of the nuclear shell structure model and Bohr's liquid-drop model are being studied with the view of finding common ground for the two approaches.

In the Department of Physical Chemistry, investigations on the chain transfer of vinyl acetate using hydrocarbons, alcohols, ketones and chlorinated solvents gave results in agreement with the α-hydrogen theory. With acrylonitrile the results also agree with that theory except when halogenated solvents are used. A study of the kinetics and chain-transfer coefficients of vinyl and other monomers in the hydrogen peroxide-catalysed systems has led to a method for evaluating solvent transfer in the catalysed system. Work with nine azonitriles as initiators in the polymerization of vinyl monomers was completed, and work on the synthesis of hydroperoxides and the X-ray-initiated polymerization of vinyl monomers commenced. Lauroyl, caprinyl and caproyl esters of methylethylcellulose have been prepared. Seven osmometers have been constructed and calibrated for the determination of the molecular weight of co-polymers. Results obtained for the molecular weight distribution of polystyrene were in good agreement with the theoretical distribution equation of high polymers deduced by S. R. Palit and K. C. Majumdar. The solubility of anthracene and phenanthrene in the binary systems ethyl iodide or iodobenzene, cyclohexane or cyclohexene, has been determined.

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* Indian Association for the Cultivation of Science. Annual Report for 1953–54. Pp. 64. (From the Association, Jadavpur, Calcutta, 1954.)

Work in the Department of Organic Chemistry has been reoriented considerably. In the study of diterpenoids a new general method has been developed by the synthesis of tricyclic C_1-ketones. A new stereo-specific synthesis of *dl*-homocamphoric acid has been developed from camphononic acid and a similar synthesis of *dl*-homoapocamphoric acid completed. Efforts are also being made to develop a stereospecific synthesis of a steroidal nucleus, and the technique using liquid ammonia for the preparation of intermediates has been improved. A synthesis of the dicarboxylic acid, $C_{12}H_{14}O_4$, obtained by the degradation of picrotoxin, has been achieved, and the ultra-violet absorption spectra of benzo-α- and γ-pyrones correlated with the corresponding chromophoric structures.

The Department of Inorganic Chemistry has been concerned chiefly with the chemistry of co-ordination complexes, especially the *cis-trans* isomerism of copper complexes, and with the use of organic reagents for inorganic analysis. A critical review is in progress of colorimetric methods for the determination of titanium, chromium, uranium and palladium, and a new method has been developed by the colorimetric determination of titanium with salicylhydroxamic acid, while salicylamidoxime has been used for the gravimetric determination of transitional elements, as well as for their separation and the colorimetric determination of uranium and iron.

LAW OF RED SHIFTS AND THE DISTANCES OF NEBULÆ

THE George Darwin Lecture of the Royal Astronomical Society was delivered by the late Dr. Edwin Hubble on May 8, 1953, in the Society's rooms at Burlington House, London, the subject of the Lecture being the law of red shifts—the correlation between distances of nebulæ and displacements in their spectra*. Three phases in the history of the law of red shifts were discussed; the first, the discovery phase, commenced with Slipher's measurement in 1912 of the velocity of *M* 31, which he found to be −300 km./sec., and during the next ten years he contributed forty-two out of forty-six nebular velocities then available. The list was completely dominated by large positive velocities which ranged up to 1,800 km./sec. in the case of *NGC* 584.

Attempts from 1916 onwards to derive the solar motion with respect to the nebulæ were frustrated by the positive signs indicating general recession, but improvements in the results followed Wirtz's introduction of a constant *K* term in the equations. Although the improvement was not sufficient to render the results acceptable, it was seen that the next logical step would be to replace the constant *K* by *rK*, that is, by a term which varied with the distances of the individual nebulæ; and during the early and middle twenties various solutions were made, measures of relative distances being based on apparent luminosities and apparent diameters. Failure was due, as appeared later, to the relatively short range covered by the radial velocities being insufficient to give reliable individual distances. The problem was finally solved when the brightest stars in late-type spirals and irregular nebulæ were established as suitable indicators of distance and were calibrated by Cepheids in a few of the nearest nebulæ. Using the upper limits of brightness of these stars as a distance criterion and applying it to the nebulæ with measured velocities, the law of velocity-distance shifts, now known as the law of red shifts, emerged approximately in its present form. This law was established in 1928 out to about seven million light-years, as an approximate linear relation according to which velocities of recession increased at the rate of the order of 500 km./sec. per million parsecs of distance, or about 150 km./sec. per million light-years.

The second phase, a Mt. Wilson project, lasted from 1928 to 1936, during which Humason assembled spectra of nebulæ and Hubble attempted to estimate their distances. For various reasons, attention was concentrated on clusters, and, when these could not be observed to advantage, spectra of field nebulæ, isolated or members of small groups, were assembled in large numbers; these data provided an account of red shifts in the nearer, more conspicuous nebulæ of all kinds. The results of the second phase were as follows. The law of red shifts appeared to be linear, and the red shifts increased at the rate of about 160 km./sec. per million light-years. The solar motion was largely accounted for by galactic rotation, and the residual represented the peculiar motion of the stellar system and was small and uncertain, of the order of 100–150 km./sec. towards galactic latitude + 30° approximately, and longitude in the quadrant 50°–140°. The law of red shifts did not operate within the Local Group; and, lastly, magnitude–velocity relations, fitted to data for clusters, resolved nebulæ and field nebulæ, and displaced from one another by magnitude intervals indicating relative absolute luminosities, could be used to calibrate all the relations in terms of brightest stars.

In the interim between the second and third phases, Mayall began assembling spectra with a very fine ultra-violet spectrograph on the 36-in. Crossley at Mt. Hamilton, and gave special attention to the later-type spirals and other systems of low surface brightness for which his reflector was as efficient as the larger telescopes on Mt. Wilson. His list now numbers about 280 nebular velocities and with Humason's list, when the two are published, will total about 750 individual nebulæ. The data furnish most important information of every kind, and full discussion must await publication of the lists, though certain matters are divulged by Hubble; limits of space prevent anything more than reference to them in this article.

The completion of the 200-in. reflector and its accessories initiated the third and current phase of the development, the programme of which has two parts, the first being the extension of the observed range. During the first season that a nebular spectrograph could be used on the 200-in. (1950–51), Humason obtained spectra in three clusters which had been unsuccessfully tried with the 100-in.; one of these, the Hydra cluster, had a velocity of 61,000 km./sec. The 48-in. Schmidt reflector can be used to this limit, but beyond it clusters cannot be identified with certainty on the survey plates. Humason is confident, however, that velocities up to 75,000 km./sec. at least can be recorded when clusters have been located, but such locations would depend on purely chance finds with the 100-in. and 200-in.

The second part of the programme deals with the revision of the distance scale. A review of the unit of distance has been pending for more than twenty years—after it was realized that many novæ and globular clusters in *M* 31 were fainter with respect to the Cepheids than was the case in our own system. It is now known that the classical Cepheids in *M* 31 are nearly 1·5 magnitudes brighter than was previously supposed; in consequence, current estimates of absolute distances must be nearly doubled, and the so-called 'age of the universe' must be increased on the same scale. Among other steps in the programme are included the setting up of faint-magnitude sequences in Selected Areas, the measurement of nebular magnitudes, corrections for effects of red shift on apparent magnitudes, and the examination of the possibility of errors arising from inter-nebular obscuration and systematic evolution changes in luminosities during the travel time of the light from the nebulæ. Each of these is considered in logical order in the later part of the Lecture, which ends with a warning that "we are already in the region of diminishing returns"—in other words, instruments will be increasingly expensive and progress increasingly slow. So far as the immediate future is concerned, the most promising programmes accept the observable regions as now defined, and, while hoping for only modest extensions in space, concentrate on increased precision and reliability in the recorded description. "The reconnaissance is being followed by an accurate survey; the explorations are pushed towards the next decimal place instead of the next cipher." The Lecture ends with an optimistic outlook: "From our home on the Earth, we look out into the distance and strive to imagine the sort of world into which we are born. Today we have reached far out into space. Our immediate neighbourhood we know rather intimately. But with increasing distance our knowledge fades, and fades rapidly, until at the last dim horizon we search among ghostly errors of observations for landmarks that are scarcely more substantial. The search will continue. The urge is older than history. It is not satisfied and it will not be suppressed".

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ABSORPTION OF IONS BY PLANTS

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It has been shown[1] that in water culture some plants may absorb both cations and anions at a rate which is independent over a wide range of the total concentration in the culture medium, provided their relative concentrations in the medium are kept fixed. Such results may be explained on the basis that the rate of absorption is limited either by the number of suitable 'carrier' molecules or by the amount of energy available from respiration[2]. However, recent work has shown that ion exchange processes may follow a closely similar pattern. The rate of exchange of sodium for hydrogen on both strong-[3] and weak-acid[4] cation exchange resins has been shown to be independent of the sodium ion concentration in solution over a wide range. In this range, the rate-controlling process has been shown to be the diffusion of ions through the resin material, the constancy of rate being due to the fact that the *boundary* concentrations are independent of those in solution. It appears, therefore, that a simple alternative hypothesis for the uptake of ions by plants may be postulated on the basis of ion exchange.

The assumption must be made that there is present in plant cells a membrane (or membranes) containing both anion- and cation-exchange materials across which the movement of ions occurs. However, it is not necessary to postulate two entirely homofunctional substances, one completely acidic and the other completely basic; only that one is predominantly acidic and the other predominantly basic. The two might even be part of the same protein molecule provided the acidic and basic units were sufficiently segregated. The properties of such 'mosaic membranes' have been studied, both theoretically and experimentally, by Sollner[5,6]. To cause ion exchange to proceed it is necessary for the plant to provide on the inside of the membrane a continual supply of an appropriate electrolyte such as carbonic acid or some other weak organic acid. The cations would then be exchanged for hydrogen ions on the cation exchange material, and the anions likewise for bicarbonate (or other anion) on the anion exchanger. Thus the hydrogen ions and anions would diffuse separately through the cation and anion exchange materials respectively and recombine in the culture medium, while other ions from the medium would move in the opposite direction. It is known that hydrogen ions, bicarbonate and other anions are, in fact, yielded by plants to the external solution.

The energetics of transport by ion exchange diffusion are particularly simple and account readily for the fact that ions may be absorbed against a concentration gradient. Consider a cation exchange membrane separating infinite volumes of solutions 1 and 2, in which the activities of sodium and hydrogen ions are, respectively, $[a_{\mathrm{Na}}]_1$, $[a_{\mathrm{H}}]_1$, $[a_{\mathrm{Na}}]_2$, $[a_{\mathrm{H}}]_2$. 1 represents the culture medium and 2 the solution on the inside of the plant membrane. Sodium will diffuse through the membrane from solution 1 to solution 2 provided that the concentration of sodium ions *in the membrane* is greater on the side nearer solution 1. Since the uptake of sodium ions by cation exchange materials of both the strong- and weak-acid type has been shown to depend on the ratio $a_{\mathrm{Na}}/a_{\mathrm{H}}$ (if hydrogen is the competing ion), transport of sodium ions from solution 1 to solution 2 will occur if:

$$\frac{[a_{\mathrm{Na}}]_1}{[a_{\mathrm{H}}]_1} > \frac{[a_{\mathrm{Na}}]_2}{[a_{\mathrm{H}}]_2} \qquad (1)$$

that is, if

$$\frac{[a_{\mathrm{H}}]_2}{[a_{\mathrm{H}}]_1} > \frac{[a_{\mathrm{Na}}]_2}{[a_{\mathrm{Na}}]_1} \qquad (2)$$

Now consider the energetics of the process. Let $[a_{\mathrm{Na}}]_1$ be less than $[a_{\mathrm{Na}}]_2$. This means that sodium ions must be transported against a concentration gradient. For this an expenditure of free energy $RT \ln \frac{[a_{\mathrm{Na}}]_2}{[a_{\mathrm{Na}}]_1}$ per gm. ion is required. However, hydrogen ions will diffuse in the opposite direction assisted by their own concentration gradient which provides an amount of free energy $RT \ln \frac{[a_{\mathrm{H}}]_2}{[a_{\mathrm{H}}]_1}$ per gm. ion. This will be sufficient to drive the sodium ions across provided

$$RT \ln \frac{[a_H]_2}{[a_H]_1} - RT \ln \frac{[a_{Na}]_2}{[a_{Na}]_1} > 0,$$

which reduces to the inequality (expression (2)) above. It is therefore necessary for the hydrogen ion concentration inside the membrane to be raised through metabolism to a value satisfying the conditions of expression (2) if the absorption of sodium against a concentration gradient is to occur. In a similar manner the absorption of anions requires a suitably high concentration within the plant of carbonate or bicarbonate ions or anions of an organic acid.

In the respect that it depends upon metabolically maintained gradients of exchangeable ions this hypothesis resembles those of Brooks[7], and Osterhout[8], which were criticized by Hoagland[9], on the grounds that the necessary gradients either do not always exist or bear no direct relationship to the rate of ion absorption. A critical point in this connexion appears to be the precise location of the effective membrane in a vacuolated cell, whether it is to be represented by the whole protoplast or by the outer or inner surface membrane. Clearly, if the whole protoplast is involved the ion exchange mechanism cannot operate unless gradients exist for hydrogen ions and suitable anions between the external medium and vacuolar sap. Hoagland claimed that ions may be absorbed when these conditions do not apply, and therefore rejected the exchange hypotheses.

On the other hand, if the outer cytoplasmic surface acts as the membrane, it is evident that respiratory processes in the protoplasm may create the necessary gradients and accumulation of ions in this region be brought about. With meristematic cells in which there are no obvious vacuoles this mechanism is sufficient to account for absorption. It has generally been supposed that ions move passively into the protoplasm of plant cells[2,10-12], but clearly the presence of metabolic products in the form of charged particles is an essential pre-requisite, since diffusion alone is insufficient and adsorption-exchange reactions are obviously involved. Frey-Wyssling[13] has suggested a structure for the surface membrane of a protoplast which is not inconsistent with its possession of ion exchange properties.

With mature cells, however, ions accumulate in the free state within the vacuoles, and in so doing an additional barrier, the tonoplast, is encountered. Since metabolic reactions are on the whole occurring outside this membrane it seems unlikely that the necessary gradients for hydrogen ions and anions will exist to account for movement from the protoplasm. It is probable, therefore, that in this case a mechanism other than ion exchange is responsible for transport. A discussion of the possibilities in this connexion is outside the scope of the present communication; but a mechanism based on the ideas of Goldacre[14] or Conway[15] would appear to be adequate. In support of the hypothesis that the movement of ions across the plasmalemma and tonoplast are accomplished by fundamentally different processes, Arisz[16] has shown that whereas chloride transport into the protoplasm of *Vallisneria* leaves is inhibited by cyanide it is unaffected by dinitrophenol at a low concentration which prevents vacuolar accumulation. Moreover, Steward[17] has claimed that the mechanism of absorption of ions by meristematic tissue-culture cells is not identical with that of cells in the vacuolated condition, and this may be interpreted as above.

If two distinct mechanisms are involved in the transport of ions from an external medium into the vacuoles of individual cells or the stele of the root, then either may be the limiting factor according to the particular environmental or experimental conditions involved. The work with resins suggests that contrary to general opinion the rate of ion exchange in a preliminary phase may control the rate of absorption of mineral salts by the plant as a whole. Recently Epstein[18] has advanced the view that active transport of both anions and cations requires their combination with protoplasmic constituents, a view consistent with our own.

One of us (D. R.) wishes to thank the Director of the Chemical Research Laboratory for permission to publish this communication.

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FINDING THE DIRECTION OF TRAVEL OF SEA WAVES

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TO describe the nature of wind waves, or to locate a storm by observations of swell, it is necessary to be able to distinguish waves by their direction of travel. The study of period[1] is insufficient by itself.

Some preliminary experiments have been made in the Waitemata Harbour, Auckland, measuring wave direction by the correlogram. The photographs of Fig. 1 show statistical relations between wind waves of period near 2 sec. at points separated by distances of 2, 9, 18 and 27 ft. along a fixed line. From them may be obtained the curve of Fig. 2, showing how the energy is distributed among the various directions of travel. The wind was about 15 knots and 2-sec. waves were dominant; but because the fetch in the wind direction was much greater than elsewhere, it is not expected that the curve of Fig. 2 will apply to open water.

The elevation in a sinusoidal wave train may be written:

$$\text{elevation} = \text{real part of } a \exp i(lx + my - \sigma t),$$

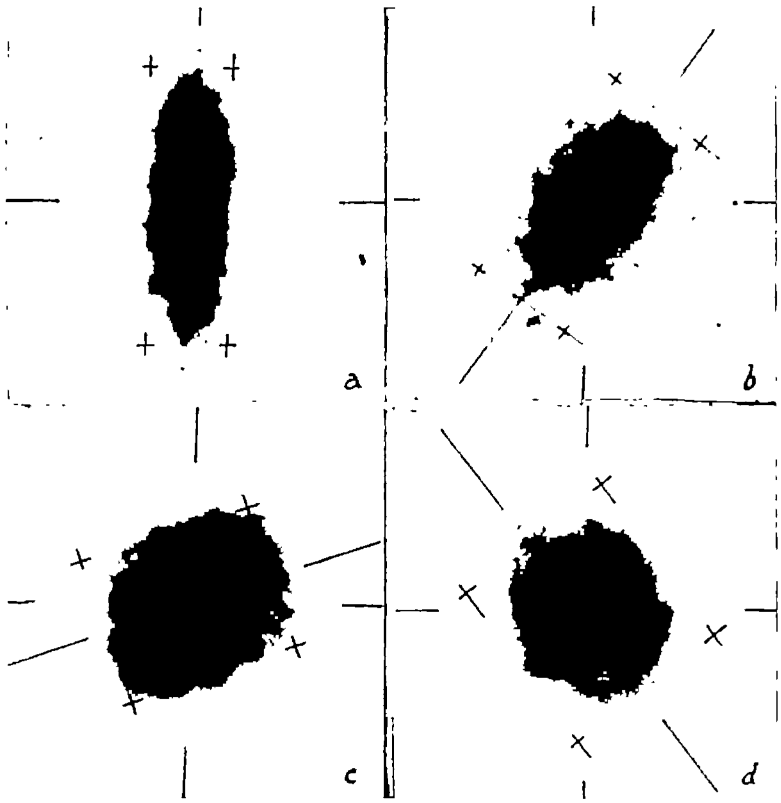

Fig. 1. Photographs showing the statistical phase relations between waves at points separated by 2, 9, 18 and 27 ft. along a fixed line. Attention is confined to waves of period near 2 sec.

where a is the amplitude, σ the frequency, and l, m are wave numbers in rectangular directions x, y. Khintchine's theorem[2] relating the energy spectrum $E(l, m)$ of a more complicated wave system with its autocorrelogram $R(x, y)$ then becomes[3]:

$$R(x, y) = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} E(l, m) \exp i(lx + my)\,dl\,dm. \quad (1)$$

In progressive incoherent waves, $R(a, b)$ is obtainable as the covariance of complex wave elevations at two fixed points separated by distances a, b, the average being taken over a long time.

It was desired to restrict the wave measurements to discrete points upon a line taken as the x-axis. Such results can give E so long as attention is restricted to waves very near some frequency σ_0 with corresponding wave-length $2\pi/k_0$. It then appears, to a sufficient approximation, that equation (1) inverts to a Fourier series:

$$E(k_0, \theta) = E_0 \sin\theta\,[\tfrac{1}{2} + \sum_{n=1}^{\infty} C_n \cos(nlD - \psi_n)], \quad (2)$$

where θ is $\cos^{-1} l/k_0$, the direction of wave progress relative to the line of recorders, $E(k_0, \theta)\delta\theta$ is the energy of waves with number k_0 and directions between θ and $\theta + \delta\theta$, and C_n, ψ_n are the modulus and phase of the complex correlation coefficient between wave elevations at points separated by a distance nD. The distance D should not exceed π/k_0 or half a wave-length. The expression is valid so long as no waves have directions outside the range 0°–180°. The factor $\sin\theta$ is an approximation the error of which causes an under-estimate of the wave energy in directions near 0° and 180°.

In the experiment, each detector was a pair of parallel vertical copper strips, partly immersed in the sea and fed with 2 volts (mains frequency) from a transformer. The current that passed was proportional to the depth of immersion, varying with the waves, and a corresponding voltage signal was conveyed to the analyser. Two such instruments were hung from a pile wharf at separations of 2, 9, 18 and 27 ft. in succession.

A pendulum of period near 2 sec. was used to select a narrow frequency-band and to produce the pictures in Fig. 1. Its free motions in all azimuths had equal period and damping, and it was electrically driven through amplifiers fed with the wave signals. The motion of the pendulum was recorded optically as a spot of light moving over a photographic plate, an exposure of 15 min. being required for each of the pictures in Fig. 1.

The electrical arrangements were such that a coherent signal $P \cos \sigma_0 t$ from one instrument would give the pendulum a circular motion in the positive sense, that is, $P \exp i\sigma_0 t$ if the picture is thought of as an Argand diagram. From the other instrument, that at the smaller x-value, a signal $Q \cos \sigma_0 t$ would give a motion in the opposite sense, or $Q^* \exp - i\sigma_0 t$. In natural incoherent waves the amplitudes P and Q are complex quantities changing slowly and randomly in magnitude and phase, and have equal variance. The modulus C and the phase ψ of their complex correlation coefficient may be deduced from the elliptic form of the photographic record:

$$C = (A^2 - B^2)/(A^2 + B^2),$$

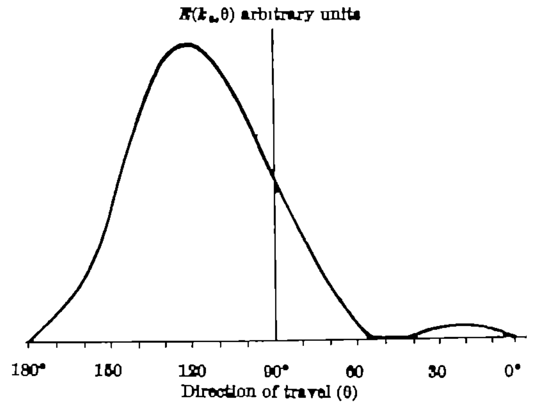

Fig. 2 Distribution of wave-energy with respect to direction of travel relative to the line of instruments. The curve is deduced from the records in Fig. 1

where *A*, *B* are the principal diameters and $\frac{1}{2}\psi$ = azimuthal angle of the major axis. To make its form more obvious, each record was taken on an emulsion having a high contrast.

The $E(k_0, \theta)$ curve in Fig. 2 was computed from the last three photographs in Fig. 1. It shows that the highest waves are travelling in the direction 120° to the positive sense of the line joining the instruments. This was, in fact, the direction of the wind at the time of the measurements, so the method has given reasonable results.

An improved apparatus is being built for further work. With some changes in experimental detail the method appears suitable for a shore-based observatory studying ocean waves. It appears preferable to the better-known 'phase' method in which detectors are combined into a directional array. One advantage is that equal resolving power is obtained with fewer underwater instruments.

It is worth noting that no account need be taken of wave refraction at a coast, so long as its underwater contours are straight and parallel to the line of instruments. The deep-water directions may be inferred without reference to the tidal changes of depth or stream. Further, Longuet-Higgins has shown (personal communication) that only a few terms in (2) are needed to resolve swells the directions of which are well defined. [July 23.

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SIMULTANEOUS DETERMINATION OF SODIUM, POTASSIUM, CALCIUM, MAGNESIUM AND STRONTIUM BY A NEW MULTICHANNEL FLAME-SPECTROMETER

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SODIUM, potassium, calcium, magnesium and strontium have been found universally associated with living matter. The osmotic effect of these elements, their interaction in enzyme-substrate reactions, their participation in intra- and extracellular processes and their formation of salts and chelate complexes with biological substances have been studied intensively. The development of flame-photometry for the analytical assessment of these elements has been decisive in accelerating the understanding of their biological function.

We have recently completed the design and construction of a direct-reading multi-channel flame-spectrometer for the simultaneous analysis of sodium, potassium, calcium, magnesium and strontium. The design allows of the addition of recording equipment to determine additional elements[1]. The instrument, as at present constituted, combines an oxy-hydrogen burner (Beckman No. 4020) with a Wadsworth stigmatic mounting grating spectrograph (Jarrell-Ash Co.). The grating has an effective surface of $3\frac{1}{4}$ in. × $1\frac{1}{4}$ in., 15,000 grooves to the inch, a radius of curvature of 1·5 m. and a reciprocal linear dispersion of 10·8 A./mm. in the first order. Five photomultiplier tubes provided with power supplies for low and high voltage and d.c. amplifiers are placed at the focal plane of the grating. 1P28 photomultiplier tubes (Radio Corporation of America) are placed on the Mg line at 3838·258 A., the CaO band-head at 5495 A., the Na line at 5889·953 A., and the Sr line at 4607·331 A. A 1P22 photomultiplier tube (Radio Corporation of America) is placed on the K line at 7664·907 A. The entrance and exit slits are 0·4 mm. wide. Microammeters, calibrated to read from 0 to 200 μamp., serve at present as recorders for each channel. Control for null and sensitivity adjustments is provided for.

Calibration curves obtained for all five elements are linear over a range of 1–1,000 times the initial concentration, and 1–3 per cent precision is achieved (Fig. 1). The present limits of sensitivity are as follows: sodium, 0·01 p.p.m.; calcium, 0·1 p.p.m.; potassium, 0·2 p.p.m.; magnesium, 0·3 p.p.m.; strontium, 0·1 p.p.m. No internal standard is employed.

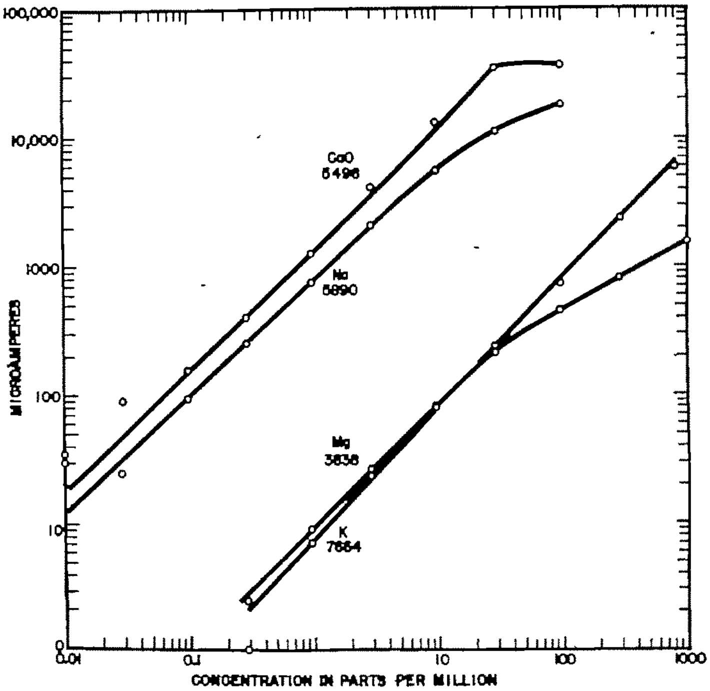

Fig. 1. Calibration curves for calcium, sodium, potassium and magnesium. The receivers were set at the wave-lengths indicated

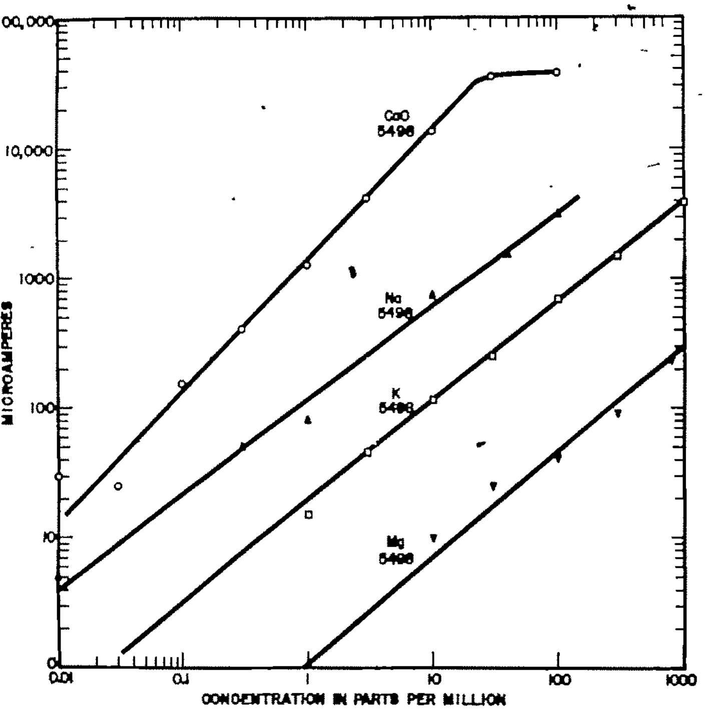

Fig. 2. Rising concentrations of calcium, sodium, potassium and magnesium, all measured with photomultipliers at 5495 A.

Many observers have noted the effect of variable quantities of one or several of these elements upon the measurable light intensity elicited from another. This phenomenon, referred to as 'interference', covers various effects of extraneous, dissolved materials on the monochromatic radiation attributable to the test substance. This 'interference' has been variously attributed to alterations in "the rate of fluid aspiration into the burner", preferential excitation of an 'interfering' element in the flame, the "rate of propagation of the flame"[2], "photochemical effects"[3], the inadequate resolution of monochromatic light "or other defects in the optical system"[4].

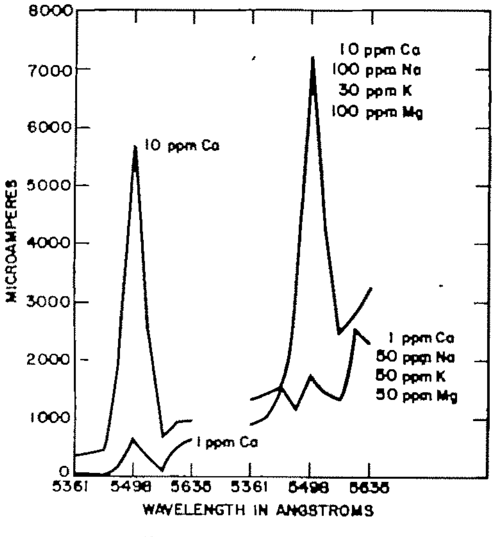

Fig. 3. Left: a solution containing calcium, in the concentrations indicated in the graph, was used. Right: similar measurements of calcium, carried out in the presence of an excess of sodium, potassium and magnesium

Internal standardization and dilution of samples have been recommended and used empirically and remedially with limited success. The removal of interfering ions from complex substances of unknown composition has been recommended as the only means of obtaining accurate results[5].

Our investigations indicate that the effect of these cations upon one another can be attributed to the superposition of their monochromatic emission upon heterochromatic background radiation. The background increases in direct proportion to the concentration of each radiating species. Fig. 2 shows the response of the calcium receiver, at 5495 A., to increasing concentrations of calcium, sodium, potassium and magnesium. Sodium, potassium and magnesium contribute heterochromatic background radiation to the calcium receiver. The absolute quantity of background differs for sodium, potassium and magnesium, but the slopes of their contributions are identical and additive.

In a corroborative experiment the photomultiplier tube was moved stepwise from background radiation at 5361 A. to background radiation at 5635 A. across the CaO bandhead at 5495 A. Results for 1 and 10 p.p.m. of calcium alone and in the presence of large excesses of sodium, potassium and magnesium are shown in Fig. 3. Emission, as shown by the right-hand curves, is raised above that shown by the left-hand curves due to background, attributable to the extraneous cations. Subtraction of the mean background from the right-hand curves yields intensity values identical with those for calcium alone, as in the left-hand curves. The relationship holds true with 5 p.p.m. of calcium in the presence of as much as 1,000 p.p.m. of sodium or potassium. The contribution of the background can be corrected for readily, and thus more accurate and precise flame spectrometry becomes possible.

Similar results were obtained when other permutations of these ions were studied. These results, under the conditions employed in our experiments, give no support to the hypothesis that 'interference' between calcium, sodium, potassium and magnesium in the source is caused by their energy relationships. Rather, they suggest that heterochromatic background radiation contributes to the observed analytical errors. The instrument here described should greatly facilitate the study of physiological relationships of these and other cations.

The design and construction of the instrument were supported by a grant from the C. F. Kettering Foundation, Dayton, Ohio, and the experimental work by a grant from the Office of Naval Research to Harvard University, Contract No. *N5 ori*—07660.

[June 23.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Infection of Chickens and Chick Embryos with the Viruses of Foot-and-mouth Disease and of Vesicular Stomatitis

IT has been generally believed that domestic or wild birds are resistant to infection with the virus of foot-and-mouth disease. Previous studies had been largely limited to experiments in mature birds which were observed mainly for epithelial lesions. Consideration was given, therefore, to the possibility that this virus might infect young chicks, with the involvement of cardiac and skeletal muscle as is observed in infection of the young of many other species.

In the first experiment (April 1953) chicks a few hours after hatching were inoculated intramuscularly with 10^6 ID_{50} of the 85th mouse passage of the cattle strain *M* 11 (Vallée *O* type). Pools of the inoculated muscles and of the hearts of chicks killed four days later each had a titre of 10^{-3} in mice one week old. The reacting mice were used as a source of virus for the inoculation of a further group of newly hatched chicks, and during a series of twelve alternate passages in chicks and mice carried out in this manner no difficulty was experienced in recovering the virus from the blood of the chicks over the period three to five days after inoculation.

Other chick tissues were tested at the same time, and consistently the highest titre ($> 10^{-5}$) was obtained with the tongue, on which macroscopic lesions were observed after the eighth alternate passage. Reverting to the original cattle strain, it was found that when 10^5 ID_{50} or more for mice were inoculated intramuscularly into newly hatched chicks, well-defined tongue lesions developed one to two days later. These lesions often involved the whole of the epithelium of the dorsum and appeared to be similar to the tongue lesions seen in other susceptible species. This was confirmed by histological examinations made by my colleague Dr. H. Platt. After direct inoculation of the tongue epithelium of older birds, local lesions developed and six serial passages of the cattle strain were made in this way in birds two to four months old.

Following intramuscular inoculation of large doses of another cattle strain (*VEN* 1 Vallée *O* type) and of three stock guinea pig strains of *O*, *A* and *C* types into newly hatched chicks, tongue lesions again developed and the guinea pig strains were passaged four to six times by intradermal inoculation of the tongue of older birds. With two of these strains, small areas of separation of the deeper epithelial layers developed near the points of pressure on the under surface of the feet of newly hatched chicks inoculated intramuscularly, and following direct inoculation of the area adjacent to the central pad of the foot slight local lesions were followed by severe secondary lesions on the tongue.

In chickens of all ages there was no severe systemic disturbance in the course of the infection. The epithelium from freshly developed tongue lesions usually had a titre of 10^{-6} or more in mice one week old. Even if the lesion was extensive, the affected epithelium was usually completely exfoliated in one or two days and the tongue left without blemish.

Material infecting chicks at the ninth of the alternate mouse – chick passages referred to above was inoculated intravenously into 14-day chick embryos and, after a single alternate passage in mice, serial passaging in 14-day chick embryos was continued by this route. In chick embryos of this age the myocardium appeared to be the main site of multiplication of the virus, and during the earlier passages the highest infectivity was reached after incubation of the inoculated eggs for five to six days at 35° C. At higher temperatures the susceptibility of the embryos to infection was reduced. After the eighth serial passage, infection was usually indicated by the death of the embryo three to six days after inoculation or by marked macroscopic lesions in the cardiac muscle of embryos killed during this period. The heart tissue and the pericardial effusion from such embryos usually had a titre of at least 10^{-6} in mice one week old, and 10^2 ID_{50} for mice was usually sufficient to infect 14-day embryos by the intravenous route, whereas embryos seven days old survived inoculation of 10^6 ID_{50} by the chorio-allantoic method and newly hatched chicks did not develop macroscopic heart or tongue lesions after the inoculation of larger doses by the intramuscular route. Chick embryo passaged strains with similar properties were later initiated with virus from the 24th and the 110th mouse passages of this cattle strain (*M* 11) without the intermediate use of chicks.

In attempts to initiate a chick embryo strain direct from the *M* 11 cattle strain using the intravenous route, recovery of the virus from embryos inoculated when eleven and fourteen days old was not achieved. The tongue tissue of embryos inoculated when seventeen to eighteen days old was found to be infective on the second and third day after inoculation, but passaging was not attempted. With the one other cattle strain (*VEN* 1) tested directly on chick embryos, severe macroscopic lesions in the myocardium were seen at the first passage five days after inoculation of 14-day embryos. Serial passaging in these embryos was continued without difficulty. Identical results were obtained with the same cattle strain after it had received twenty-nine culture passages in cattle tongue epithelium.

Other workers attempting to propagate the virus of foot-and-mouth disease in the embryonated hen egg have usually adopted the chorio-allantoic method of inoculation, and success has been achieved in only a few instances. The use of the intravenous route of inoculation, which brings the virus into immediate contact with the body tissues of the embryo, and the subsequent incubation at 35° C. for at least three days, may have been factors which contributed to success in the present experiments.

The virus of vesicular stomatitis can be propagated readily in chick embryos seven to ten days old. Only unsuccessful attempts to infect chickens have been recorded. However, in earlier work (unpublished observations, 1948) I had found that this virus could be passaged in chicks up to three weeks old by the intracerebral route. The tongue and feet were not then examined for lesions. A repetition of the methods used for infecting chickens with the virus of foot-and-mouth disease showed that adult and young birds were highly susceptible to infection with the virus of vesicular stomatitis when this was inoculated intradermally into the tongue. Virus strains of Indiana or New Jersey type previously passaged intradermally in guinea pigs or intracerebrally in mice were tested, and very severe local lesions developed within twenty-four hours. Guinea pigs or mice receiving the same inoculum by the most sensitive method in each case took 6–24 hr. longer to show signs of infection. The course of the infection was very similar to that seen in the case of foot-and-mouth disease. The vesicular epithelium of fresh tongue lesions was again highly infective. Two ducks also have been inoculated on the tongue with this virus, and local lesions developed in both.

In all these experiments the specificity of the infective agent has been checked.

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Oct. 21.

Enhancement of Insulin Action by Pituitary Growth Hormone

The injection of purified preparations of pituitary growth hormone into normal[1], adrenalectomised[1] and eviscerated-hypophysectomized[2] rats results in a fall of blood sugar-level. The *in vitro* addition of pituitary growth hormone can, under certain conditions, increase the glucose uptake of the isolated diaphragm from normal[3] and hypophysectomized[3] rats, but cannot increase the glucose uptake of the isolated diaphragm from alloxan-diabetic rats[3]. This insulin-like action of growth hormone[3,4] may result from a direct action of the hormone, or from an enhancement by growth hormone of the usual action of insulin, or from an activation by growth hormone of insulin trapped in the diaphragm in an inactive form (Ottaway[3]). Dependence of the insulin-like action of growth hormone on the presence of insulin is strongly suggested by the failure of growth hormone to lower the blood sugar-level of alloxan-diabetic rats[1] or to increase *in vitro* the glucose uptake of the diaphragm from alloxan-diabetic rats unless the diabetic rat has received an injection of insulin before removal of the diaphragm[3].

The possible dependence of the insulin-like action of growth hormone on the presence of insulin has been investigated by studying the influence of low concentrations of insulin and growth hormone upon the glucose uptake of the isolated normal rat diaphragm, surviving *in vitro*. The growth hormone was prepared from ox pituitary glands by a modification of the method of Wilhelmi *et al.*[4]. Solutions of growth hormone of the required concentration were prepared by dissolving the hormone in the Gey's buffer[5] used for the incubation. Crystalline insulin (Boots, 23 units/mgm.) was dissolved in $N/300$ hydrochloric acid to make a stock solution containing 20 units/ml., and the solutions used for incubation were prepared by serial dilution with Gey's buffer. The experimental procedure was as follows.

The hemi-diaphragms of normal male albino Wistar rats of 100–150 gm. were used. The animals were fasted for 20 hr., killed by decapitation and the diaphragms rapidly removed, divided and washed for exactly five minutes at room temperature in Gey's buffer (containing glucose, concentration 2·5 mgm. per ml.) previously gassed with 93 per cent oxygen, 7 per cent carbon dioxide. The hemi-diaphragms were then lightly blotted and transferred to Warburg manometer cups containing 1 ml. of incubation fluid; the flasks were attached to manometers and incubated for three hours at 37° C. with a shake-rate of 100 cycles per min. The glucose concentration in all cases was 2·5 mgm./ml. and the gas phase during incubation was 93 per cent oxygen, 7 per cent carbon dioxide. At the end of incubation the hemi-diaphragms were blotted and weighed on a torsion balance and the residual glucose determined on 0·2-ml. samples of incubation fluid by the colorimetric method of Somogyi[6]. The glucose uptake was calculated as mgm. glucose disappearing from the medium per gm. of wet diaphragm per hr. of incubation.

Table 1. INFLUENCE OF DIFFERENT CONCENTRATIONS OF PITUITARY GROWTH HORMONE, ADDED *in vitro*, UPON THE GLUCOSE UPTAKE OF THE ISOLATED RAT DIAPHRAGM

Conc. of growth hormone added *in vitro* (μgm. per ml.)	Glucose utilization, mgm. glucose per gm. of wet diaphragm per hr. (Mean ± S.E. of mean)	No. of hemi-diaphragms	Comment
None	2·25 ± 0·14	8	No significant difference between any of these means
0·1	2·46 ± 0·24	8	
1·0	2·24 ± 0·21	8	
10·0	2·27 ± 0·22	8	
50·0	2·34 ± 0·25	8	
100·0	2·58 ± 0·24	8	

Table 2. INFLUENCE OF PITUITARY GROWTH HORMONE AND INSULIN, ADDED SEPARATELY AND TOGETHER, *in vitro*, UPON THE GLUCOSE UPTAKE OF THE ISOLATED RAT DIAPHRAGM

Incubation medium	Glucose utilization, mgm glucose per gm. of wet diaphragm per hr. (Mean ± S.E. of mean)	No. of hemi-diaphragms	Comment
Buffer	(*a*) 2·32 ± 0·08	23	*t* for *a* versus *b* is 11·6 $P < 0.001$
Buffer + growth hormone (conc. 0·1 μgm. per ml.)	2·30 ± 0·06	23	
Buffer + insulin (conc. 2 × 10^{-4} unit per ml.)	(*b*) 3·27 ± 0·10	23	*t* for *a* versus *c* is 12·7 $P < 0.001$
Buffer + insulin + growth hormone in above conc.	(*c*) 3·80 ± 0·08	23	*t* for *b* versus *c* is 4·27 $P < 0.001$

Under these experimental conditions, the *in vitro* addition to the fluid in which the isolated diaphragm was suspended of growth hormone alone had no influence upon the glucose uptake of the diaphragm at any concentration of growth hormone tested (Tables 1 and 2). The presence of low concentrations of both growth hormone and insulin resulted in significantly greater uptake of glucose by the diaphragm than was produced by insulin alone (Table 2).

These results confirm the earlier observation of Park *et al.*[3] that growth hormone itself has no influence upon the *in vitro* glucose uptake of normal rat diaphragm; it has not been possible to confirm, under these conditions, the observations of Ottaway[3] and of Bulbrook and Ottaway[7] that growth hormone can increase or decrease the *in vitro* glucose uptake of normal rat diaphragm, depending upon the concentration of growth hormone used. Nevertheless, these results show that the addition of growth hormone *in vitro* can increase the glucose uptake of normal rat diaphragm by enhancing the action of insulin also added *in vitro*.

Young[8] has recently commented that the enhanced rate of entry of glucose into the cell, which insulin can promote[9], may provide the additional energy needed for the cellular enlargement or mitosis which occurs under the influence of growth hormone. The results reported here suggest that one action of growth hormone may be to accentuate the action of insulin in promoting the entry of glucose into the cell.

I wish to thank the Medical Research Council for personal and expenses grants in aid of this investigation.

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An Improved Resolution of Cytoplasmic Proteins of Rat Liver after *n*-Butanol Treatment

In an earlier communication[1], a technique was described for obtaining consistent separations of the cytoplasmic proteins of rat liver using electrophoresis on filter paper. A notable improvement in resolution has been observed following the treatment of the protein mixtures with *n*-butanol. The use of this reagent was suggested by the experiments of Morton[2] on the extraction of various enzymes from the particulate fractions of the cell structure.

The cytoplasm of rat liver (5 volumes), prepared as previously described[1], was shaken at room temperature with *n*-butanol (1 volume) and separated in a centrifuge. The lower aqueous layer was dialysed at 4° C. against distilled water to remove butanol and dried in the frozen state. The cytoplasmic proteins were obtained as a readily soluble powder. A 6–7 per cent solution of this powder subjected to electrophoretic analysis on filter paper as previously described[1] gives a characteristic reproducible pattern of seven bands; the correspondence between the patterns with and without the butanol treatment is illustrated in Fig. 1. Band No. 2 of the untreated sample has become resolved after butanol treatment into three distinct bands (2*a*, 2*b* and 2). Band No. 4 in both patterns corresponds to an esterase activity identified by the diacetyl-fluorescein reagent of Jermyn[3]. The esterase band is sometimes split into two close but distinct components.

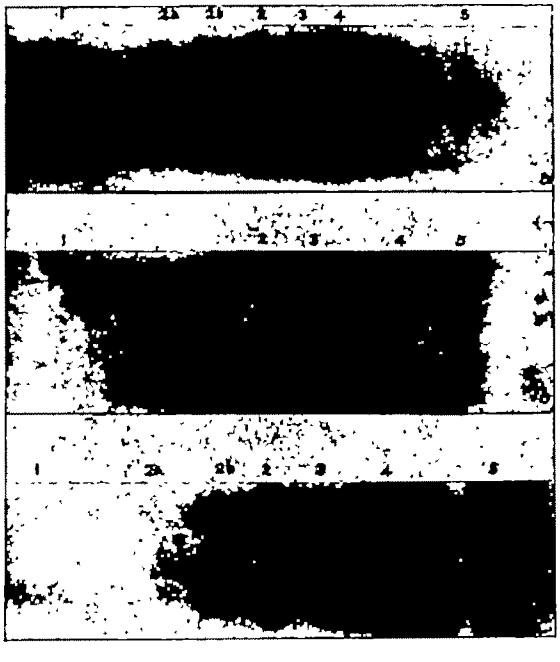

Fig. 1. Electrophoretic pattern of rat liver cytoplasm. *b*, Before, *a* and *c*, after butanol treatment. The numbering of the bands corresponds with those previously described (ref. 1)

Even when butanol is used, a borate buffer is required to obtain satisfactory resolution of the protein components.

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Inhibition by Cystine of Lecithinase (α-Toxin) Production in *Clostridium welchii* (*perfringens*) BP6K

The highest yields of lecithinase per ml. of medium in cultures of *Clostridium welchii* were reported by Logan *et al.*[1]. In the course of investigations of factors present in this medium which increase toxin production, we have encountered specific instances of the inhibition of the production of lecithinase.

The medium was a pancreatic digest of beef heart prepared according to Logan[1], used at a level of 7·5 per cent of solids. Optimal iron and dextrin concentrations were determined for each fresh preparation of digest. Culture tubes containing 10 ml. of medium, final *p*H 7·5, were inoculated as described by Logan[1] and incubated for 16 hr. at 34° C. The tubes were then centrifuged and the supernatant tested for enzyme activity. The lecithinase activity was measured by the development of turbidity when the culture filtrate was incubated with lecitho-vitellin in the manner described by van Heyningen[2]. The final turbidities were read in a Coleman spectrophotometer at a wave-length of 590 mμ. From these turbidities the *LD*50 was obtained by comparison with a reference curve given by a stabilized control toxin solution which had been standardized in mice by intravenous injection. Such a standard curve was set up with each experiment.

The pancreatic digest of beef heart was fractionated by means of a 'Dowex 2' cation exchange resin; some of the fractions thus obtained, when added to the original medium, stimulated, while others inhibited, lecithinase production. The inhibition of lecithinase production appeared to be due in part to free amino-acids.

The effect of adding to the normal medium each of the common amino-acids (final concentration of $1 \cdot 5 \times 10^{-3}$ *M* L-amino-acid) was studied. Each of three amino-acids inhibited enzyme production. Thus cultures containing valine, cysteine or cystine had *LD*50/ml. of 375, 315 and < 10, respectively, as compared to a control culture which had 500 *LD*50/ml. Cystine suppressed lecithinase production whether added to the medium before autoclaving or as a Seitz-filtered solution at the time of inoculation. Cysteic acid had no effect on enzyme production when tested in a similar manner. The *in vitro* activity of the lecithinase is unaffected by cystine up to a concentration ten times that which produces almost complete inhibition of the production of the enzyme.

The effect of cystine would appear to be an inhibition of the production of the toxin rather than any modification of the protein formed (for example, toxoid). Three separate experimental approaches in addition to the measurement of lecithinase activity give results which support this view. A comparison of the lecithinase activity and of the hæmolytic, lethal and antitoxin-combining power of the control culture filtrates and filtrates of cultures grown with cystine was made, with the results summarized in Table 1. The control culture was a normal 7·5 per cent solids beef-heart medium, incubated at 34° C. for 16 hr. The cystine culture differed only in that L-cystine had been added to a final concentration of $1 \cdot 5 \times 10^{-3}$ *M*. Not all activities were measured on the same two culture filtrates but on similar filtrates prepared on different days. Lecithinase activity was measured by the lecithovitellin method of van Heyningen[2], α-toxin hæmolytic titre by the method of Roth and Pillemer[3], and the antitoxin-combining power by the method of Pillemer[4]. The lethal effect was measured by injecting intravenously into 18–20 gm. mice, 0·5 ml. of solution made by diluting culture filtrate with pancreatic digest of heart medium containing 3 per cent solids. The end-point was taken as that dilution which killed 50 per cent of the mice within 72 hr. By each method, cystine was shown to effect a marked decrease in activity.

Table 1. EFFECT OF CYSTINE ON VARIOUS ACTIVITIES ASSOCIATED WITH α-TOXIN

Activity measured	Control culture per ml. culture filtrate	Cystine culture per ml. culture filtrate
Lecithinase activity	500 *LD*50	<10 *LD*50
α-Toxin hæmolytic titre	2,500 units	500 units*
Lethal effect	400 *LD*50	<20 *LD*50
Antitoxin-combining power	10 *Lb*	<1 *Lb*

* These 500 units represent a maximum figure as some activity may have been due to φ-toxin, active under the conditions of the test.

This example of the specific effect of cystine on the production of lecithinase by an anaerobe demonstrates once again the difficulties of controlled production of α-toxin in a complex medium. Slight changes in the amino-acid composition of such a medium may have a marked effect on the synthesis of this protein.

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A New Amino-acid in the Peel of Apple Fruits

SMALL quantities of an amino-acid which, from its position on two-dimensional paper chromatograms and other properties, does not appear to be an acid already reported in plant material, has been isolated, by use of a series of ion-exchange columns, as fine silky needles from the peel tissue of immature Worcester Pearmain apples. This acid is also certainly present in the peel of mature Edward VII apples and probably in the peel of other varieties, but it is absent from the sub-cortical tissue ('pulp') of all the varieties so far examined.

The position of this acid on chromatograms of the Worcester Pearmain peel is seen from Fig. 1, in which spot 1 represents hydroxyproline, spot 2 the new acid, spot 3 proline and spot 4 γ-amino-butyric acid. Sprayed with ninhydrin, the new acid gives a pinkish-yellow colour which shows an intense salmon-pink fluorescence in ultra-violet light. With isatin it gives an intense blue colour characteristic of pyrrolidine compounds[1]; piperidine compounds isomeric with methyl pyrrolidine give an intense and characteristic blue-green colour under similar conditions[2]. The new acid also gives the nitroprusside–acetaldehyde test for a secondary amine. None of these characteristic properties is affected by treatment with 6 *N* hydrochloric acid at 100° C. for 20 hr. Support for a pyrrolidine carboxylic acid structure comes from its being similar to proline in its anomalous behaviour on a series of phenol–methylene–sulphonic polystyrene cation and polystyrene anion resin columns[3]; it is, however, separable from proline on 'Zeokarb 215'.

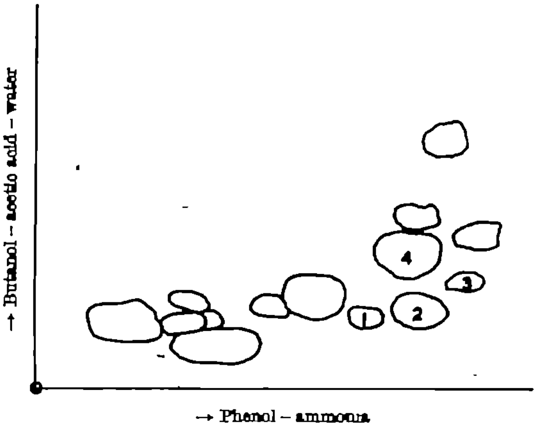

Fig. 1. Chromatogram of an extract of the peel of immature Worcester Pearmain apples with added hydroxyproline

It was at first thought that this compound might be identical with the compound isolated from the fruits and leaves of Granny Smith apples by Urbach and McKee[4], which these authors suggest is probably 4-methoxyproline. However, analysis of the 'acid 2' in Fig. 1 fails to reveal any methoxy group. Elementary analysis of the acid gives: C, 49·6; H, 7·7; N, 9·1 per cent. From the available evidence, including the position taken up by the acid on two-dimensional chromatograms, it is suggested that this new acid is a methyl-hydroxyl-proline, which would give an analysis of: C, 49·7; H, 7·6; N, 9·7 per cent. No evidence is available as to the position of the suggested methyl and hydroxyl groups.

When more of this compound becomes available, the infra-red spectrum of the acid will be examined for indications of hydroxyl and methyl groups.

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Conversion of Schradan and Parathion by an Enzyme System of Rat Liver

Schradan (octamethyl pyrophosphoramide) and parathion (OO-diethyl O *p*-nitrophenyl phosphorothionate) are converted by insects or mammals into inhibitors of cholinesterase. In mammals the liver is responsible for the metabolism of both compounds[1] and the conversion appears to be an oxidative one.

Work in these laboratories has shown that the conversion of either compound can be obtained by rat liver suspensions shaken in air at 37° in the presence of nicotinamide, magnesium ions and diphosphopyridine nucleotide. Separation of a suspension of rat liver in saline or 0·25 *M* sucrose by differential centrifugation has resulted in the finding that liver microsomes, together with the soluble supernatant, can effect these conversions provided diphosphopyridine nucleotide (shown by a chromatographic technique to contain less than 5 per cent of the tri-nucleotide) is present. Conversion is not obtained with microsomes alone.

Brodie and Cooper[2] and Axelrod[3] have found that barbiturates and sympathomimetic amines are oxidized by liver microsomes and supernatant with the addition of triphosphopyridine nucleotide but not the di-nucleotide. These workers also made the surprising discovery that microsomes were only effective without supernatant if reduced triphosphopyridine nucleotide was added. With the conversion of schradan and parathion, the addition of a triphosphopyridine nucleotide preparation (15 per cent tri-nucleotide, 29 per cent di-nucleotide) to microsomes plus supernatant resulted in less conversion than an equivalent amount of diphosphopyridine nucleotide. Addition of glucose-6-phosphate to produce reduced triphosphopyridine nucleotide through glucose-6-phosphate dehydrogenase only increased the conversion of schradan. No satisfactory interpretation of these findings has so far been found.

Table 1. Conversion of Parathion and Schradan by a Rat-Liver Microsome Preparation.

Chilled rat-liver suspension was suspended (10 per cent w/v) in 0 15 *M* sodium chloride, 0 015 *M* magnesium sulphate and centrifuged for 10 min. at 8,500 *g* at room temperature. Nicotinamide was then added to give a final concentration of 0 008 *M* to the microsome and supernatant preparation. 0·4 mgm./ml. Diphosphopyridine nucleotide (70 per cent), 1 6 mgm./ml. triphosphopyridine nucleotide, 2 mgm./ml. glucose-6-phosphate, 1 mgm./ml. schradan and 200 μgm./ml. parathion were added as indicated. 10 (2 − $\log_{10}$ per cent activity) = units of inhibitor per 10 mgm. of protein

Addition	Schradan	Parathion
Diphosphopyridine nucleotide	73	500
Triphosphopyridine nucleotide	24	222
" and glucose-6-phosphate	80	153
No addition	10	7

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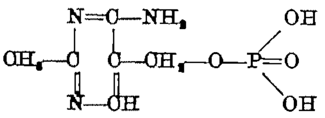
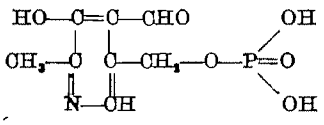
Competitive Inhibition of Pryidoxal Phosphate Action by Toxopyrimidine Phosphate in the Tyrosine Decarboxylase System

In the previous communication, it has been reported by K. Makino *et al.* that 'atoxopyrimidine', which protects against the onset of convulsions or death of the mouse and rat caused by the injection of the pyrimidine moiety of thiamine(2-methyl-6-amino-5-hydroxymethylpyrimidine, which they called 'toxopyrimidine'), is contained in rice bran. Moreover, they confirmed that the vitamin B_6-complex has strong atoxopyrimidine action[1,2], indicating a typical 'biological antagonist' owing to the similarity of its structure to that of toxopyrimidine.

We have now attempted to find whether an analogous relation exists between toxopyrimidine phosphate (I) and pyridoxal phosphate (II) in an enzymic system.


(I)


(II)

We synthesized the phosphoric ester of toxopyrimidine by treating the latter with phosphorous oxychloride and investigated the inhibitory action of this synthetic compound on the bacterial tyrosine decarboxylase which is one of the vitamin B_6-dependent enzymes formed by *Streptococcus faecalis* R.; the results obtained agreed very well with our assumption.

The synthesis of toxopyrimidine phosphate was carried out as follows: toxopyrimidine was dissolved into 1 *N* hydrochloric acid and water, cooled, and phosphorous oxychloride was added with stirring at such a rate that the temperature did not exceed 50° C. After hydrogen chloride had been removed *in vacuo* as much as possible, the reaction mixture was cooled and neutralized to *p*H 5 $\sim$ 6 by adding a suspension of calcium carbonate in water, and again chilled, and filtered. The filtrate was diluted with three times its volume of alcohol with chilling, and the precipitate thus formed was gathered by centrifugation, and washed with alcohol and ether. This crude compound was purified by fractional precipitation with alcohol. The yield was 10 per cent of the theoretical. R_F values of this compound by paper chromatography using Tōyō Roshi filter paper No. 50 were 0·45 or 0·31 with a mixture of acetone with 85 per cent formic acid in the ratio 60/40 or 40/20, 0·45 with a mixture of acetone with 50 per cent acetic acid in the ratio 50/50 and 0·25 with a mixture consisting of lutidine, water, alcohol and diethylamine in the ratio 55/25/20/1 as developers. The ultra-violet absorption spectrum of the calcium salt of this synthetic compound showed at *p*H 1·2, λ_{max} 245·5 mμ, and at *p*H 12, $\lambda_{max\ 1}$ 271·5 mμ and $\lambda_{max.2}$ 233 mμ.

In the preliminary experiment, we found that the activity of holotyrosinedecarboxylase which was obtained by autolysing the dried acetone extract of *St. faecalis* R. in 0·02 *M* phosphate buffer (*p*H 5·5), which was grown on a synthetic medium containing yeast extract, was inhibited to the extent of 99, 92, 52, 17 and 14 per cent by the synthetic phosphate (I) in concentrations of 3×10^{-6}, 3×10^{-7}, $7·5 \times 10^{-8}$, 3×10^{-8} and 3×10^{-9} *M*, respectively.

St. faecalis R. was also grown on a vitamin B_6-deficient synthetic medium; from this a cell-free preparation of the tyrosine apodecarboxylase was prepared according to Epps's method[3]. Assay of the tyrosine decarboxylase was carried out as follows: 0·02 *M* tyrosine, 0·666 *M* acetate buffer (*p*H 5·5), pyridoxal phosphate ($3·2 \times 10^{-7} \sim 3·2 \times 10^{-10}$ *M*), inhibitors ($1 \times 10^{-6} \sim 1 \times 10^{-10}$ *M*), purified apoenzyme and water to make a total volume of 2·0 ml.; temperature 30° C.

Tyrosine apodecarboxylase prepared by us was activated so sensitively that $\frac{1}{2}$ $V_{max.}$ was attained by addition of $1·6 \times 10^{-8}$ *M* pyridoxal phosphate, a value which agreed well with that reported by O'Kane and Gunsalus ($1·5 \times 10^{-8}$ *M*)[4].

The effects of toxopyrimidine and its phosphoric ester on the activity of the purified tyrosine decarboxylase were as follows: (1) toxopyrimidine itself had no inhibitory action at concentrations between 1×10^{-6} *M* and 1×10^{-10} *M*, regardless of the concentration of pyridoxal phosphate; (2) toxopyrimidine phosphate at a concentration of 1×10^{-7} *M* inhibited 99 ∼ 100 per cent of its activity, and at concentrations of 5×10^{-8}, 1×10^{-8}, 1×10^{-9} and 1×10^{-10} *M* showed inhibition of 60, 20, 16 and 0 per cent, respectively.

We are indebted to Dr. T. Matsukawa for giving us a sample of toxopyrimidine, and to Dr. Y. Sakurai for supplying a sample of pyridoxal phosphate. This work was aided by the Scientific Research Fund of the Ministry of Education of Japan.

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Isolation of Lignin from Finely Divided Wood with Neutral Solvents

IN 1939, Brauns[1] found that a few per cent of the total amount of lignin is present in the extractives obtained from black spruce with ethanol. It is now well known that greater proportions of lignin cannot be extracted from wood unless the solvent contains an acid reagent or rather drastic conditions are used, resulting in more or less severe alteration of the lignin. This fact is usually explained in two ways: (1) chemical bonds exist between lignin and the carbohydrates; (2) lignin has a very high molecular weight, and may form a three-dimensional network. A third possibility, that weak forces like hydrogen bonding and physical phenomena may be involved in the retention of lignin, has not been given much consideration, though such forces would render the dissolution of cellulose in water impossible.

I have re-examined the problem of extracting lignin with solvents with the last-mentioned possibility in mind, and with due consideration to the mechanism of grinding in a ball mill. The difference in dissolving power of various lignin solvents has also been considered. I have found it possible to extract about two-thirds of the lignin from spruce at room temperature after grinding wood sawdust in a vibrational ball mill[2]. To aid the grinding, the wood was dispersed in a liquid. It was found, however, that the liquid must not swell wood more than a few per cent, otherwise the wood becomes difficult to handle and little or no lignin is released in the extraction step. It is equally important that the amount of wood in the mill should be small enough to allow the 'equilibrium curve', which characterizes the milling performance[3], to reach its peak at a sufficiently small particle-size. The ideal milling liquid is hard to select; toluene has been used in most experiments.

The choice of lignin solvent for the extraction of milled wood is not critical, though the extraction is quicker and more complete with solvents which stand moderate dilution with water without the lignin being precipitated, for example, 'Methyl cellosolve' (ethylene glycol monomethyl ether). Depending on the grinding conditions, more or less of the lignin is extracted rapidly; but for maximum yield the extraction must go on for months. In a blank with the original sawdust, from which the 'Brauns's native lignin' had been removed by pre-extraction with ethanol and 'Methyl cellosolve', no extraction occurred during eighteen months. Solvents like ethanol, acetic acid and dioxane require a small amount of water in order to dissolve lignin, but substantial water content will reduce the dissolving power considerably. Mixtures of ethanol and chloroform or ethanol and 1,2-dichloroethane are powerful solvents but very sensitive to water. It is believed that in dissolving lignin the many hydroxyl groups of the wood carbohydrates have an influence similar to water on the solvents, which makes 'Methyl cellosolve' a superior extraction medium.

As already indicated, the grinding conditions are most important in obtaining high lignin yields. It remains to be determined if all the lignin can be removed by this technique. Definite conclusions as to the state of lignin in wood cannot be made yet, but there seem to be indications that few, if any, bonds exist between part of the lignin and the carbohydrates. Moreover, the diffusion of part of the lignin in wood is apparently extremely slow. It should be added that the average temperature during the grinding was only slightly greater than room temperature.

This new material (milled wood lignin) has been obtained as a faintly cream-coloured powder from spruce, pine, birch, aspen, western hemlock and black spruce, and an evaluation of its authenticity as a chemically unchanged lignin is under investigation. It seems to differ in several respects from Brauns's native lignin. Brauns's native lignin and milled wood lignin obtained from the same spruce

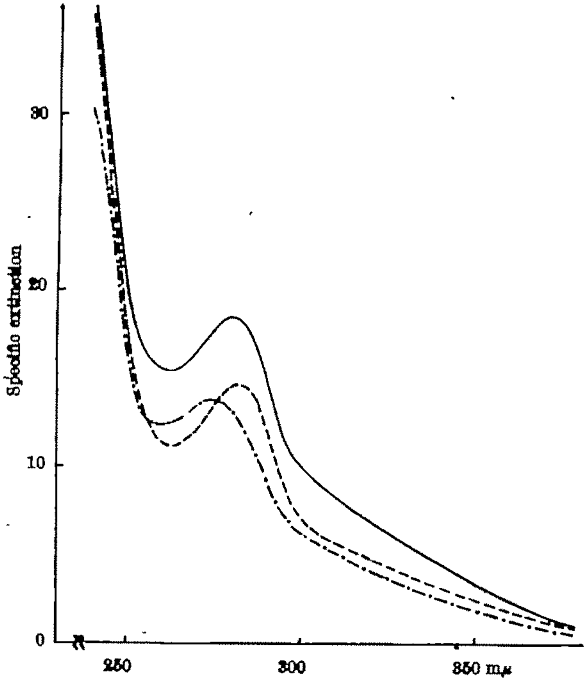

Fig. 1. Specific extinction versus wave-length: ———, milled wood lignin from spruce; —·—·—, milled wood lignin from aspen; — — —, low-sulphonated lignosulphonic acid. Solvent: 'Methyl cellosolve'

log had methoxyl contents of 14·8 and 15·5 per cent respectively, after thorough purification; in the case of the latter, there are indications of a slight variation of MeO with the yield of lignin, but further investigations are required to elucidate this point. Milled wood lignin from spruce dissolves considerably more slowly than Brauns's native lignin in solvents, and the solutions of the former have a lighter colour than those of the latter. The content of phenolic hydroxyl groups in the milled wood lignin from spruce has been estimated according to Aulin-Erdtman[4] and Adler and Hernestam[5] and was found to be lower than in Brauns's native lignin. The ultra-violet absorption spectra of milled wood lignin from spruce and aspen are shown in Fig. 1 together with the spectrum of a low-sulphonated lignosulphonic acid from spruce.

Details on the characterization of milled wood lignin as well as its reactions will be given in forthcoming papers.

Since the inception of this work, ultrasonics and a colloid mill have been tried to release the lignin with no success. This may be due partly to the circumstance that the treatments were carried out with the wood dispersed in lignin solvents causing the blocking effect of swelling as stated above.

This work has been supported by a grant from Statens Tekniska Forskningsråd, Sweden.

ANDERS BJÖRKMAN

Billeruds AB,
Säffle, Sweden.
Aug. 4.

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Structure of Cotton Alpha-Cellulose

THE structure of cotton α-cellulose has been developed on the assumption that its building unit is glucose only. It is, of course, believed that raw cotton contains small amounts of pentoses which are removed by prolonged boiling in alkali and subsequent treatment of the product with 17·5 per cent sodium hydroxide during the preparation of purified α-cellulose. Chromatographic analysis has shown[1] that raw cotton contains glucose, xylose, arabinose and a trace of rhamnose. Adams and Bishop[2] reported that cotton α-cellulose does not contain any pentose. But our findings[1,3] that a part of the pentoses is very strongly associated by chemical bonds with jute α-cellulose, which was also later confirmed by Adams and Bishop[3,4], suggested reinvestigation of the association of these pentoses with purified cotton α-cellulose.

For this purpose various samples of raw cotton from different sources have been examined and precautions taken in the preparation of purified cotton α-cellulose. Wax, etc., was removed from raw cotton by prolonged alternate extractions with alcohol and ether followed by washing with water. The air-dried product was then treated with 1 per cent boiling sodium hydroxide for a period of 10 hr. as outlined by Corey and Gray[5]. α-Cellulose was then prepared by treating this purified cotton with the usual 17·5 per cent sodium hydroxide.

By hydrolysing the α-cellulose by the formic acid method[6] (85 per cent, 12 min. at the boil) and analysing chromatographically the hydrolysate in different solvents (for example, moist *n*-butanol, moist phenol and *n*-butanol/acetic acid/water mixture), the presence of glucose, xylose and arabinose was readily detected. A typical chromatogram (Fig. 1) is reproduced. This observation, obtained by the formic acid method, has been confirmed recently by G. A. Adams of the National Research Council, Canada (private communication), who also states that these findings with cotton α-cellulose are at variance with those of Adams and Bishop[2] when they used a different technique and did not find any trace of pentose sugars.

Cotton α-cellulose was also hydrolysed by the 72 per cent sulphuric acid method and the hydrolysate examined chromatographically, but the identification of pentoses was found to be very difficult. If, however, before spraying the chromatogram with aniline oxalate reagent the lower portion of the spot corresponding to glucose is cut off, extracted with water, concentrated and chromatographed again, xylose and arabinose are readily detected. Further proof of the presence of pentoses in cotton α-cellulose was obtained by separating these pentoses from glucose present in the hydrolysate (72 per cent sulphuric acid) of Egyptian cotton α-cellulose (2 gm.) through a cellulose column with an alcohol/benzene (35 : 65) mixture as developed in this laboratory[7], followed by chemical analysis. The above results therefore show that xylose and arabinose are present not only in α-cellulose derived from jute or allied materials but also in that prepared from purified cotton. Estimation of the amounts of these pentoses associated with this α-cellulose is in progress. The main difficulty is to assess the amount of pentoses that decomposes under the exact condition of complete hydrolysis of α-cellulose. Nevertheless, from the nature of the chromatogram, it appears that the total amount is likely to be appreciable. On

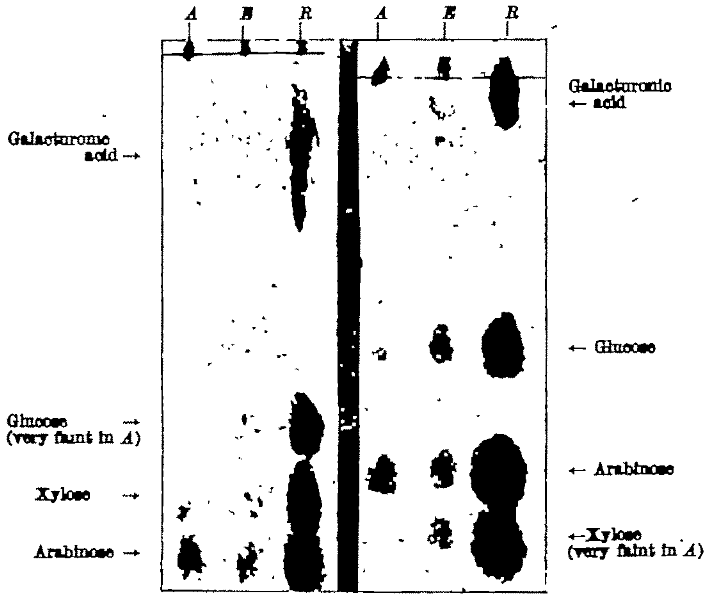

Fig. 1. *A*, American cotton α-cellulose; *E*, Egyptian cotton α-cellulose; *R*, reference sugars.

Left: Chromatogram in moist phenol for 48 hr. in Whatman filter paper No. 1.

Right: Chromatogram in moist *n*-butanol for 96 hr. in Whatman filter paper No. 1

these grounds we feel that the above observations may have far-reaching implications for the accepted structure of cotton α-cellulose. The possibility of mixed crystals with these pentoses and glucose cannot be ruled out, and as already noted[8], it remains to be seen if the new spacing observed recently by Sen and Roy[9] even in cotton is due to such mixed crystals.

Thanks are due to the Indian Central Cotton Committee and Ahmedabad Textile Industries Research Association for the samples of raw cotton.

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Localization of Embryonic Antigens by Antisera labelled with Fluorescent Dyes

Antibodies labelled with fluorescent dyes have been used for histochemical localization of antigens in tissue sections by Coons and Kaplan[1], Marshall[2] and Hill and Cruickshank[3]. It would seem that this method might be applied to locate tissue antigens during the course of development.

Since the changes in distribution of antigens relative to one another at different stages of development are of interest from the point of view of differentiation, a modification of the method, which enables one to study several antigens simultaneously, has been employed. The use of a mixture of several antisera of different specificities, each coupled to a different dye, makes this possible. It has a further advantage in practice. The antibodies appear to compete to some extent, which has the effect of eliminating some of the minor cross-reactions. Thus a given antiserum will give more restricted localization in combination with another antiserum than by itself.

The colours chosen were green, yellow and red fluorescence; these were found to be readily distinguished from one another.

The green was due to fluorescein isocyanate, which Dr. R. Smith, of King's College, London, kindly coupled on to a number of samples of antisera. The yellow was 1-dimethyl-amino-5-sulphonyl-chloride-naphthalene, a sample of which he also provided. The red was nuclear fast red (benzaldehyde-6-nitro-2-sodium-diazotate). All uncombined dye was removed by dialysis. Samples of each antiserum were coupled to each of the three dyes, the specificity and localization remaining the same whatever the colour. The antisera thus treated were against lens and muscle respectively of the mouse, *Mus musculus*.

The eye of the week-old mouse (which has also been made the subject of a quantitative study by means of radioactive antisera[4]) was treated with a mixture of muscle and lens antisera after freeze-drying and sectioning in paraffin. Where, for example, the lens serum was dyed red and the muscle green, the following localizations were observed: lens bright red, ciliary process and retina pale pink, epithelium of cornea doubtfully pale pink, extrinsic muscles and suspensory ligament green, choroid pale green. The cross-reactions indicated by the paler colourings may be due either to small quantities of the same or to a similar antigen. Thus the ciliary process, which in Amphibia can regenerate the lens, may actually contain small quantities of lens crystallins or scleroproteins. The choroid and suspensory ligament must contain antigens similar to or identical with some of those in whole muscle.

In the early stages of the embryo mouse, the lens antisera give a diffuse reaction with the brain and a somewhat stronger one with the eye cup and lens vesicle. The highest fluorescence surrounds the cavity of the lens vesicle. There is a cross-reaction of the lens antiserum with the epidermis, which is strongest in the adult.

Thus the use of labelled antibodies may make possible a simple and direct test of insoluble antigens hitherto tested only by indirect methods which may be subject to interfering factors.

A full report will be published elsewhere.

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Edinburgh. Aug. 9.

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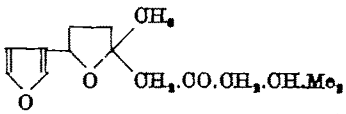
Increase of Respiratory-rate in Sweet Potato Tissue infected with Black-Rot

An increase in respiratory-rate is commonly observed in the tissues of higher plants when infected by pathogens. We have found the same phenomenon to accompany black rot in the sweet potato caused by *Ceratostomella fimbriata* infection, and the simultaneous activation of cytochrome oxidase, polyphenol oxidase and peroxidase in the tissues.

P. J. Allen[1] believed from his observation of increase of inorganic phosphate and inhibition of Pasteur effect in wheat infected by powdery mildew that the respiratory increase could be explained by the mildew toxins acting as uncouplers and accelerating the release of inorganic phosphate and regeneration of adenosine diphosphate; thus a given level of phosphate acceptors would lead to more rapid oxidation. We, on the other hand, took the view that something metabolized in the infected sweet potato might act as an uncoupler and permit the respiratory increase.

Several substances have been found as abnormal metabolites in black-rot of sweet potato. Ipomeamarone,



(130°/3 mm. mercury), was found by M. Hiura[2] in infected tissue, and its structure determined by T. Kubota *et al.*[3]. In sound tissue next to the infected part, polyphenols such as chlorogenic acid[4] (isolated by G. Rudkin *et al.* from sound tissue), isochlorogenic acid and a new isomer which we call pseudochlorogenic acid, and also coumarins such as umbelliferon and scopoletin have been isolated by us. Among these, ipomeamarone was known from our experiments to accelerate the respiration of sweet potato slices by *c.* 30 – 50 per cent in a dilution of 1 : 4,000, while 2,4-dinitrophenol ($2{\cdot}5 \times 10^{-4}$ *M*) showed *c.* 100 per cent increase under the same condition. Further, ipomeamarone in a dilution of 1 : 10,000 gave a slight increase of oxygen uptake with white potato tubers.

We have now examined these effects on the oxidative phosphorylation system of mitochondria-like particles in mung bean and sweet potato (using Maruo's method[5] and Bonner's method[6]). We find that ipomeamarone (1 : 4,000) distinctly depressed the coupled phosphorylation, as did also 2,4-dinitrophenol, though there was no apparent influence on oxygen uptake. Coumarin substances did not show any similar action. Chlorogenic acid inhibited to some extent the oxidative phosphorylation of sweet potato tissue particles only; this, we supposed, was because of the inhibitory effect of chlorogenic acid oxidative products which were produced by polyphenol oxidase in sweet potato tissue. A fraction (180°/3 mm. mercury) in the infected tissues, also, increased the respiration in sweet potato slices, and depressed the oxidative phosphorylation of the particles.

Ipomeamarone, in addition to being a factor concerned in the abnormal increase of respiration in sweet potato, may be considered to be a protector against the penetrating fungus: ipomeamarone was found to inhibit the spore germination[2], growth[7] and oxidative phosphorylation of *Ceratostomella fimbriata*, and depress its respiration in a higher concentration.

Table 1. Effect of Substances from Black-rot Tissue of Sweet Potato on Oxidative Phosphorylation of the Mitochondria-like Particles in Mung Bean and Sweet Potato

The control contained 20 μ*M* of phosphate buffer (pH 7·0), 20 μ*M* of citrate, 100 μ*M* of glucose, 3 μ*M* of adenosine triphosphate, 20 μ*M* of magnesium chloride, 20 μ*M* of sodium fluoride, 20 μ*M* of versene, 3 mgm of hexokinase, and 1·0 c.c. of enzyme solution (mitochondria-like particles prepared by Millerd's procedure as improved by Akazawa) in a total volume of 2·5 c.c. 60 min. incubation at 30° in Warburg vessels

Particles	Substances tested		Oxygen uptake	Phosphorus uptake	P/O
			μ atom	μ atom	
Mung bean	Control		2·83	4·60	1·62
	Ipomeamarone,	2 μ*M*	2·57	2·68	1·04
	,,	4 μ*M*	2·03	0	0
	Chlorogenic acid,	4·2 μ*M*	3·10	4·26	1·36
	Umbelliferon,	4·2 μ*M*	3·04	4·26	1·38
	Scopoletin,	4·2 μ*M*	—	4·26	—
	Dinitrophenyl,	0·05 μ*M*	2·97	2·90	0·98
Sweet potato	Control		2·06	2·73	1·33
	Ipomeamarone,	2 μ*M*	2·15	1·48	0·69
	,,	4 μ*M*	1·82	0·25	0·14
,,	Control		2·28	2·96	1·25
	180°/3 mm. mercury,	500 γ	2·25	1·29	0·57
	Chlorogenic acid,	4·2 μ*M*	4·27*	1·78	0·44
,,	Control		1·40	2·10	1·41
	Umbelliferon,	4·2 μ*M*	1·54	2·10	1·36
	Scopoletin,	4·2 μ*M*	1·58	2·10	1·33

* Oxygen uptake here is much more than the control, due to the oxidation of chlorogenic acid by polyphenol oxidase in the particles.

Higher activity of adenosine triphosphatase in black-rot tissue of sweet potato, compared with that in sound sweet potato tissue, seems to be one of the factors for the occurrence of oxidation uncoupled to phosphorylation.

We thank Prof. Yusuke Sumiki, Tokyo University, and Prof. Saburo Funahashi, Nagoya University, for advice and encouragement, and also Dr. P. J. Allen, University of Wisconsin, for valuable suggestions.

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Micro-fungal Population of Acid Sandy Podsols

We would like to direct attention to the remarkable similarity between the composition of the micro-fungal population of some acid sandy podsol soils in England, as recorded by Jeffreys, Brian, Hemming and Lowe[1], and that of some acid podsol soils in Victoria, Australia[2]. This similarity is associated with the presence in the *B*-horizon of what is described as an iron-pan in the English soils.

The *B*-horizon of the Australian podsol studied by us has been referred to as an iron-pan. However, analysis has shown that only a trace of iron is usually present, the characteristic dark colour being due to the abundant organic matter. In both soils the C-horizon was sand.

In each country this type of soil is characterized by the marked dominance of *Mortierella ramanniana* (Moll) Linnemann[3] (syn. *Mucor ramannianus* Moll). Jeffreys *et al.* state that this form was "usually particularly abundant in the pan layer. This may have been purely fortuitous but is worthy of record". Our results show that the distribution of this fungus is not fortuitous, for it formed 98 per cent of the population of the B-horizon in one experiment, and 86 per cent when all the samplings were considered. In those English soils in which *M. ramanniana* was absent, the pan was not a feature of the profile. We have some evidence that this is true for Australian soils also. It seems, on the evidence, that it is the characteristic micro-fungus of acid sandy podsols irrespective of geographical location, and that its dominance is indicative of such soil types.

The species list given in the profile tables for the English soil is equally descriptive of those compiled for the Australian profiles. The general micro-fungal population is practically identical, in contrast to the different floristic population of the heathlands in the two countries.

Of the Penicillia isolated from the Australian podsol twenty-six were tested for antibiotic activity against bacteria. Of these, thirteen gave a positive result with *S. aureus*, and only one, *P. rubrum* Stoll, was inhibitory to both *S. aureus* and *B. coli*.

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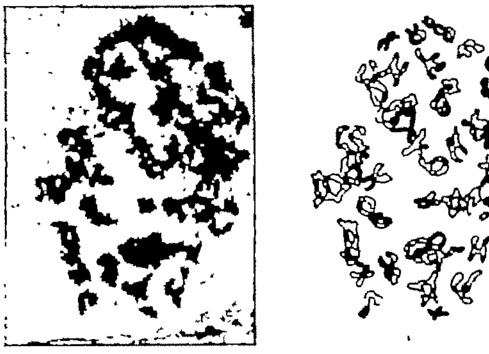
Allopolyploidy in the Melaniid Snails

IN a recent communication[1], I recorded the occurrence of apomictic parthenogenesis combined with polyploidy in a few species of *Melanoides*. One of these species, *Melanoides tuberculatus*, includes a diploid race with $2n = 32$ chromosomes and a polyploid race with 90–94 chromosomes, which thus appears to be more or less at the hexaploid level when compared to the former. Both these races are parthenogenetic, but in the latter there occur exceptional males which are sterile, constituting about 3 per cent of the population. The males show evidence of structural and numerical hybridity in the occurrence of bridge and fragment in the meiotic divisions and in the presence of non-pairing univalents with irregular distribution in the first meiotic metaphase and anaphase.

The present communication records the analysis of the chromosome combinations in the hybrid. Figs. 1 and 2 show the diakinetic stage from an aceto-carmine squash of the testis of the rare males of the polyploid race of *Melanoides tuberculatus*. Fig. 2 shows twenty univalents represented in black and thirty-five bivalents and a quadrivalent (right of centre) in dotted outline. From examination of diakinetic, first metaphase and first anaphase stages, it is found that a maximum of six quadrivalents may be present, bivalents may vary from thirty to thirty-eight and the number of univalents show less variation, usually from fifteen to twenty. During the first meiotic division the univalents pass undivided to the poles in a random fashion in advance of the separating bivalents, and the secondary spermatocytes possess an unequal number of chromosomes. The complete absence of trivalents and higher multivalents other than quadrivalents is a noteworthy feature.


(1) (2)

Diakinetic stage, acetocarmine preparation. (1) Photomicrograph; (2) camera lucida drawing. × 900

It is evident from the chromosome behaviour that the polyploidy involved is certainly not regular autopolyploidy with homologous sets of chromosomes. The presence of fifteen to twenty non-pairing univalents in all the stages analysed indicates hybridity involving more than one genome. The evidence of structural hybridity has been already mentioned. The polyploidy is therefore allopolyploidy. There is no sure way of distinguishing an allopolyploid, unless its origin is known or unless it is a rather extreme or typical example of one of the known types. However, in the present instance the presence of dissimilar genomes seems certain. The fact that up to six quadrivalents occur (though the number is small compared to the total number of chromosomes of this polyploid) indicates that at least certain chromosomes are represented four times. The polyploid is therefore probably autotetraploid with respect to one genome, but since a different genome is also present as stated earlier, it is allopolyploid. The polyploid race of *Melanoides tuberculatus* is an allopolyploid somewhat similar to what has been classified as autoallopolyploid by Kostoff[2] and what Darlington[3] refers to as an allopolyploid with non-reduction in the female parent. A cross between an apomictic autotetraploid and another diploid bisexual species might result in a hybrid of the type discussed here. However, this conjecture cannot be verified experimentally, since neither an autotetraploid nor a diploid bisexual species appears to be available.

Very similar features have been observed also in the meiotic stages of the rare males of *Melanoides lineatus*. Suomalainen[4] inferred allopolyploidy from the gonomery at the maturation metaphase. Except for this example, polyploidy recorded in animals so far is autopolyploidy. In view of the rarity of natural hybrids among animals, the allopolyploidy in *Melanoides* is of great interest.

I wish to thank Prof. R. V. Seshaiya for suggesting the problem and guidance, and Prof. A. D. Peacock for reading the manuscript.

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Annamalainagar. July 27.

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Constitution of Cynarine, the Active Principle of the Artichoke

It has been known for some time that the artichoke (*Cynara scolymus*) contains some hitherto unidentified substances which stimulate biliary secretion and cholesterinic metabolism[1]. The extraction of these substances can be carried out by infusion or decoction. We have been able to isolate from cauline leaves of *Cynara scolymus* a crystalline substance which we have also found in *Cynara cardunculus*. Because of its physiological activity, we have used the word 'cynarine', which has been generally used for the chemical principle of the artichoke with the same activity[2].

We have isolated this compound by treating a decoction of the fresh leaves with lead acetate. The precipitate is extracted with dilute acetic acid and the lead is removed with sulphuric acid and hydrogen sulphide. Crystallization of the cynarine is obtained after concentration and standing. The yield is 0·1–0·2 p.p.m. of the leaves. It gives flat needles or colourless small plates of melting point 227–228° (dec.). It is slightly soluble in cool or warm water, more soluble in alcohol and acetic acid.

The substance has a left-handed rotatory power: $[\alpha]^{20}_{D}$, $= -59$ (methanol, $c = 4$). It is a weak acid, giving deep yellow alkaline solutions slightly stable in air. It gives a green colour with ferric chloride; it can be easily oxidized and gives a yellow precipitate with lead acetate and with barium hydroxide.

After drying in air to constant weight the percentage composition is $C_{25}H_{24}O_{12}.H_2O$. It gives a hexa-acetyl derivative (m.p. 168–172°) and a tetrahydro derivative (m.p. 134–140°).

Protocatechuic acid (3,4-dihydroxybenzoic acid) can be obtained by fusion with alkali. Its saponification by diluted alkalis produces quinic acid (1,3,4,5-tetrahydroxycyclohexane carboxylic acid) and two molecules of caffeic acid (3,4-dihydroxycinnamic acid); saponification of the tetrahydroxy derivative produces quinic acid and dihydrocaffeic acid.

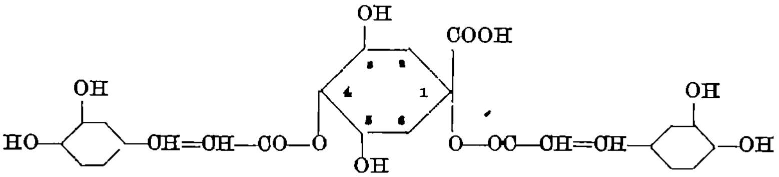
Methylation of cynarine with methyl sulphate and potassium carbonate in acetone gives pentamethyl-cynarine (m.p. 160–161°). Alkaline saponification of this compound gives methyl alcohol, quinic acid and two molecules of 3,4-dimethoxycinnamic acid; permanganic oxidation gives veratric acid.

Such data are sufficient for establishing that cynarine is a three-depside which occurs by esterification of two molecules of caffeic acid and one of quinic acid.

Because in the synthesis of cynarine the caffeic groups are introduced on the γ-lactone of quinic acid (quinide) we can exclude, among six isomeric esters, those blocking —OH of quinic acid in position 3. The pentamethyl-cynarine is stable to periodic acid and for this reason we can exclude the isomer 1–5 also. Hence, we can reduce the number of possible isomers to two (1–4 and 4–5).

The complete methylation of pentamethyl-cynarine by methyl iodide and silver oxide gives a substance that can be saponified. We obtain 3,4-dimethoxycinnamic acid and a dimethylether of quinic acid (m.p. 136–138°). Because of the resistance of this last compound to oxidation with periodic acid, it must be the 3,5-dimethoxy 1,4-dihydroxycyclohexane carboxylic acid.

Therefore the chemical formula of cynarine is:



More details of this work will be published elsewhere, with an account of the synthesis of cynarine.

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July 21.

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A New Paper Column for Preparative Chromatography

SEVERAL types of paper columns have been described for separating closely related substances on a preparative scale; but with these methods it has proved difficult to get the same degree of separation as is achieved by simple paper-strip experiments[1]. This disadvantage is overcome by the present method, the principles of which have been reported in a previous communication[2]. The technique has now been improved and simplified.

The column (manufactured by Grycksbo Pappersbruk, Sweden, and sold by LKB-Produkter Fabriksaktiebolag, Stockholm) consists of a roll of filter paper (*A*), closely packed around a central core (*B*) of inert material and placed in a polythene tube (*C*), closed at each end (Fig. 1). Close packing is a prerequisite for sharp fronts, because otherwise the solvent velocity varies through the cross-section of the column, reaching a maximum at the outer and inner column surfaces. Before using the column, solvent must be absorbed by the paper roll, which then swells and, being confined by the walls of the column, is subjected to great pressure. This condition ensures a constant flow velocity throughout the cross-section, thus achieving straight fronts and sharp separations. After the paper roll has been wetted by solvent through the lower cover, tube *C* is dipped into the

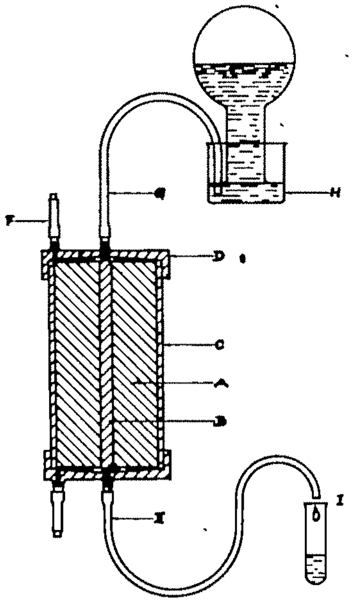

Fig. 1. Diagram of the chromatographic column

beaker (*H*) containing solvent. By applying suction to tube *F*, tube *G* and the upper space between the inner wall of the cover and the upper end of the roll are filled with solvent. Tube *F* is then closed and the solvent flows through the column. Equilibrium is established in a few hours, after which tube *G* is introduced into the container holding the solution, and the required volume of solution drawn into the column. Tube *G* is again transferred to the beaker (*H*), and separation ensues. Tube *E* is coupled to a fraction collector. The flow velocity is controlled by the height of the beaker (*H*) relative to the outlet (*I*). The effectiveness of separation is a function of flow velocity.

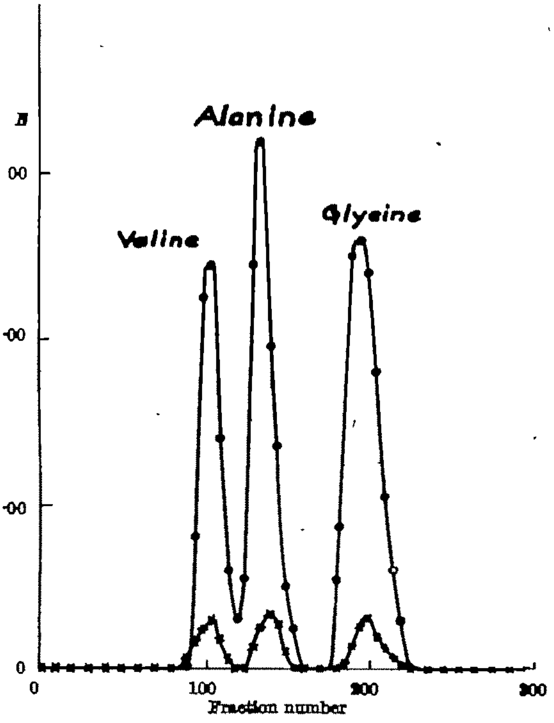

Fig. 2. Separations of glycine, alanine and valine

Fig. 2 shows the results of two experiments. In one experiment (crosses), 25 ml. of a solution containing 25 mgm. glycine, 25 mgm. alanine and 25 mgm. valine in 70 per cent ethanol were used. In the other experiment (filled circles) 250 mgm. glycine, 250 mgm. alanine and 250 mgm. valine dissolved in 100 ml. of 70 per cent ethanol were used. The elution was carried out with 3·8 l. of 70 per cent ethanol. The dimensions of column used were 10 cm. × 25 cm. The volume of each fraction was 15 ml. The elution process was continued for 48 hr. Every fifth fraction was analysed for amino-acids with the ninhydrin method according to Moore and Stein[3]. Fig. 2 shows that the amino-acids are separated sharply into three peaks.

The column has also been used for salting out chromatography according to Hagdahl and Tiselius[4] with excellent results. Glycyl-l-tryptophan, glycyl-l-tyrosine and glycyl-glycine were separated in 1 *M* disodium hydrogen phosphate + 2 *M* sodium dihydrogen phosphate on a 5-cm. column, 10 cm. in diameter. Metal ions have also been separated using this type of column.

Repeated use has been made of the column, and different columns give consistent and reproducible results. The amount of substances separated by this method is only limited by the dimensions of the column.

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[1] Mitchell, H. K., and Haskins, F. A., *Science*, 110, 278 (1949). Porter, W. L., *Anal. Chem.*, 23, 412 (1951). Hough, L., Jones, J. K. N., and Wachman, W. H., *Nature*, 162, 448 (1948).

[2] Danielson, C. E., *Arkiv. Kemi*, 5, 173 (1953).

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Improvements in Vapour-phase Chromatography at Relatively High Temperatures

FURTHER experience of the application of the vapour-phase chromatographic method to fatty-acid esters and fatty alcohols[1] has led us to adopt certain improvements which are of general interest. The separation of fatty-acid esters was found to be considerably influenced by the quality of the silicone grease used in the chromatograph column, and, in fact, some batches of silicone grease gave very poor results; treatment of silicone grease with ethyl acetate followed by addition of ethanol and decantation of solvent removed an oily fraction and left a residue of grease which has always, so far, proved very satisfactory. The acetate-washed grease from a 'poor-quality' batch was superior even to the best quality unwashed grease, and we have, therefore, used acetate-washed grease in all our subsequent work. We find a mixture comprising 60 per cent 'Celite 545' and 40 per cent acetate-washed silicone grease to be satisfactory for applications.

Difficulties were encountered in the analysis of hexadecanol–octadecanol mixtures, and of brominated technical methyl oleates, at 265° C., owing to slight thermal decomposition of each 'load' of sample, which after a series of tests eventually gave a column so full of charred decomposition products that its efficiency was impaired. In order to reduce the temperature to a more tolerable level, it was considered necessary that the resistance of the column should be reduced so that the inlet pressure could be brought down from about 40 cm. mercury (as hitherto) to, say, 4 cm. mercury. This was achieved by replacing the 'Celite 545' with sodium chloride crystals; the crystals (A.R. grade) were mixed with about 5 per cent of acetate-washed silicone grease. The mixture can be packed into columns quite conveniently; the grease remains on the surface of the sodium chloride crystals even at high temperatures, and the resistance of the 3-ft. column[1] is such that the inlet pressure is 4 cm. mercury when the outlet pressure is 2 cm. mercury. Analyses of hexadecanol–octadecanol mixtures can be carried out at 190–200° C., under which conditions the column can be used for considerable periods. The use of these columns reduces the working temperature for a given separation by about 60° C., and gives separations which are rather better than those obtained with 'Celite'/silicone grease columns at the higher temperatures.

Instead of the straight-wire catharometers previously used, we now have coiled platinum wire catharometers in a small glass envelope, which are about five times as sensitive; a small detachable fraction collector is available for isolating condensate corresponding to any unrecognized maxima on the records, so that unidentified fractions can be analysed by other means, for example, infra-red spectroscopy, mass spectrometry.

We are building a much longer column (20 ft.), with a compact zig-zag shape so that it will fit into the lagged heating cylinder. We hope this will give reasonable flow-rates and will prove effective in separating even more difficult mixtures.

A detailed account of this work will soon be submitted for publication elsewhere.

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Aug. 20.

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[1] Cropper, F. R., and Heywood, A., *Nature* 172, 1101 (1953).

Interaction between Metal Ions through Anions

In order to overcome experimental difficulties in determining polarizing absorption spectra of substances in the crystalline state, one of us (R. T.) devised a new apparatus, which consists in principle of a polarizing microscope and a sector photometer[1]. By means of the apparatus, we have been determining the dichroism of metallic complexes[2] and aromatic compounds[3]. In this communication we wish to report on the anomalous dichroism of crystals of some compounds showing unusually deep colours.

According to X-ray analysis[4], the crystals of $\mathrm{Pt(NH_3)_2Br_3}$ consist of infinite chains, each containing alternate planes of $\mathrm{Pt^{II}(NH_3)_2Br_2}$ and octahedra of $\mathrm{Pt^{IV}(NH_3)_2Br_4}$. Cohen *et al.*[5] supposed from crystallographic and magnetic examination that the crystals of $\mathrm{Pd(NH_3)_2Cl_3}$ might involve similar chains, in agreement with the results of the X-ray analysis[4]. Quantitative measurement of dichroism with a crystal of $\mathrm{Pd(NH_3)_2Cl_3}$ has been carried out by Tsuchida–Kobayashi's microscopic method[1] in the visible and ultra-violet. The absorption measurement shows that the crystal absorbs at much longer wavelengths than does either of the component complexes. Referring to absorption with the electric vector along the *c*-axis, that is, in the direction of the chains, $\mathrm{Pd^{II}—Cl—Pd^{IV}—Cl{-}{-}Pd^{II}{-}{-}}$, as *c*-absorption, and absorption with the electric vector perpendicular to the *c*-axis as *a*-absorption, then we find that the *c*-absorption is very bathochromic and fairly hyperchromic to the *a*-absorption; the *c*-absorption, exhibits an absorption band at about 40 × 10^{13} sec.$^{-1}$ which is not observed with the *a*-absorption. This band may be considered as a kind of charge-transfer band[7] principally due to the chain, $\mathrm{Pd^{II}{-}{-}Cl—Pd^{IV}—Cl{-}{-}Pd^{II}{-}{-}}$.

$\mathrm{Pt(en)Cl_3}$ may be supposed to be a compound of a similar type. On oxidizing with ammonium persulphate an aqueous suspension of $\mathrm{Pt(en)Cl_2}$ or evaporating a mixed solution of $\mathrm{Pt(en)Cl_2}$ and $\mathrm{Pt(en)Cl_4}$, red, plate-like crystals of $\mathrm{Pt(en)Cl_3}$ are formed. Its properties are similar in many ways to those of $\mathrm{Pt(NH_3)_2Br_3}$ and $\mathrm{Pd(NH_3)_2Cl_3}$, showing that the compound should be formulated as $\mathrm{[Pt^{II}(en)Cl_2][Pt^{IV}(en)Cl_4]}$. The crystal is strongly dichroic; purplish-red and pale yellow with the electric vector along and perpendicular to the *c*-axis, respectively. Since the crystal of $\mathrm{Pt(en)Cl_3}$ has been found to exhibit absorption at far longer wave-length than any of the component complexes, the complexes in this crystal should be under some specific forces. The dichroism measurement indicates that the *c*-absorption is very bathochromic and hyperchromic to the *a*-absorption. These relationships may be readily understood, assuming that the crystal involves infinite chains, $\mathrm{Pt^{II}{-}{-}Cl—Pt^{IV}—Cl{-}{-}Pt^{II}{-}{-}}$, along the *c*-axis. Thus the absorption band between 50 and 65 × 10^{13} sec.$^{-1}$ with the *c*-absorption, which is not observed with the *a*-absorption, is supposed to correspond to a charge-transfer band due to the interaction between platinum atoms in different oxidation states.

Black crystals of $\mathrm{Cs_2AgAuCl_6}$ are known to contain another type of infinite chain consisting of alternate planes of $\mathrm{Au^{III}Cl_4}$ and linear anions, $\mathrm{Cl—Ag^{I}—Cl}$. Dark-brown crystals, $\mathrm{(NH_4)_3AgAuCl_7}$, are obtained, following the same procedure, except that ammonium chloride is used instead of cæsium chloride. Similarity in the properties of the crystals to those of the cæsium compound suggests that the former involves similar chains of $\mathrm{Cl—Ag^{I}—Cl{-}{-}Au^{III}(Cl_4){-}{-}Cl—}$, and might be formulated as $\mathrm{(NH_4)_2AgAuCl_6.NH_4Cl}$. The crystal has been found to absorb at much longer wavelengths than would be expected for the component complexes. It has also been found that the *c*-absorption is very bathochromic and fairly hyperchromic to the *a*-absorption. These relationships, which are similar to those for crystals of $\mathrm{Pd(NH_3)_2Cl_3}$ and $\mathrm{Pt(en)Cl_3}$, seem to agree with the above assumption that the crystal of $\mathrm{(NH_4)_3AgAuCl_7}$ may contain infinite chains of $\mathrm{Ag^{I}—Cl{-}{-}Au^{III}{-}{-}Cl—Ag^{I}—}$ along the *c*-axis. Thus the absorption at 55 × 10^{13} sec.$^{-1}$ for the *c*-absorption may be assigned to a kind of charge-transfer band due to the above chains.

It seems to be the general rule that for compounds of the above type a charge-transfer band is observed with the electric vector along the infinite chains. This may be taken as evidence for strong interaction between metal atoms in different oxidation states through the halogen. The interaction also seems to be closely related to the unusual stability of the groups, Cl—Ag^{I}—Cl and Pd^{IV}(NH$_3$)$_2$Cl$_4$, in these crystals.

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Japan. July 27.

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Kornerupine from Rannu, Uttar Pradesh, India

KORNERUPINE, a rare magnesium–aluminium borosilicate, is reported for the first time from India. It occurs in a small band of coarse biotite-schist in the pre-Cambrian pink biotite-gneisses, about a mile and a half north-west of Rannu (24° 53′ 45″ : 83° 13′), Dudhi *tahsil*, Mirzapur District, Uttar Pradesh.

The kornerupine prisms occur in aggregates, which are sometimes radiating. Well-developed crystals with the characteristic faces were not noted. The mineral is light to dark grey, has a semi-vitreous to greasy lustre and breaks with an uneven fracture. Its hardness is 6–7 (Mohs's scale); specific gravity of a fairly pure lump, 3·27. In thin sections, the mineral is colourless, non-pleochroic, with one set of indistinct, prismatic (110) cleavages. Fractures transverse to the elongation direction, usually parallel, are common. The refractive indices determined in sodium light at room temperature (32° C.) are $N_x = 1{\cdot}6755$ ($\pm$ 0·0015), N_y and $N = 1{\cdot}6905$ ($\pm$ 0·0005); $N_z - N_x = 0{\cdot}015$. $2V_x$ determined on a four-axis Federov stage is 17° (± 1). Prismatic sections show straight extinction, and are length fast. The optic axial plane is parallel to (100); $c = X$, $b = Z$, $a = Y$.

Thin sections of the kornerupine aggregates show, in places, intergrowth with a few grains of green spinel and colourless corundum, both of which are occasionally surrounded by narrow plates of sapphirine (colourless to pale blue pleochroism). Euhedral sapphire and irregular grains of rutile are often present. Radial cracks are common around zircon inclusions. Two small sillimanite needles were noted within the kornerupine in one of the sections.

Some parts of the biotite schist are rich in thin aggregates of short sillimanite needles; here spinel and corundum are rare and kornerupine appears to be absent. Where kornerupine is well developed, spinel and corundum occur only in minor amounts. The felspathized schists do not show kornerupine and the associated minerals.

Kornerupine has been reported previously in association with sapphirine, gedrite, corundum, sillimanite, andalusite, etc.[1]. The Rannu occurrence is apparently the only one in which the mineral is associated with green spinel. Further work on the mineralogy and paragenesis of the kornerupine is in progress.

Mr. B. J. Skinner, of the Department of Geology, Harvard University, has confirmed the identification of the mineral by X-ray analysis and I thank him for the same. This communication is published by permission of the Director, Geological Survey of India.

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Aug. 16.

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[1] Vogt, T., *Bull. de la Comm. Geol. de Finlande*, No. 140, 15 (1947).

A New Type of High-Voltage Machine

THE Van de Graaff high-voltage generator is limited as to its current output by the electrostatic charges which can be carried on moving belts. If a belt could be made to carry charged condensers instead of such surface charges, the current output would become much greater.

This can be achieved in the following way. A series of condensers is attached to or incorporated in an endless moving belt and it is so arranged that they become charged on passing a certain point (*A*, Fig. 1), but later become connected in series as they travel away (*B*). In this way, it should be possible to add voltages together and generate very high potentials.

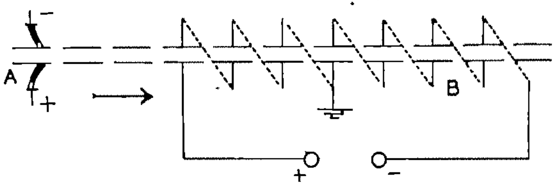

Fig. 1

To test the principle, thirty 8-kV. porcelain tubular condensers of capacity 0·001 mfd. were mounted between two disks of 'Bakelite' board (30 cm. in diameter) forming a circle near the periphery. The terminals of the condensers were connected to brass segments fastened to the outer rims of the disks, and the whole system was mounted on an axle and driven by a motor. Two brushes (at the bottom of the machine) connected to a 7-kV. d.c. supply charged the condensers as they passed. Over the upper half of the disks a set of stationary wire links was provided which connected in series the thirteen condensers that at any moment happened to be at the top. The middle of this set of links was earthed to minimize sparking from either end.

On rotating the wheel at 750 r.p.m., a discharge occurred between blunt wires up to a distance of 11 cm., corresponding to a potential difference of at least 80 kV. It thus appears that very high voltages can be built up almost additively in this way, and with suitable capacity quite heavy currents should be available.

Dr. J. E. Best has kindly directed our attention to an earlier reference[1] in which the same principle has been employed before, chiefly for the purpose of isolating circuits, but with no reference to the production of high voltages.

We have now constructed a larger machine at Newcastle in which the condensers are stationary and the electrical 'contacts' (0·5-mm. air gaps) are caused to rotate. Twenty condensers are used, each 1·5 mfd., and their terminals are connected to two circles of brass segments 18 in. in diameter, one above the other, surrounding the horizontal disk carrying the rotating contacts. As this disk rotates, thirteen of the condensers are connected at any instant through the sparking contacts, so that their voltages add together. The disk, which is made of 'Tufnol', is driven by a motor at 600 r.p.m.

Charging the condensers is carried out by a pair of contacts connected through slip rings to a d.c. charging voltage. The brass sectors are spaced to prevent sparking between them, giving an on/off ratio of 0·52.

The machine operates smoothly at charging voltages of 1·8–2·8 kV. and gives a steady current to an X-ray tube of 5–10 m.amp. The step-up ratio was rather less than expected. Thus, charging at 2·3 kV., the open-circuit output was found to be 26 kV. instead of the calculated 30 kV. When current was drawn from the machine the voltage dropped by 2·3 per cent per m.amp. instead of the 1 per cent calculated. This may, in part, be due to the rather unsteady discharge at small currents.

Preliminary observations of the voltage wave-form indicate that instead of each pulse being of a steady 'square wave' shape, it is broken up into about ten separate discharges. This is probably connected with the irregularity of sparking across air gaps.

This communication is published in the hope that others with wider resources will continue to investigate machines of this kind. We have no desire to reserve the field.

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F. T. Farmer

Radiotherapy Department,
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Newcastle upon Tyne.
Nov. 3.

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[1] Brooks, N. W., and G.E.C., Brit. Pat. 615,896 (1947).

Artificial Increase of Electrical Breakdown Strength of Air at Low Pressure in the Region of 300 Mc./s.

It has been known for some time[1,2] that the presence of a d.c. bias voltage can, under certain conditions, modify the electrical breakdown strength of air at low pressures and ultra-high frequencies. Published information, however, has been restricted to exploration at very small gap-lengths and pressures in excess of about 59 mm. mercury. Further measurements have now been made covering a range of pressures from 5 to 120 mm. mercury, and of gap-widths from about 1 to 4 mm., at two frequencies, 227 and 379 Mc./s. Under these conditions, the superposition of a moderate d.c. stress on the ultra-high frequency alternating stress can increase the ultra-high frequency breakdown stress quite considerably.

If the breakdown strength of a gas is examined as the frequency of the applied stress is increased, two discontinuities are found to occur during the diminution of strength which has been observed to take place between very low and ultra-high frequencies. These are generally believed to mark the regions where the average amplitudes of oscillation of free ions and electrons respectively become comparable with the width of the gap. As soon as it becomes possible for an electron, for example, to have a free life in excess of half a period of the applied stress, then the conditions necessary for the rapid build-up of an electron 'avalanche', the prerequisite of breakdown, are attained more readily. The measurements reported here refer to a region where this condition exists. If, under this condition, steps are taken to increase the rate of loss of free electrons in the gap, for example, by applying a constant d.c. stress, so that free electrons are being constantly 'captured' by the anode, then the onset of breakdown will be delayed, even though in alternate half-periods the total stress is increased. The effect will not be noticed at any frequency so low that the avalanche has to be formed during one half-period for breakdown to occur.

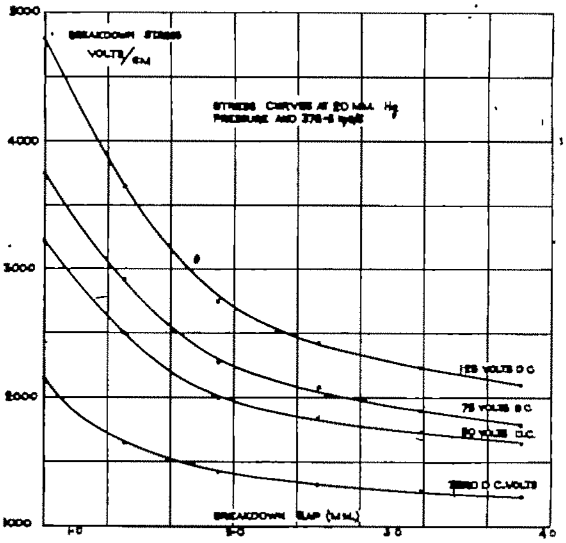

Fig. 1

The scale of the effect is illustrated in Fig. 1, which shows typical results obtained under one set of conditions. The effect is large enough to find practical application as an inhibitor of breakdown in electronic equipment required to operate at high altitudes, particularly if space is restricted, so that gap-widths cannot be increased.

Measurements were made using an evacuated resonant concentric line, which itself contained the breakdown gap, the alternating and direct supplies to which were isolated by conventional means. Ultra-high frequency voltage was measured by means of a small probe and diode rectifier, the probe being situated in the line, in the plane of the gap. Calibration was carried out at lower voltages, where it was possible to use a directly-connected diode rectifier.

The full results, and a quantitative analysis based on the above theory, are being published elsewhere.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

G. W. E. Stark
G. L. Fougere

Royal Aircraft Establishment,
Farnborough, Hants. Aug. 20.

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[1] Varela, A. A., *Phys. Rev.*, 71, 124 (1947).

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FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, December 6

University of London (at the Postgraduate Medical School of London, Ducane Road London, W.12), at 4 p.m.—Dr. Donald Hunter: "Hazards of Handling Toxic Substances in Industry".*

Institution of Electrical Engineers (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Applications and Limitations of Electronic and Other Computers".

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Cedric Marsh: "Aluminium as a Bridge Material".

Royal Institute of Chemistry, London Section (joint meeting with the London Section of the Society of Chemical Industry, in the Chemistry Lecture Theatre, University College, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. J. Grange Moore: "The Value of Work Study to the Chemical Industry".

Tuesday, December 7

Ross Institute of Tropical Hygiene, Industrial Advisory Committee (in the Council Chamber of the Rubber Growers' Association, 19 Fenchurch Street, E.C.3), at 2.15 p.m.—Discussion on "The Training of Laymen in Tropical Hygiene"

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Symposium on "High Buildings".

University of London, British Postgraduate Medical Foundation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. F. Bergel: "Some Chemical Aspects of Abnormal Growth". (From a series of Lectures on "The Scientific Basis of Medicine".)*

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. P. J. Flory: "The Structure and Properties of Polymers".

Institution of Mechanical Engineers, Education Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Recruitment to the Engineering Profession from the Secondary Grammar Schools".

Wednesday, December 8

Physical Society, Colour Group (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 2.30 p.m.—Mr. J. D. Moreland: "An Investigation of Peripheral Colour Perception by Direct Comparison between Peripheral and Foveal Vision"; Dr. M. Gilbert: "Acuity to Coloured Letters".

British Society for the History of Science, Philosophy of Science Group, Northern Branch (in the Senate Committee Room, The University, Manchester), at 4.30 p.m.—Sir Geoffrey Jefferson, F.R.S.: "Personality Changes in Cerebral Lesions".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. C. C. Hall and Mr. A. H. Taylor: "Design and Operation of a Fluidized Pilot Plant for the Fischer–Tropsch Synthesis".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Dr. Archibald Clow: "Distinguished Men of Science".

Institution of Electrical Engineers, Education Discussion Circle (joint meeting with the Education Group of the Institution of Mechanical Engineers and the Institute of Physics, at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Kinetic Theory of Gases for Engineering Students".

Thursday, December 9

Physical Society, Optics Group (at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2.30 p.m.—Dr. A. Maréchal: "Improvement of Contrast of Details in Optical Systems by Filtering Spatial Frequencies"; Dr. E. H. Linfoot: "On the Information Theory of Optical Images".

Institution of British Agricultural Engineers (at the Smithfield Show and Agricultural Machinery Exhibition, Richmond Hall, Earls Court, London), at 3 p.m.—Mr. C. Culpin: "Ventilated Silos for Grain Drying and Storage on the Farm".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. F. P. Bowden, F.R.S., and Mr. K. Singh: "Irradiation of Explosives with High Speed Particles and the Influence of Crystal Size on Explosion"; Miss A. L. Bailey and Mr. J. S. Courtney-Pratt: "The Area of Real Contact and the Shear Strength of Monomolecular Layers of a Boundary Lubricant".

Physical Society, Low Temperature Group (in the Science Museum Lecture Theatre, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. N. Kurti: "Nuclear Alignment".

Institute of Fuel (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. J. K. Matthews: "Note on the 'Optimum Degree' of Coal Washing".*

Sir Thomas Middleton Memorial Trust (at the University of London, Senate House, London, W.C.1), at 5.30 p.m.—Prof. Kenneth Mather, F.R.S.: "Fundamental Science in Agricultural Research" (Second Middleton Memorial Lecture).*

University of London, British Postgraduate Medical Federation (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. A. Haddow: "Theory and Application of the Nitrogen Mustards". (From a series of Lectures on "The Scientific Basis of Medicine".)*

University College, London (in the Chemistry Theatre, Gower Street, London, W.C.1), at 6 p.m.—Sir George Pepler: "Geddes' Contribution to Town Planning".*

Society of Chemical Industry, Microbiology Group (in the Large Hall of the Medical Society of London, 11 Chandos Street, London, W.1), at 6.15 p.m.—Meeting on "Industrial Uses of Enzymes".

Royal Society of Tropical Medicine and Hygiene (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Prof. George Macdonald: "The Medical Implications of the Volta River Project"

Friday, December 10

Association of Applied Biologists (in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7), at 10.55 a.m.—Scientific Papers.

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. W. B. Carlson and Mr. J. D. McKean: "Cylindrical Pressure Vessels: Stress Systems in Plain Cylindrical Shells and in Plain and Pierced Drumheads".

Society for Analytical Chemistry, Biological Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Annual General Meeting. 6.30 p.m.—Scientific Papers.

Institution of Chemical Engineers, Graduates and Students Section (at Caxton Hall, Westminster, London, S.W.1), at 6.30 p.m.—Prof. F. Morton: "The Training of the Chemical Engineer".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Scientific Papers.

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Charles Ellis, F.R.S.: "Coal and Smokeless Fuels".

Saturday, December 11

British Mycological Society (in the rooms of the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon—Annual General Meeting. 2.30 p.m.—Dr. J. Ramsbottom: "Mycology and the Amateur" (Pearson Memorial Lecture).

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. David Diringer: "The Origins of the Alphabet".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Master to teach General Science to Cambridge Overseas School Certificate level, at Markham College, Lima, Peru—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Markham" (December 7).

Senior Lecturer (with a good honours degree, or equivalent, in mechanical engineering, and with some practical experience in industry and teaching) in Mechanical Engineering—The Principal, Wigan and District Mining and Technical College, Wigan (December 7).

Assistant Coal Survey Officer, Scientist Grade I or II (with a good honours degree, or equivalent, in chemistry or fuel technology, and preferably with experience in industry, laboratory control and the critical assembly of scientific data), at the Coal Survey Laboratory, Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/860 (December 10).

Assistant Experimental Officer (preferably graduate in chemistry or physics) required for the Soil Survey of England and Wales to work on clay mineralogy by X-ray and thermal methods—Rothamsted Experimental Station, Harpenden, Herts (December 11).

Assistant Lecturer, Grade B, in the Pharmacy Department, to teach mainly physical and inorganic chemistry to degree standard—The Principal, Brighton Technical College, Brighton 7 (December 11).

Grassland Agronomist (Scientific Officer or Senior Scientific Officer grade); a Grass Breeder (Scientific Officer grade); a Cereal Breeder (Scientific Officer grade); and Assistants to a Cytologist and Grass Breeder (Assistant Experimental Officer grade), at the Welsh Plant Breeding Station, Aberystwyth—The Registrar, University College of Wales, Aberystwyth (December 11).

Microanalyst (preferably with previous experience in microanalysis) in the Department of Organic Chemistry—The Registrar, The University, Leeds (December 11).

Agricultural Economist (graduate, preferably with qualifications in economics or agriculture) in the Agricultural Economics Department—The Registrar, Wye College (University of London), near Ashford, Kent (December 13).

Scientist, Grade III (with a good honours degree or equivalent qualification in a science subject, and preferably with a sound background in geology or chemistry), in the Coal Survey Laboratory, Newcastle, for work which will include the preparation of detailed reports on the structure and physical and chemical properties of the coal seams covered by the laboratory—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/874 (December 17).

Assistant Experimental Officer in the Department of Scientific and Industrial Research, Road Research Laboratory, Harmondsworth, Middx, for editing technical publications—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.728/54A (December 18).

Lecturer in Education—The Registrar, The University, Liverpool (December 18).

Metallurgist (with a first- or second-class honours degree) at the Ministry of Supply Royal Aircraft Establishment, Farnborough, Hants, to undertake metallographic work on fatigue of metals with special reference to effects of different microstructures—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F 807/54A (December 18).

LECTURER, Grade II, or ASSISTANT LECTURER (with an honours degree in botany with subsidiary zoology) IN BOTANY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 20).

BIRMINGHAM CHEMICAL CO., LTD., RESEARCH FELLOW (with some research experience in organic chemistry) IN CHEMISTRY, to work on the chemistry of flavouring and aromatic materials—The Registrar, The University, Sheffield 10 (December 31).

J. LYONS FELLOW (graduate in chemistry, and preferably with industrial experience) IN ANALYTICAL CHEMISTRY—The Acting Registrar, The University, Birmingham 15 (December 31).

SCIENTIFIC OFFICER (qualified geneticist, preferably with mycological experience) IN THE GENETICS DEPARTMENT—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (January 1).

UNIVERSITY LECTURER (with an honours degree in some branch of natural science and experience in teaching) IN VETERINARY ANATOMY—Dr. A. S. Watt, Botany Department, University of Cambridge, Downing Street, Cambridge (January 1).

CHAIR OF BOTANY, and a LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (January 8).

PROFESSOR OF MATHEMATICS, and a PROFESSOR OF CHEMISTRY, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, January 29)

AGRICULTURAL OFFICERS (with either (*a*) a university degree involving specialization in soil conservation and at least one year's practical postgraduate experience) or (*b*) a university degree in agriculture or an allied subject and with at least two years postgraduate study or experience of soil conservation), in the Gold Coast Local Civil Service, for duties connected with land-use and anti-erosion measures—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W 1, quoting BCD 63/13/04.

ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. or equivalent and a good general knowledge of electronic equipment, and preferably with some laboratory experience and familiarity with pulse techniques) at Fort Halstead, Kent, to assist in the development of high voltage pulse circuits, and to be responsible for a small electrical measurements laboratory—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 303/WGE/2.

ASSISTANT METEOROLOGIST (with H.S.C. or equivalent in mathematics or physics, and preferably with experience in forecasting) in Nigeria—The Crown Agents, 4 Millbank, London, S.W.1, quoting M3B/34743/TA.

CHEMISTS (2) (with a first- or second-class honours degree, or equivalent) at the Central Laboratory, Chiswick—Staff Officer (F/EV.514), London Transport, 55 Broadway, London, S.W.1.

ELECTRICAL ENGINEERS and PHYSICISTS (with at least H.S.C. (science) or equivalent) at the Ministry of Supply Radar Research Establishment, Malvern, Worcs, for research and development work on radio and electronic equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.330/54A.

EXPERIMENTAL OFFICER (preferably with a pass degree in chemistry, or at least H.S.C. (science) or equivalent), to be a member of a team carrying out research on inorganic materials, and to control junior staff carrying out routine physico-chemical measurements—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 72/WGE.

JUNIOR SCIENTIFIC OFFICER (with an honours degree in science, pharmacy or biology) for duties which will consist of technical work in the Blood Transfusion Service laboratories—The Director, Blood Transfusion Service, Roby Street, Manchester 1.

MISTRESS (with an honours degree) to teach zoology to university entrance and scholarship level, and to share in the teaching of general science in the Middle School—The Headmistress, London Haberdashers' Aske's School, West Acton, London, W.3.

PHYSICIST (with a good honours degree, preferably with some research experience and a knowledge of electronics) to continue research on the drying of yarn packages—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester, quoting P.5.

REGIONAL TRIALS OFFICER, to work at Leeds University Farm, Headingley Hall, Yorks; and an ASSISTANT TRIALS OFFICER, to work at Norfolk Agricultural Station, Sprowston—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

RESEARCH ASSISTANT (honours graduate, preferably with research experience) IN ORGANIC CHEMISTRY—The Secretary, University College, Exeter.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree in chemistry, and preferably with an interest in the phenomena of crystal growth, detonation or combustion), to study problems connected with the generation of detonation in high explosives—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 108/WGE/34.

SENIOR LECTURER IN PHYSICS—The Clerk, Northern Polytechnic, Holloway, London, N.7.

SENIOR LECTURER (with research experience in the electrochemical aspect of the subject) IN PHYSICAL CHEMISTRY; a SENIOR LECTURER (with good industrial experience) IN CHEMICAL ENGINEERING; a LECTURER IN BIOLOGY to teach up to B.Sc. ancillary subject standard; a Grade B LECTURER IN CHEMISTRY; a SENIOR LECTURER (with good industrial experience) IN TELECOMMUNICATIONS; a Grade B LECTURER IN ELECTRICAL ENGINEERING; a LECTURER IN PHYSICS, and a Grade B LECTURER IN MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

TECHNICIAN IN THE ZOOLOGY DEPARTMENT—The Secretary, Royal Holloway College, Englefield Green, Surrey.

REPORTS and other PUBLICATIONS

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Transactions of the Royal Society of Edinburgh. Vol. 62, Part 3 (No. 17), 1954–55: The Ecology of Exposed Rocky Shores of Caithness. By Dr. John R. Lewis. Pp. 695–724+4 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 10s. 6d. [249

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Department of Mines and Technical Surveys. Publications of the Dominion Astrophysical Observatory, Victoria, B.C. Vol. 9, No. 11: Spectrographic Studies of the Combination Variables Z Andromedae, BF Cygni and CI Cygni. By L. H. Aller. Pp. 321–362. 25 cents. Vol. 9, No. 12: The Spectrum of the Shell Star 48 Librae. By Anne B. Underhill. Pp. 363–398. 25 cents. (Ottawa: Queen's Printer, 1954.) [249

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UNIVERSITY STANDARDS AND THE SOCIAL BACKGROUND

AN article by R. K. Kelsall on the social background of the higher Civil Service in Britain, in the current issue of *The Political Quarterly*, is based on data obtained as part of a wider study to be published next year. The article suggests that there has been a marked alteration in the social background pattern of candidates presenting themselves for examination, and that the main hope of ultimately securing a more equal representation of those originating in the lower social strata still lies in more widely dispersed educational opportunities, and in the maintenance and possible expansion of the present more liberal policy of promotion from the ranks. It recognizes that, before the Second World War, most successful candidates had been at the University of Oxford or of Cambridge, due largely to the fact that relatively few candidates who had been to other universities presented themselves. The other universities are, however, better represented in post-war candidates generally, though most of them still contribute very much less than the appropriate share of competitors for entry to the administrative class, and thus to some extent contribute to the lack of social balance among the entrants.

Some further light is thrown on this question, which clearly may affect the ability of the administrative class both to draw on the full reserve of intelligence in the population and to maintain full touch with the citizens it serves, from a recent broadsheet, "Background of the University Student", issued by Political and Economic Planning (No. 373 ; November 8, 1954). The broadsheet compares the results of a survey at one of the two ancient universities, two English provincial universities, a university college, a college of the University of Wales, and a college of the University of London in 1952–53 with those of a previous survey at the same institutions in 1947–48. In both surveys the information required was extracted from university records, and afterwards arranged and analysed on a similar basis.

As might be expected, on account of the departure of ex-Service students, there was a marked shift towards the younger age-groups for men students in the second survey ; but no clear conclusions regarding the effect of national service on the age at entry can yet be drawn. Some institutions seem to bring most of their students up before they have done their national service, while others, notably the ancient universities, bring them up afterwards. The proportion of British students whose homes are near the universities they attend is still fairly high, except at Oxford and Cambridge ; but it has fallen steadily since the Second World War. At London, the percentage of students with homes within thirty miles of the University increased from 47·4 per cent in 1937–38 to 56·2 per cent in 1947–48 and fell to 52·7 per cent in 1952–53 ; for other English universities and university colleges (excluding Oxford and Cambridge) the corresponding figures are 64·0, 58·4 and 43·7, and for Wales 64·7, 53·5 and 48·2.

The P E P surveys show that while the proportion of men students entering the ancient university from other universities or technical colleges remained almost unchanged (22 per cent in 1952–53 compared with 21 per cent in 1947–48), the percentage entering from fee-paying schools decreased from 52 to 46, while the percentage of students from non-fee paying schools (local authority schools) increased from 21 to 27 per cent; for women students similar figures were observed—a decrease from 51 to 47 per cent and an increase from 30 to 38 per cent, respectively. At one provincial university and at the university college there was a striking increase in the proportion of students coming from other universities and technical colleges, and at the London college where, in 1947–48, 34 per cent of men and 28 per cent of women students came from this source, there was a slight increase. At the other provincial university there was little change in the percentage of men students so recruited, but an increase in the proportion of women students; while at the Welsh college the percentage of men and women students so recruited declined from 11 per cent and 5 per cent, respectively, to 5 per cent and 1 per cent.

This second survey confirms the observation made in the first survey—that, whereas ex-Service students at the ancient universities coming from independent public schools had not been seriously affected by competition from the former pupils of grammar schools, competition from school leavers seemed to be growing more severe. At four of the other institutions the shift was in the same direction, although at the London college it was slight, and at one other institution it was slight. For women students the changes have been in contrary directions. But apart from these aberrations, the representation of the State secondary schools at the universities of Britain has been strengthened during the five years. For men students only the ancient university now has a larger proportion coming from fee-paying schools, and the gap is narrowing; apart from foreign and Colonial students, the Welsh college and the university college are virtually preserves of the State schools, and a recent survey by P E P of the University College of North Staffordshire showed that an average of 81·2 per cent of its men students and 79·8 per cent of women students came from State schools.

Analysis of the occupations of parents of United Kingdom students was based on seven groups: professional, administrative, proprietors and managers; forces, police, fire service, etc.; farmers; personal services; retail traders, innkeepers, etc.; clerks, shop assistants, salesmen, etc.; and manual workers. At all four institutions there has been a shift towards the latter end of the scale; even at the ancient university the last two groups increased their representation by seven per cent for men and one per cent for women at the expense of the first two groups. Elsewhere among men students the representations of the last two groups have risen from about a third to about one-half of the total, and there has been a similar change among women students; but even at the Welsh college it is still true that women students tend to come from higher social groups than their male colleagues.

Further analysis of the first occupational group indicates that in the five-year period the proportion of students whose fathers are higher Civil servants or senior officials in local government has decreased, and also the proportion of students whose fathers are in business, either on their own account or holding senior managerial positions. A recent analysis of students registered at Hull University College (now the University of Hull) showed that thirty-four per cent are of working class origin, while the earlier P E P survey showed that this figure for the ancient university was seven per cent and at provincial universities twenty per cent. The broadsheet also quotes from two other recent studies of the social and educational backgrounds of students covering more limited fields. H. Jenkins and D. Caradog Jones's study of "The Social Class of Cambridge Alumni" showed that the proportion of public school men at Cambridge rose during the second half of the nineteenth century, being eighty-two per cent during 1850–99, until the growth of local authority secondary schools brought about a decline to sixty-eight per cent in 1937–38. Since only the ablest pupils from grammar schools went up to Cambridge, these students had the best academic record over the whole period 1752–1899, although they were less successful in their careers than the products of famous public schools. Schools or families of high social standing had a definite relation to securing posts of distinction, though not those of the highest importance; but apart from this bias, successful students at Cambridge usually did well in later life.

C. A. Anderson and M. Schnaper's survey of the social background of Oxford and Cambridge students was based on individuals at the university between 1850 and 1900, and indicated the extent to which the older universities provided for the education of men who achieved or inherited eminence in later life. Men who made their names in government service had the most diversified educational background; but at that time the older universities did not dip very deeply into the social pyramid. The most noticeable feature was for Oxford and Cambridge to have the lion's share of great men, with a marked tendency for sons to follow in their fathers' footsteps.

Replying in an adjournment debate on local authority awards to university students in the House of Commons on November 17, the Parliamentary Secretary to the Ministry of Education, Mr. Dennis Vosper, made some relevant comments. As a result of university expansion, the number of students of any age-group going to a university was about double the pre-war number, and in each age-group a much greater cross-section of the social strata was represented. Even if there was not equality of opportunity from area to area, he said, we have moved much nearer to equality of opportunity so far as the income of parents and social background are concerned. In 1953 the universities took 1,250 open scholars, 2,000 State scholars and 10,000 students with local authority awards; more than 70 per cent of the 18,000 students entering the universities in that year were thus in receipt of awards.

Mr. Vosper stressed the great increase in local-authority awards, which in 1938 were only 1,500, and in 1953 had cost almost £6 million compared with £2 million in 1948. While university and State scholarship awards are for students of outstanding academic ability, local authority awards are intended to assist students of good all-round ability for whom it is in the public interest that a university education should be provided. The procedure at present in force, he said, leaves responsibility with the local authorities, which are asked to consider all candidates with a minimum academic standard, but are left some discrimination and particularly with reference to the headmaster's report and interview panel. Only six out of 146 authorities in Britain do not now accept the minimum standard laid down in the Circular of 1952, and Mr. Vosper thinks that, apart from the six authorities noted, there has been much improvement in uniformity of standard and equality of opportunity. The universities at the moment do not feel able to undertake the work involved in making an award dependent on acceptance by a university, and while it might be possible for the Ministry of Education to select the two thousand State scholars each year on academic achievements, he does not think it possible for the Ministry to select ten thousand students of all-round ability.

Without over-stressing the value of these partial surveys, it is clear that these trends, of which the University Grants Committee, from its last quinquennial report, is clearly aware, pose problems of which the universities must increasingly take account pending the completion of the inquiries now being carried out by the Committee of Vice-Chancellors and Principals and by P E P itself. The former inquiry is expected to furnish, in due course, a mass of information about the educational and social origins of university students, as well as about their qualifications, awards held and courses followed, and the reasons for rejection of unsuccessful candidates. The second is concerned with graduates—and especially with graduates in industry—and should also provide material of use to the universities as well as to industry.

On the evidence now presented, even if the proportion of students coming from homes within a short radius of the provincial universities does not increase, the shift in the social strata from which students are drawn may well accentuate the difficulties which arise when a considerable proportion of students is drawn from homes with no tradition of culture. It is not a problem to be solved merely by the increase in financial grant or by the more generous provision and equipment of libraries and halls of residence.

The inquiry into ways of learning by students of university age which the University Grants Committee has sponsored, and which is being conducted by Sir Godfrey Thomson under the auspices of the University of Edinburgh, should go closer to the heart of the matter. What is involved is an attitude of mind that is endangered by the deficiencies of home life and conditions or by relative poverty, and which also is discouraged by the tendency of the times to rely on the State rather than on individual effort or initiative. It is also in part a question of values; and unless this problem of the attitude to learning and of cultural and intellectual values is faced and solved, there is danger that the State will receive little or no return from the six million pounds now being spent annually on university awards by the local authorities alone.

There are other disturbing consequences at which the surveys already published hint. It may be questioned whether the dominance of students from the State schools will not endanger the full value of the experiment which has been proceeding at Keele for the past four years. Diversity of entry offers, for the moment, a hope of correcting some of the more serious consequences which may flow from the present trend in the background of the university student. At least it may be said that the evidence of the P E P broadsheet affords strong support for caution in regard to university expansion, and endorses the view already expressed by the University Grants Committee that the main immediate task of the universities is consolidation. Adjustments to meet particular needs of the community and the improvement of methods of selection are important indeed; but the primary task is that of so adjusting the teaching work and responsibilities of the university to the changing types of student that successive generations of student will continue to acquire the same secret of learning, to catch the same inspiration, and to carry away with them the same powers of vision and imaginative understanding as did those who in former years entered the universities with greater social and cultural advantages.

THE CONQUEST OF PLAGUE

The Conquest of Plague

A Study of the Evolution of Epidemiology. By Dr. L. Fabian Hirst. Pp. xvi + 748. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 42*s*. net.

THIS is a comprehensive study of plague. The author, Dr. L. Fabian Hirst, is a microbiologist who, as Lieut.-General Sir William MacArthur writes in a foreword, during a period of twenty-two years has paid special attention to the disease in various parts of the Middle and Far East, particularly in Ceylon.

Part 1 of the book deals with traditional conceptions of the nature of plague. Dr. Hirst reminds the reader that primitive beliefs and observations may hold truths that are only revealed to the man of science centuries later. Instances of this are the epidemics of plague among the Philistines, described in the Old Testament (I Samuel, v, vi), which are associated with the presence of small rodents. The Hebrew word *akbar* may mean rat or mouse. If the civic authorities of London had read their Bible more carefully, they would not have favoured the rat population in ordering the destruction of cats and dogs as possible vectors of plague in 1665. Dr. Charles Singer has pointed out that during the seventeenth century natural causes were first assigned to plague, and even that it was due to the multiplication of minute organisms, a hypothesis not verified for two hundred years.

Concerning the spread of the disease, miasma versus contagion was for centuries the subject of debate, and it was not until the middle of the nineteenth century, when Sir John Simon organized careful investigation of plague outbreaks as recorded in his "Annual Reports" to the Privy Council, that scientific opinion progressed from the conception of a miasma emanating from putrefying filth to a specific chemical poison in air and water, and, finally, to the modern view that specific infections are due to invasion of the body by specific micro-organisms. In his historical narrative Dr. Hirst demonstrates how the study of plague has played an important part in the general evolution of epidemiology. The plagues of London, the Marseilles epidemic of 1720–21, the "Short Discourse concerning Pestilential Contagion" of Richard Mead, which advanced knowledge of the disease and its control by quarantine, all these historical landmarks receive careful attention.

To those engaged in work on plague, whether as research worker, administrator or medical practitioner, the remaining three parts of this work will be of special interest. In these parts the author considers the modern conceptions of the nature of plague, its spread in time and space, its conquest and its international and national control. Here Dr. Hirst has drawn freely upon his own researches dealing with the parasitological and preventive aspects of the disease. It is all most systematically and carefully done. On the vexed question as to whether Kitasato or Yersin discovered the bacillus of plague at Hong Kong in 1894, Dr. Hirst examines the evidence and states (p. 108): "The conclusion must be that both bacteriologists discovered the plague bacillus independently within a few days. Kitasato saw it first, but Yersin, the former *préparateur* of the Pasteur Institute, was probably the more accomplished technician and gave by far the best description of the micro-organism".

There are interesting studies in the book of rats as transmitters of plague, of the classification of the fleas which convey plague, together with a full account of plague among the rodents of the great plains. The author then describes inter-human plague; the temporal spread of plague, together with a consideration of the periodicity of epidemic disease; and the territorial spread of plague. Last of all he discusses administrative measures for the prevention of plague and, from a wealth of experience, points out the difficulties and pitfalls, as well as the successes, of the measures pursued. This portion of the book might have been expanded with advantage; but Dr. Hirst records the chief steps in international control of plague and its prevention, and a second volume would be required to treat the subject exhaustively.

In an epidemiological treatise only brief reference is possible to the successful modern treatment of plague. Formerly, the early injection of a fresh and potent anti-plague serum was the chief method. Since the introduction of the sulphonamides by Domagk in 1935 it has been shown that plague can be successfully treated by certain of these preparations. Later still, some of the new antibiotics, especially streptomycin, have proved even more efficacious. Penicillin, the best known of these, does not act on the plague bacillus.

This erudite work, which investigates many aspects of a deadly but now a controllable disease, is clearly written and can be read with profit by both lay and medical readers. The book is appropriately illustrated and well produced. ARTHUR S. MACNALTY

SCIENTIFIC DESIGN OF ABSORPTION TOWERS

Absorption Towers

With Special Reference to the Design of Packed Towers for Absorption and Stripping. By G. A. Morris and J. Jackson. Pp. xi+158+3 plates. (London: Butterworths Scientific Publications in association with Imperial Chemical Industries, Ltd., 1953.) 30s. net.

THE design of absorption towers is a complicated process owing to the large number of factors involved and the irregular flow conditions which are often encountered; it was not until the middle 'thirties that any success was achieved. The two-film theory was available as a suitable basis; but the real clue to scientific design was given by the development of the comparatively simple grid-packing together with the surprisingly belated recognition of the fact that for best performance it is essential to have uniform liquid flow over the surface of the packing. Even now, mere wetness appears sometimes to be regarded as satisfactory, although this is by no means always the case. While the general principles of design have not appreciably changed since 1937, many improvements have been introduced and much data accumulated. Making full use of these and a great deal of hitherto unpublished information, G. A. Morris and J. Jackson have produced a monograph of outstanding merit. In spite of the complexity of the subject, the clarity of presentation is such that, with the help of this book, anyone with some knowledge of physical chemistry should be able to design an absorption tower.

A brief introduction to the subject of absorption is followed by a chapter on the determination of film coefficients by laboratory methods and by one on packings. Two methods of design—in other words, calculation of the most economical dimensions of the tower and the best type of packing—are elaborated, one using absorption coefficients and the other transfer units, and their relative merits are discussed. Economic factors are treated separately, and a table of economic gas-rates for different packings will be found of much assistance. A very valuable chapter on the mechanical features of design is largely devoted to the important subject of liquid distribution already mentioned, and a number of fully worked-out examples are appended to assist in applying the principles discussed in the main part of the book. To conclude, a glossary is added, in which exception must be taken to the authors' use of the not altogether accurate term 'gas-film limitation' instead of the older and more usual 'gas film control'.

Special features are the comprehensive tables and well-drawn diagrams which supply practically all the facts required by the designer, thereby saving him from the inconvenience of continual reference to bulky volumes of tables. A minor omission is a table of heats of solution, while a welcome item rarely found in British books is an indication of the price of the main components of the plant. Absorption calculations unfortunately require the use of a great many symbols which are difficult to remember; but the reader is helped in the present book not only by a six-page summary at the end of the volume but also by an explanatory list after each important formula, a practice much to be commended. Units are often a source of confusion: the C.G.S., British and metric systems are all used, but the first is confined to the laboratory section. Both British and metric values are given in the tables, the figures being set out with such clarity that a mistake is well-nigh impossible.

One omission, no doubt intentional, is greatly to be regretted—the complete absence of data for the performance of existing large towers and comparison with calculated values. This tends to impart an academic atmosphere to the book, despite its obviously practical nature. The authors emphasize that large towers are difficult to test, that some of the design methods recommended are still tentative, and that it is sometimes desirable to introduce factors of safety; but a few definite figures for the discrepancies actually found would indicate the reliance to be placed on the calculations. Apart from this, the book is a model of the way in which to treat a complex chemical engineering subject and is a particularly good example of the application of science to industry. All chemical engineers will adopt it as a standard work of reference, and all chemical manufacturers should study it. H. E. WATSON

NAPHTHOIC ACIDS AND THEIR DERIVATIVES

Elsevier's Encyclopædia of Organic Chemistry

Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 12*B*: Naphthalene. (*A*) Compounds Containing One Naphthalene Nucleus. Naphthoic Acids and Their Halogen, Nitrogen, and Hydroxyl Derivatives. Pp. 3965–4560. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1953.) £21 net. (Series Subscriber, £18 10*s*.; Complete Subscriber, £16.)

THIS seventh part of Vol. 12*B* makes a useful addition to the section of the Encyclopædia dealing with naphthalene derivatives. The seven parts together already constitute an impressive survey of naphthalene chemistry, but the end is not yet in sight. Part 7 is concerned with the two naphthoic acids and their hydrides and homologues, together with the usual types of acid derivatives, and various substitution products containing halogen, nitrogenous groups, hydroxyl and alkoxyl. Polycarboxylic acids derived from naphthalene will find a place, presumably, in Part 8. As is usual with such a method of treatment, the result is an assembly of information about an assortment of compounds which will appeal to a variety of tastes.

For the natural product chemist there is an interesting review of the recent chemistry of naturally occurring lactones derived from naphthoic acids. These comprise the conidendrins and the constituents of 'podophyllin'. As regards the latter, the structural relationships between podophyllotoxin and picropodophyllin and their derivatives are set forth in a characteristically clear chart of formulæ. These substances have aroused some interest among biologists on account of their destructive action on certain pathological growths. The chemical reader who consults the index may well wonder what is an 'oncolytic' compound. If he refers to the text, he will find that it is a substance with tumour-damaging activity.

For the dyestuffs chemist there are surveys of aminonaphthoic and hydroxynaphthoic acids. The anilide of 2-hydroxy-3-naphthoic acid (Naphthol *AS*) and its applications are fully discussed; many azo dyes derived from this and related compounds are described, and there is a table occupying fifteen pages which summarizes the properties of the many known arylamides of 2-hydroxy-3-naphthoic acid. For the pharmacological chemist there are descriptions of many compounds with local anæsthetic activity derived from the aminonaphthoic acids.

There are the usual references to physical constants, including optical data, and to biological properties as far as these have been recorded. For 1-naphthonitrile, for example, the ultra-violet absorption maxima and Raman frequencies are given, as well as the fluorescence, phosphorescence and magnetic properties, the dielectric constant, the heat of combustion and the density. Its polyploidogenic action is also mentioned. The only misprint which has been noted is an obvious one, in a heading on p. 4009. The high standard of previous parts of this Encyclopædia is well maintained. J. W. COOK

BASIC DYNAMICS FOR STUDENTS OF AERONAUTICS

Introduction to Aeronautical Dynamics

By Prof. Manfred Rauscher. Pp. xv + 664. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 96*s*. net.

AERONAUTICS is, with the possible exception of astronomy, the subject in which the greatest and most diverse applications of classical mechanics are made. These applications cover problems of the dynamics of particles and of rigid and deformable bodies, oscillations of many kinds and the whole field of the mechanics of fluids. Investigations of great difficulty and much technical importance arise in which the system consists of a deformable body (aircraft) in motion through a viscous and compressible fluid (air). Questions of the stability of motion are of great importance, while thermodynamic considerations are essentially involved in the problems of propulsion and of high-speed flight in general. All this implies that aeronautical scientists and engineers must be well versed in dynamical techniques, some of which have indeed been specially devised for the treatment of aeronautical problems, while students must have a thorough training in dynamical fundamentals. It is these fundamentals which the book under review aims to provide.

Dynamical theory may be regarded as composed of three parts: kinematic theory, dynamical principles, and mathematical techniques for the solution of problems. Kinematic theory is based only on pure geometry and the concept of time and is thus not, properly speaking, dynamics at all. However, the analysis of every dynamical problem must begin with a thorough kinematic investigation, and when this has been made and the results assimilated, the application of the truly dynamical principles is usually easy. In my opinion, the importance of kinematics has been greatly under-estimated in recent times. It is therefore pleasing to find that due attention to kinematics is paid in this treatise. The first chapters cover basic kinematics, the dynamics of a particle and the dynamics of sets of particles. Next, Chapters 4–7 give an outline of the kinematics and dynamics of fluids, with sections on vortices and the application of the complex variable, while Chapters 8–9 are concerned with the theory of aerofoil-in two and three dimensions. Chapter 10 deals very briefly (and it must be said, too briefly) with viscosity, turbulence and the applications of dimensional analysis. The next two chapters are concerned with the kinematics and dynamics of rigid bodies, and the final chapters deal with the oscillations of dynamical systems having one or a larger finite number of degrees of freedom.

I can sum up my opinion of this book by saying that it gives a competent account of basic dynamics for students of aeronautical engineering from the point of view of one experienced teacher. Many readers will be disappointed to find that the more advanced topics of aeronautical dynamics, such as the theories of stability and control and of flutter, are not discussed at all. The title of the book is, indeed, rather misleading in this respect.

W. J. Duncan

THE ADVANCE OF PLANT PHYSIOLOGY

Annual Review of Plant Physiology

Edited by Daniel I. Arnon, in association with Leonard Machlis. Vol. 5. Pp. x+400. (Stanford, Calif.: Annual Reviews, Inc., 1954.) 7 dollars.

With the publication of its fifth volume the "Annual Review of Plant Physiology" may claim to be well established. The present volume follows the same lines as its predecessors and contains fourteen articles on different aspects of plant physiology. While some of these cover a wide field, such as that on tropisms and nastic movements (L. Brauner), or deal with subjects of considerable appeal to plant physiologists, such as the long article on photosynthesis (R. Lumby, J. D. Spikes and H. Eyring) with no less than 401 references, that on the connected subject of the photosynthetic function of pigments other than chlorophyll (L. R. Blinks) and the one on the occurrence, formation and inactivation of auxins (S. A. Gordon), others deal with matters of which knowledge is perhaps not so widely distributed, even among plant physiologists. Among such might be included the articles on the physiology of plant tumours (A. C. Braun), dormancy in woody plants (R. M. Samish), the post harvest physiology of fruits and vegetables (W. T. Pentzer and P. H. Heinze), the physiological aspects of fungus diseases of plants (P. J. Allen), and the role of plant physiology in plant geography (H. L. Mason and P. R. Stout). Yet, with the exception of the last-named, none of these articles has less than a hundred references to literature.

Of the subjects dealt with in the present volume, perhaps those in which advances in knowledge are most spectacular concern enzymes. One of these, by W. D. McElroy and A. Nason, is on micronutrient elements in enzyme systems; the other, by D. A. Goddard and H. A. Stafford, deals with the localization of enzymes in the cells of higher plants. A perusal of these reviews cannot fail to impress on the reader the real progress that has been made in these subjects during the past few years. Thirty years ago, that such things as trace elements were essential for plants had scarcely been accepted by plant physiologists in general. Ten years ago, by which time the necessity for trace elements was well recognized, their function was obscure and a matter for conjecture. The article by McElroy and Nason now shows strikingly how widespread is the necessity for one or other of these elements for the activation of enzymes. Iron and copper enzyme systems, as well as some involving magnesium, have been known for some time, but now McElroy and Nason list more than twenty enzymes which are activated by manganese, and they conclude that manganese is the chief metal concerned in general enzymatic decarboxylation and hydrolysis. Zinc and magnesium appear to be similarly involved to some extent. Manganese, though not to the same extent as magnesium, appears also to be required for enzyme actions involving group transference. Copper, iron and molybdenum are concerned with electron-transferring systems.

A few years ago knowledge of the subject here dealt with by Goddard and Stafford was negligible. Now at the end of their article on the localization of enzymes in the cell they list 101 references, 90 per cent of which refer to publications that have appeared not earlier than 1950. The extension of knowledge of enzyme systems to include their localization in the cell has resulted from the new technique of differential centrifugation of cell-free homogenates, by which a partial separation at least of cell constituents such as nuclei, plastids, mitochondria and microsomes is attempted. While the authors of the review show that the results so far obtained must be accepted with caution, it seems clear that the development of this line of investigation gives promise of information of the greatest importance in the not distant future.

Another article dealing with a new development is that on soil conditioners by J. H. Quastel. While the importance of the natural soil conditioner, humus, has been known for centuries and, maybe, thousands of years, it is only during the past few years that the possibility of using synthetic substances for improving poorly aggregated soils has been indicated. This article gives a clear account of the nature of the synthetic soil conditioners and their effects on soil, and will be read with interest by pedologists as well as by plant physiologists.

The remaining two articles are on nutrition by foliar application (D. Boynton), and the mineral nutrition of phytoplankton (B. H. Ketchum). The former, concerned as it is with the effect of sprays, will be of particular interest to pomologists, while the latter will be of special appeal to that growing band of physiologists who use unicellular algae, as providing reproducible material, for their investigations. Once again the editors and contributors are to be congratulated on providing for their fellow plant physiologists a most useful and welcome volume.

Walter Stiles

The World of Learning, 1954

Fifth edition. Pp. xii+1030. (London: Europa Publications, Limited, 1954.) 100*s.* net.

THE fourth edition of the "World of Learning" was published in 1947, and though it was very useful at the time to have this reference book so soon after the Second World War, it was not really so valuable as it at first sight seemed, in that the information relating to a number of countries that had been devastated by the War, was not up to date. The new fifth edition, besides being as up to date as such a compilation as this can be, is a good deal enlarged; in particular, it opens with a new section on Unesco, giving its origins, aims, functions and organization as well as an account of its recent activities, and this is followed by a list of the principal international scientific organizations, with brief statements of their objects and the names of their main officials.

The rest of the book follows the plan of the previous edition. It is divided alphabetically (by English name) into the various countries of the world, and, where the entries for a country are sufficiently numerous, a contents list is given. The arrangement of entries for Great Britain gives an idea of the range of institutions, etc., covered: learned societies and professional associations; research institutes; libraries; museums and art galleries; universities and university colleges; centres for adult and technical education; schools of art, music and dramatic art; and educational trusts. Naturally, the range of headings varies somewhat from country to country. In general, the entry for each institution contains its address, the names of the leading officials and the date of foundation, and for each university a complete list of all the professors is given. Where applicable, the titles of publications issued by the body concerned are listed. A useful section of the book is that on the U.S.S.R., which is twenty-nine pages long; no universities are quoted, but a very full list of the numerous higher educational institutions and research establishments in the U.S.S.R. is given.

The book ends with a fifty-four page index of institutions, with more than two hundred entries per page. There is no name index. Other reference books exist covering universities and the more academic bodies to be found in the various countries of the world, and in this particular field the "World of Learning" is no more comprehensive, probably less so. But where it scores over the other books is in the very complete lists of non-university organizations such as learned societies, professional organizations, museums, etc., and for this it can be recommended.

Public Health Engineering

By Peter C. G. Isaac. (Spon's Civil Engineering Series.) Pp. xvii+277. (London: E. and F. N. Spon, Ltd., 1953.) 36*s.* net.

THE average member of the public in Britain is apt to take things for granted and has little conception of the magnitude and complexity of the undertakings which deal with unhealthy products and supply him with pure water, 10–15 per cent of which he wastes. These and kindred activities are now classed under the heading of public health engineering, and this book under review is a welcome introduction to the subject. Nearly half of it is given up to water, its sources, collection, quality, analysis, treatment and distribution. Fifty pages are devoted to sewage and its purification—the ever-growing problem of river pollution is given a separate chapter—and the methods of treatment of trade wastes are illustrated by a number of specific examples. After discussion of refuse disposal and atmospheric pollution, the author concludes with a chapter on district heating, a subject which scarcely comes under the heading of sanitary engineering but one which is to be welcomed in view of its importance and the necessity of propaganda to induce the British public to revise its ideas on the subject of warming houses.

It is obviously impossible in one small volume to deal with all the subjects mentioned above in any detail, but the author has succeeded in giving an immense amount of information and, in addition, in presenting it in a readable and interesting manner. As the result of a stay in the United States, he has been able in many cases to quote American practice and to compare it with British, and there can be few people, even among sanitary experts, who will find nothing that is new to them. For the benefit of those wishing to go more deeply into a subject, numerous references are given at the end of each chapter. "Public Health Engineering" was written primarily for students and sanitary engineers; but it is to be hoped that it will attract the attention of a far larger circle of readers, since the matters dealt with are of vital importance to all. H. E. W.

Table of Binomial Coefficients

Prepared for the Mathematical Tables Committees of the British Association and the Royal Society, under the Editorship of J. C. P. Miller. (Royal Society Mathematical Tables—Vol. 3.) Pp. viii+162. (Cambridge: At the University Press, 1954.) 35*s.* net.

THIS volume is actually the second of those to appear under Royal Society auspices as a consequence of the Cunningham Bequest of 1928, the first being E. H. Neville's "The Farey Series of Order 1025" (1950). Many establishments have co-operated in its production, including the National Physical Laboratory and the Royal Aircraft Establishment. As the computation of the tables was fairly simple, there is no need for a lengthy introduction. The basis of the calculations was the elementary recurrence formula of Pascal's triangle, and no further details or formulæ have been included.

All the tabulated values are exact, in order to meet the requirements of number theory (the primary object of the Cunningham Bequest). For values of n up to and including 200, every value of the binomial coefficient $\binom{n}{r}$ for each value of r up to $\frac{1}{2}n$ is supplied, and the maximum coefficient (or pair of coefficients) appears in bold type. This tabulation, which forms the main part of the book, occupies a hundred and three pages in all. The remaining sixty pages are devoted to higher values of n, as far as 5,000, with corresponding entries for small values of r only, first up to 12 and then (as n increases) 11, 5 and finally 3.

A page index, showing at a glance where any particular coefficient may be found, is supplied on p. 1, and there is also a list of references to publications used or consulted. The whole book is beautifully produced, in the highest traditions of the Cambridge University Press. J. H. PEARCE

THE JUBILEE OF THE THERMIONIC VALVE

ON November 16, 1904, Prof. J. A. Fleming first described, in British Patent Specification No. 24850, the application of a two-electrode thermionic valve to the rectification of alternating currents of high or, as we now term them, radio frequencies. The jubilee of this invention was celebrated on November 16 last at a special meeting of the Institution of Electrical Engineers, at which lectures on the history and development of thermionic devices were given, and an exhibition of some 240 different types of valves was opened. The widespread interest in the occasion was evident from the fact that the members present filled to capacity the lecture theatre of the Institution.

Earlier in the day, the Marquess of Salisbury, Lord President of the Council, unveiled a plaque to the memory of Sir Ambrose Fleming, F.R.S., at University College, London, the birthplace of the valve, where Fleming was professor of electrical engineering during 1885–1926. Lady Fleming was present at this ceremony, at which Lord Salisbury recalled that this invention of the thermionic valve was the starting-point for the vast developments of the present day in the field of electronics.

During the period November 16–18, an exhibition was held in the Electrical Laboratories of University College, at which were displayed a large and historical collection of lamps, valves and electrical measuring equipment which, together with laboratory and lecture manuscript notebooks and a collection of published works, represented Fleming's wide range of interests and great contributions to electrical engineering. It was very appropriate that the exhibition should include demonstrations of current research in progress in the College laboratories, illustrating new techniques for measurement at very high radio frequencies and the study of wave propagation along conducting surfaces.

The meeting at the Institution of Electrical Engineers was opened by Lord Salisbury, who directed attention to the significance of the discovery of the thermionic valve by Sir Ambrose Fleming, whose inspiration carried him far beyond the work of previous investigators and so enabled him to add further lustre to the record of British scientists. Lord Salisbury referred to the fact that the birth of the thermionic valve was one of the most far-reaching events of the past half-century; and he directed attention to the remarkable technological applications to which the principle of the valve pointed the way. Wireless transmission, broadcasting, television, radar and radio aids to navigation and surveying, he pointed out, have all been exploited within the past few decades; and we appear to be only just at the beginning of a vast new era of the application of electronics to industrial techniques and processes. Many of the necessary processes of modern industry —sorting, testing, measuring, etc.—are fatiguing and boring tasks, and much progress has been made, particularly in the United States, in exploiting the new techniques, which open up a vista of relief from exhaustion and increased leisure for the whole working population. Lord Salisbury concluded his address with the following remarks: "Let us, then, regard this jubilee not only as an occasion for looking back with thanks and admiration to Sir Ambrose Fleming for all that we owe him, and with gratitude to those who have followed him, but also as an occasion for looking forward, for straining forward, towards that land of promise which his genius has brought within our sight, and almost within our grasp".

The president of the Institution, Mr. J. Eccles, then welcomed Lady Fleming and expressed the hope that she would find that the large number of members present had assembled in a sincere effort to pay tribute to the great work of her late husband.

Prof. G. W. O. Howe then delivered a lecture entitled "The Genesis of the Thermionic Valve", in the early part of which he outlined Fleming's early life and education at the University of London and later at Cambridge, where he studied under Clerk Maxwell. While holding an appointment with the Edison Electric Light Co., Fleming visited the United States in 1884, when Edison exhibited an interesting discovery which he had made the year before. He had fixed a metal plate in the bulb of a carbon filament lamp, and he found that a current flowed through a galvanometer connected between the metal plate and the positive terminal of the filament. No current was indicated, however, when the connexion was made to the negative terminal of the filament. This phenomenon, which was afterwards known as the 'Edison effect', was applied to the control of the mains voltage in a power station, but Edison made no use of it for telegraphy. This matter greatly interested Fleming and he conducted several investigations on it from 1890 onwards, in the course of which he showed that a similar but smaller effect was obtained when platinum was used instead of carbon for the incandescent filament.

Nearly ten years later, when Fleming had become scientific adviser to the Marconi Co., he had much to do with the design and equipment of the wireless station at Poldhu, from which the first trans-Atlantic signals were transmitted in December 1901. It was in October 1904, twenty years after his visit to the United States, that it suddenly occurred to him that the Edison effect could be used for rectifying or 'detecting' alternating currents of high frequency, such as those occurring in the circuits of a wireless receiver. After making some confirmatory experiments, Fleming, at the age of fifty-five, applied for a patent for the two-electrode thermionic valve on November 16, 1904. This valve, or diode as we now term it, could be in several forms; but each of these comprised a filament, which could be heated to incandescence, and an insulated metal electrode, both sealed inside an evacuated envelope. Fleming found later that better results in the detection of wireless signals could be obtained when the valve was constructed with a tungsten filament and an insulated copper cylinder surrounding it. Almost concurrently, Wehnelt had noted that if a filament was coated with certain oxides, the emission of electrons was greatly facilitated; hence currents could be obtained with a lower temperature, with corresponding greater sensitiveness and convenience of operation.

The next step in the evolution of the thermionic valve was made by Dr. Lee de Forest, who had been working in the United States on similar lines to Fleming. In 1906, de Forest applied for a patent for a three-electrode valve as a device for amplifying feeble electric currents, by using a voltage on the grid or intermediate electrode to control the current flowing to the plate or anode. A few months later, the patent was extended to cover the use of the three-electrode valve, or 'audion' as de Forest termed it, as a detector of oscillations in a wireless telegraphy receiver.

After these events, a period of several years elapsed before the thermionic valve, in either its two- or three-electrode form, found any great practical use in the reception of wireless signals. This was partly due to the fact that the technique of the production of high vacua had to be considerably improved before valves could be made and used with anything like a reliable performance; but it was also due to the advanced development of such reliable and sensitive devices as the magnetic and crystal detectors. It was about 1913 before H. J. Round in Britain and other workers in the United States began successfully to apply the valve to wireless reception; and it was really during the First World War that the development of the 'hard' or high-vacuum valve was applied successfully on a large scale to the amplification of audio- and radio-frequency currents in radio reception.

The story was continued in a lecture on "Thermionic Devices from the Development of the Triode up to 1939" by Sir Edward Appleton, who emphasized the fact that de Forest's objective was to obtain a sensitive and controllable detector, for which purpose it was considered essential that there should be some residual gas in the audion. Sir Edward pointed out that in the basic de Forest patent, granted in 1908, a radio-receiving circuit is shown with a grid condenser, and this is deemed to be the invention of what is now called cumulative grid rectification. But it still needed some years of investigation by other workers before the mode of action of the three-electrode valve and its remarkable potentialities were fully recognized. Notable in this phase of development was the work of E. H. Armstrong, who described, in papers published during 1914–15, experiments which did so much to elucidate the function of the triode as a detector and to show the advantage of applying back coupling or retro-action to reinforce the oscillations. He also dealt with the use of the three-electrode valve as a generator of oscillations and for reception on the heterodyne beat principle. Armstrong took advantage of the work of Langmuir in obtaining valves with a very high vacuum, and in consequence he found it necessary to use a high-resistance shunt to the grid condenser in order to control the 'squegging' action, which was sometimes troublesome in the reception of signals with hard valves.

In the meantime, workers in other countries were not idle: following a patent in 1911, von Lieben and Reisz described a soft three-electrode valve containing mercury vapour and its use as a relay or amplifier. The British pioneer workers, H. J. Round and C. S. Franklin, after experimenting with these and other soft valves, appreciated the advantages of the high vacuum and produced some notable valves which achieved an outstanding reputation at the beginning of the First World War. Following the lead when the Americans entered the War in Europe, the French workers under General Ferrié developed the celebrated *R*-type hard valve, which had a cylindrical anode and a spiral grid, the filament being along the axis of both.

By the end of the War, the three-electrode valve, or triode, was really understood; but it was the only valve in common use as a detector, amplifier or generator of high-frequency oscillations. Broadcasting was, in fact, started with the triode, although its limitations were by that time well recognized. To reduce the unwanted inter-electrode coupling between grid and anode, A. W. Hull suggested the insertion of another electrode; and it remained for Round to introduce the screen-grid valve, or tetrode, into practical use in 1926. This brought under consideration the phenomenon of secondary emission from the anode; to reduce this, the insertion of a suppressor grid was proposed by B. D. H. Tellegen, of the Philips organization in Holland, who thus became the inventor of the pentode, a valve which has since become very popular for many purposes.

During the period up to 1939, the two-electrode valve of Fleming had been employed almost solely as a rectifier for alternating currents at power frequency; but near the end of this period, this diode came back into use as a high-frequency detector; and also, by means of a suitable circuit, as an automatic control of the grid bias on the 'variable mu' type of valve, permitting the output from the receiver to be maintained at a sensibly constant level.

In the later portion of his lecture, Sir Edward referred to the use of the thermionic valve as an electrical instrument. While ordinary triodes were found very suitable for use in, for example, E. B. Moullin's valve voltmeter, it required special design to produce an electrometer triode with a low input capacity and a very high insulation resistance for the grid. Such valves have, however, been found very useful for a number of purposes such as the study of the change in the earth's electric field due to lightning flashes. In the period up to 1939, the valve had become a most versatile and important tool in many fields of scientific research, quite apart from its application to radio communication, broadcasting and television.

At the evening session of the meeting at the Institution, Dr. J. Thomson gave a lecture on "Developments in Thermionic Devices since 1939". It was first pointed out that during the period under review the valve has undergone extensive development, not only for radio reception, but also as an amplifier to give a steadily increasing power output in transmitters of all types. But the uses of the valve have now become very widespread; and in analysing the functions of thermionic devices in modern electronic equipment, Dr. Thomson directed attention to the fact that the valve is like an engine, performing the same duties in the electronic machine as the steam or internal combustion engine in the mechanical machine. The unique property of the electronic device is its high speed of operation. This has been exploited by the radio scientist in the development and use of microwave systems; while others are using valves for control and computing mechanisms.

Dr. Thomson made specific reference, with the aid of slides, to the various types of valve now in use for the generation and reception of centimetre-wave frequencies; and gave an explanation of the action of the klystron and its analogous relationship with the travelling-wave tube and the magnetron. He also illustrated the recent developments in the miniature and sub-miniature types of valve, and the various steps which have been taken to make valves increasingly reliable in operation. Dr. Thomson pointed out that valves are already completely reliable so far as home radio and television sets are concerned; at the same time, he emphasized the fact that the universal application of electronic machinery in offices, factories and in means of transport depends largely upon the reliability of electronic components.

The lecture closed with a brief speculation as to the future. While some may be of the opinion that an electronic valve or tube should never be used if it can be avoided, it is an essential item for high-speed operation. While this speed is still too low for many modern applications, it is likely that in the next half-century this speed of control will be exploited in all fields of activity.

An expression of thanks to the lecturers was made by Mr. C. W. Oatley, chairman of the Radio Section of the Institution, and by Sir Gordon Radley, vice-president of the Institution; Sir Gordon remarked that if Sir Ambrose Fleming could have been present at this jubilee celebration of his invention, he would have been thrilled by the very large family that has sprung from the original and simple diode, and the variety of parts they have played in peace and in war.

R. L. Smith-Rose

PHYSICAL RESEARCH LABORATORY, AHMEDABAD

By Dr. K. R. RAMANATHAN

Director

A RESEARCH laboratory for the study of cosmic rays was started at Ahmedabad in 1947 by a private body called the Karmakshetra Educational Foundation. During the past seven years, with generous assistance from the Ahmedabad Education Society, the Government of Bombay, the Ministry of Scientific Research and the Atomic Energy Commission of India, the Physical Research Laboratory, as it is known, has steadily expanded and widened its scientific interests. The foundation stone of its new building was laid by Sir Chandrashekhar Venkata Raman in 1952 and the building was opened by the Prime Minister, Shri Jawahar Lal Nehru, on April 10, 1954.

The building is in the Gujarat University campus, and facing it are the laboratories of the Ahmedabad Textile Industry's Research Association (see *Nature*, Sept. 25, p. 578) and the Lalbhai Dalpatbhai College of Engineering. In a large field, west of the Laboratory, are a 72-ft. wind tower, radio masts and an experimental hut for ionospheric research. The central wing of the Laboratory runs east to west and has two floors. Nine research rooms on the first floor and five on the ground floor are accommodated in this wing. For cosmic ray measurements, one of the research rooms on the first floor has a specially constructed light roof of aluminium. A conveniently accessible terrace on the first floor is used for observational work on the sun and the sky. The central wing of the Laboratory on the ground floor connects at one end to the library and a seminar room. The staircase is situated at the western end of the central wing, where there is also an experimental area with a high ceiling. This is flanked by the workshop, the dark room, the store and a preparation section. Adjoining the workshop is a yard and a carpentry shop.

The initial research programme of the Laboratory was decided by the interests of its principal scientific workers: Prof. Vikram Sarabhai, who started the Laboratory, is concerned with studying the time variations of cosmic rays and the light they throw on the sources of cosmic rays; the present writer is interested in problems of atmospheric physics such as atmospheric ozone and its distribution, night air-glow and problems of the ionosphere. The programme of the Laboratory at the moment comprises an integrated study of the different kinds of radiations which are received on the earth and their geophysical consequences. In order to carry out such a programme satisfactorily, two more Departments, one of Theoretical Physics and another of Radiophysics and Electronics, were added in 1949. With thirty research workers drawn from different parts of the country, the Physical Research Laboratory at Ahmedabad is now an established centre for advanced study and research in experimental and theoretical physics in western India.

Department of Atmospheric Physics. In India the Council of Scientific and Industrial Research has for many years supported a research scheme for the study of atmospheric ozone and the weather, and, with the co-operation of the India Meteorological Department, three ozone-measuring stations have been established at Delhi, Mt. Abu and Veraval. Work done in India has shown that the amount of ozone in low latitudes up to 20° N. is small and nearly constant in different seasons, and is little affected by weather. On the other hand, in European latitudes, the amount of ozone is larger and more variable from day to day. In Indian latitudes north of 20° N., during the months May–November, the amount of ozone continues to be small and steady, but increases markedly in winter. Between December and April there are large quasi-periodic increases of ozone associated with variations of high-level winds in the upper atmosphere. Studies of the vertical distribution of ozone in the atmosphere that have been made over Delhi, Mt. Abu, Poona and Kodaikanal have established that the tropical troposphere which extends to nearly ten miles above the ground contains only small quantities of ozone, but that, as one goes to higher latitudes, more and more ozone comes down to lower levels. The change from the tropical type of ozone distribution to the extra-tropical type appears to take place in the region of high-level jet streams of westerly upper winds. The study of the correlated variations of atmospheric ozone at a number of places promises to throw light on the general circulation of the atmosphere at levels not otherwise easily accessible to observation.

An important discovery has resulted from careful ozone measurements made during moonlight. It has been shown that there is a daily variation in the amount of ozone in Indian latitudes, there being an excess of ozone during the night.

Besides the work on the ozone content of the atmosphere, a large number of radiosonde ascents have been made at Ahmedabad to study the daily and the day-to-day variations of temperature and humidity in the upper atmosphere. They have considerably increased our knowledge of the upper atmosphere over north-west India, and have also been of help in interpreting the corresponding variations of cosmic ray intensities.

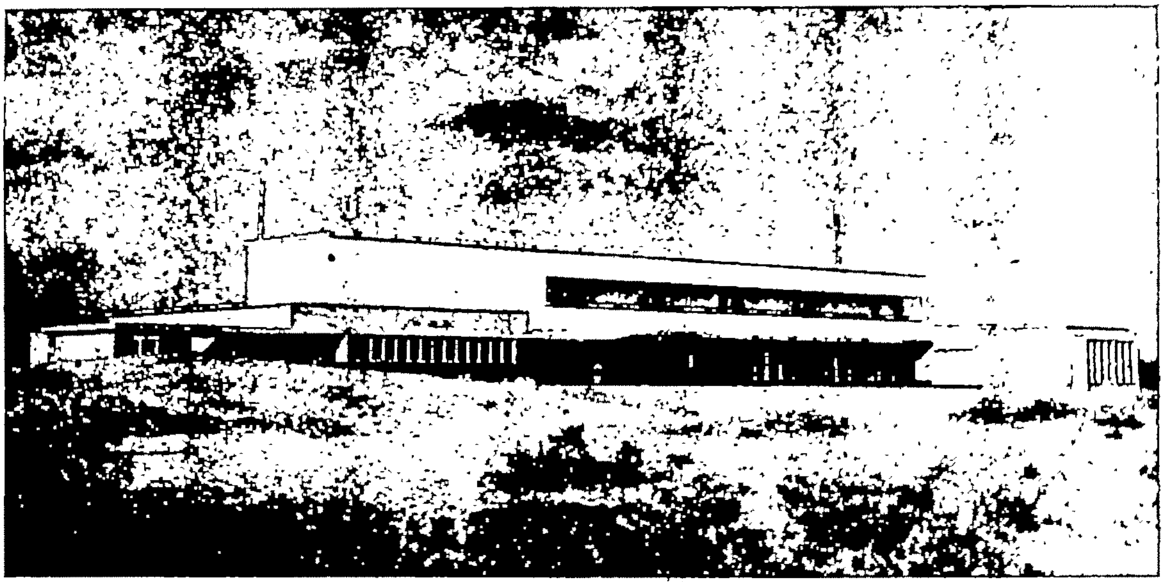

Photo. by J. M. Shah

Physical Research Laboratory, Ahmedabad

Studies of twilight sky intensities and polarizations have been undertaken using a photo-multiplier. Measurements on the brightness of the sky in different narrow spectral bands have been carried out at Mt. Abu from sunset to a time when full night conditions have set in. Observations show that, after the sun has gone down 5°–6° below the horizon, there is very much more light coming from the sky than can be explained by the primary scattering of sunlight by the molecules of the upper atmosphere. Part of this is undoubtedly due to night air-glow, but there are possibly other causes, such as scattering by meteoric dust in the upper atmosphere. The problem is under investigation.

Cosmic Ray Department. Under Prof. Sarabhai, the Cosmic Ray Department has established continuous recording stations at Ahmedabad, Kodaikanal and Trivandrum. The second and third, almost at the magnetic equator, represent a mountain and a sea-level station, respectively. Observations collected over three years have shown clearly the value of directional studies with Geiger counter telescopes, with which the daily variations are larger and capable of more unambiguous interpretation than with ionization chambers.

In interpreting the experimental results, there are several factors which have to be taken into account: the atmospheric pressure, the heights of levels where cosmic-ray mesons are created, and the atmospheric temperatures near these levels. Work done at the Laboratory indicates that atmospheric mass absorption is the only important meteorological factor so far as the daily variation of the meson intensity is concerned, and its influence can be corrected for by using the known variations of atmospheric pressure. The geomagnetic effect being small, it is possible to attribute the daily variation of meson intensity, corrected for barometric pressure, to an anisotropy of the primary cosmic rays. For the daily variations of the soft electronic component and the atmospheric shower intensity there are, however, more complicated relationships with meteorological factors. These involve, besides the total mass of the air column, its vertical distribution, depending on atmospheric temperatures at different levels.

The pressure-corrected daily variation of meson intensity, which can be attributed to the anisotropy of cosmic rays, has a maximum in the forenoon at low latitudes. The dependence of this maximum on local solar time has been interpreted as indicating that the anisotropy is under solar control. This is also supported by an analysis done by Sarabhai and Kane of the published cosmic-ray data of the Carnegie Institution stations. The analysis has led to the discovery that the daily variation of the meson intensity, corrected for pressure, undergoes large changes of world-wide character, and that these changes are connected with those in solar activity. As the simplest explanation, it has therefore been suggested that a small portion of the primary cosmic radiation originates in the sun. Sarabhai and Kane have also directed attention to a geomagnetic explanation for the difference in the daily variation studied at different latitudes and with apparatus pointing to different directions.

A comprehensive programme is now in progress at the Laboratory for developing an optimum technique for the study of the anisotropy of the primary radiation.

Department of Theoretical Physics. This Department, which was first under Dr. A. B. Bhatia and is now under Dr. Vachaspati, is concerned with fundamental theory and the problems of nuclear structure. Dr. Vachaspati and his colleagues have been interested in the question of nuclear radii and have recently suggested, on the basis of electron scattering and Coulomb energy data, that the nucleus might have some negative charge at its centre along with positive charge outside. Calculations are also being done on the scattering of π-mesons by nuclei, energy-levels of μ-mesonic atoms, alpha-decay lifetimes and some aspects of field theory. The Department gives regular courses in theoretical physics to post-graduate students.

Department of Radiophysics and Electronics. Work in this Department, which is now under Dr. U. D. Desai, is directed towards the systematic recording and analysis of the characteristics of the ionosphere at Ahmedabad with an automatic multi-frequency recorder. Hourly records of reflexions of radio waves have been obtained since February 1953, and monthly summaries of the data are published in the *Journal of Scientific and Industrial Research*. At present, Ahmedabad is one of the three stations in India at which round-the-clock observations of the ionosphere are being made.

Besides the main regions, E, F_1 and F_2, of the ionosphere, two intermediate layers between E and F_1 have been found to be regularly recorded, and these are being studied. A comparative study is also being made of the critical frequencies and heights of F_2 reflexion at different latitudes in India, and also the effect of magnetic storms and solar flares on the F_2 region. In addition, the true heights and thicknesses of the F_1 and F_2 regions, and the total electron content in a vertical column of the atmosphere up to the height of maximum electron density, are being examined. A radio pulse transmitter, aerials and recording receiver have been built for studying winds in the ionosphere on the lines of Mitra's method.

PERMANENT MAGNET ASSOCIATION

CENTRAL RESEARCH LABORATORY

THE research activities of the Permanent Magnet Association were conducted for many years by co-operative investigations carried out in the works laboratories of its members. The technical collaboration so fostered has many advantages and such work still continues; but in 1941 centralized research, more removed from the distractions of production problems, was commenced with the equipment housed temporarily in the Physics Department of the University of Sheffield, by courtesy of the University authorities.

In 1946 it became possible to proceed with the building of the first story of a laboratory in Brown Street, Sheffield. This building, opened in 1946, gave facilities for pilot manufacture and heat treatment of magnet castings. Physical, chemical and metallographic laboratories were included, and also a workshop for apparatus and instrument construction.

The original plans have recently been completed by the addition of a second story, and on November 8 representatives of the technical Press, of local industrial concerns and of scientific establishments were invited to view the laboratories and to see some of the work now in progress. The new story includes a heat-treatment laboratory, a library and conference room and also gives additional office and storage space. These extensions, in conjunction with the e-arrangement of the older laboratories, now give a rationalized lay-out of the various sections.

The laboratory is approved by the Department of Scientific and Industrial Research but is not grant-aided, being supported wholly by the manufacturing firms who are members of the Association. The director is not only responsible for the work of the Central Laboratory, but also keeps in close touch with the research activities in the laboratories of the members, thus promoting the continuation of that technical collaboration which has been found fruitful throughout the history of the Association. In these circumstances it would be invidious to distinguish between the technical progress of the Central Research Laboratory and of the Association as a whole.

The principal activity of the Laboratory lies in the development of new permanent-magnet materials and the improvement of the properties and of the economy of processing of the existing alloys. The high energy ($BH_{\max}$) of modern magnet alloys is only obtainable by the use of large percentages of expensive metals, and so the achievement of maximum properties with minimum consumption of alloy is a constant objective. In 1945 it was possible to introduce 'Alcomax II' with average $BH_{\max}$ 4·5 megagauss-oersted and coercivity 575 oersted. Work on a wide range of additions to the basic alloy led in 1948 to the discovery of the beneficial effects of niobium in small amounts. There followed the introduction of 'Alcomax III' with $BH_{\max}$ 5·0 megagauss-oersted, coercivity 670 oersted, and of 'Alcomax IV' with $BH_{\max}$ 4·5 megagauss-oersted, coercivity 750 oersted. Shortly afterwards it was predicted on theoretical grounds that similar anisotropic alloys with a common crystal axis instead of random orientation should have markedly improved properties. Considerable experimental work led in 1952 to laboratory production of 'Columax', with remanence 13,000–14,000 gauss, $BH_{\max}$ more than 8·5 megagauss-oersted, and coercivity 750–850 oersted. The production of the structure necessary for such properties requires that the solidification of the alloy should take place progressively from one face of the casting. A mould which is chilled on one face and heated on other faces to temperatures approaching the solidus temperature of the alloy is necessary. The study of the thermal conditions for a completely columnar structure and of practical means of obtaining columnar castings is an important part of the current work. The maximum properties obtained in the laboratory cannot yet be realized in quantity production, although marked improvement on random crystal material is possible.

The metallography of 'Alcomax' alloys is not fully understood, but the diagnosis of faults in composition or heat treatment by microscopic observation of the incipient development of two-phase structures has been of practical utility. Some remarkable macroscopic structures can be seen by the polishing and etching of 'Columax' specimens, which demonstrate well the effect of crystal orientation on the reflexion of light from an etched surface.

High-energy permanent magnets of complex composition have led to secondary problems. Magnets tend to smaller and smaller sizes, and the measurement of the normal B–H curve criteria on small pieces has required the development of modified apparatus and methods. New methods of chemical analysis have been necessary for alloys of increasing complexity. Electrolytic separation and the use of absorptiometric and chromatographic techniques have been found necessary. Here also the collaboration with works laboratories has been valuable, and the analytical methods standardized by the Association have been approved and published by the British Standards Institution.

With the support of the Electrical Research Association, investigations are proceeding on the stability of magnetization under extremes of temperature. Very little knowledge existed until recently on the effect of sub-zero temperatures, although there is now a definite practical interest down to −70° C. The nickel–aluminium magnet alloys are very resistant to demagnetization by heating, and so the observation in 'Alcomax' magnets of losses of magnetization to the extent of 1–4 per cent due to cooling to about −70° C. was surprising. It has been found that the coercivity of 'Alcomax' after normal heat treatment decreases reversibly with decreasing temperature between 0° and −180° C., but that this change can be reduced by modifications to the heat treatment. Any stabilization or ageing process which brings the working values of B and H for the magnet within the main hysteresis loop also eliminates the loss due to cooling.

Hysteresis motors are coming into general use as components of gyro and servo systems. The rotors of these motors require a hysteretic material of the permanent magnet type; but the operating conditions are not well defined and there have been few measurements made with non-saturating magnetic fields or of rotating rather than alternating hysteresis. It has become customary to use for these rotors one of the magnet steels, frequently in a metallurgical condition other than fully hardened. A large programme of measurements is in hand to provide a body of design data for this application and to check the optimum magnetic and metallurgical conditions for maximum utilization of material.

Fundamental physical research on high-coercivity materials has always occupied an important place in the work of the Central Research Laboratory of the Association. Measurements of magnetostriction and of anisotropy coefficients on 'Alcomax' alloys and their interpretation in the light of current ferromagnetic theory have been the basis of a series of published papers. This work, in conjunction with work elsewhere by X-ray and electron diffraction techniques and the electron microscope, has led to a better understanding of the origin of the preferred-domain orientation and high coercivity which is the basis of the nickel–aluminium–cobalt–iron alloys used for high-energy permanent magnets.

CHEMISTRY OF MUSCLE CONTRACTION

Contraction of Muscle without Fission of Adenosine Triphosphate or Creatine Phosphate

As Hill[1] has pointed out, it still remains to be proved that adenosine triphosphate is the immediate source of energy in the contracting muscle. The analytical methods now available for determining the individual phosphate fractions of animal tissues have made it possible to re-examine directly the relation between contraction and breakdown of adenosine triphosphate. Experiments are here reported which suggest that muscle can in fact do work under certain well-defined conditions without the decomposition of an energetically equivalent amount of adenosine triphosphate or creatine phosphate.

The crucial experiments were carried out on a slow muscle, the rectus abdominis of the frog, *Rana temporaria*, at 0° C. A slow muscle and a low temperature were chosen in order to reduce the rate of chemical processes. Pairs of muscles from the same animal were used in each experiment. One, left and right alternately, was stimulated while the second served as control. Otherwise both were treated in the same way. The muscles were stimulated either electrically, or by immersion in isotonic 0·765 per cent potassium chloride solution, or by immersion in 0·5 per cent caffeine–Ringer solution. The work done during contraction was calculated from the kymographic record[2]. After the attainment of contraction, the muscle and the control were quickly placed in liquid nitrogen. No contraction occurred in the controls on freezing as the muscles were thin and cold.

To determine the phosphate fractions, the frozen tissue was ground in a cold mortar and trichloroacetic acid solution was added to the frozen muscle powder. The mixture was allowed to melt at 0° C. and centrifuged. Creatine phosphate was determined in the supernatant according to Eggleton and Eggleton[3]. Two more samples were chromatographed on paper by a modification[4] of the methods of Eggleston and Hems[4] and Krebs and Hems[5] for the determination of the following six fractions: (*a*) creatine phosphate, (*b*) inorganic phosphate, (*c*) adenosine triphosphate, (*d*) adenosine diphosphate, (*e*) an 'unknown' fraction ('Dritte Fraktion' of Fleckenstein and Janke[6]), and (*f*) the total acid-soluble organic phosphate minus creatine phosphate. Recovery of added creatine phosphate, adenosine tri- or di-phosphate was quantitative[7]. The fractions $c + d + e$ form about two-thirds of f. The techniques are described in full elsewhere[4,6,8].

In the case of the potassium contracture, no significant change of adenosine tri- or di-phosphate occurred at 0° C. or 20° C., but the amounts of creatine phosphate decreased (Table 1). These findings are in agreement with the assumption that adenosine triphosphate decomposes but is almost at once regenerated by the transfer of phosphate from creatine phosphate to adenosine diphosphate. They are not in agreement with Bendall's[9] view that the

Table 1. CHANGES IN PHOSPHATE-CONTAINING COMPOUNDS AS A RESULT OF A SINGLE CONTRACTION AT 0° C. CAUSED BY IMMERSION FOR 45 SEC. IN 0·765 PER CENT POTASSIUM CHLORIDE SOLUTION

(All phosphorus estimations on each sample were carried out in duplicate and comparisons were made between the left and right side of the rectus abdominis from the same frog (*Rana temporaria*). The mean difference was obtained from the differences between the test and control of each pair of experiments. The muscles were cut off the support and frozen in liquid nitrogen. For further details see ref. 6). The absolute amounts and ratios of the various fractions vary with the time of year, so the controls in Tables 1–4 are not directly comparable with each other

Notes	Fraction *a* Creatine phosphate (µmol./gm.)	 (*a* + *b*) Creatine phosphate + the inorganic phosphorus (µmol P/gm.)	 *c* Adenosine triphosphate (µmol./gm.)	 *d* Adenosine diphosphate (µmol./gm.)	 *e* An unknown fraction ('Dritte', ref. 6) (µmol. P/gm.)	Work done by the muscle (gm. cm./gm.)
8 pairs Test		18·5	1·80	1·44	2·10	136 ± 8
8 pairs Control		18·0	1·85	1·53	2·59	—
4 pairs Test	5·90					81 ± 5
4 pairs Control	7·44					—
Mean difference	− 1·45	− 0·5	− 0·05	− 0·09	− 0·49	
Standard error of mean difference	± 0·25	± 0·5	± 0·02	± 0·06	± 0·16	

Table 2. CHANGES IN PHOSPHATE-CONTAINING COMPOUNDS AS A RESULT OF A SINGLE CONTRACTION AT 20° OR 0° C. PRODUCED BY 2½ MIN. IMMERSION IN 1 PER CENT CAFFEINE–RINGER SOLUTION
(Other details as in Table 1. For further details see ref. 8)

Notes	Fraction					Work done by the muscle (gm. cm./gm.)
	a Creatine phosphate (μmol./gm.)	(*a* + *b*) Creatine phosphate + the inorganic phosphorus (μmol P/gm.)	*c* Adenosine triphosphate (μmol./gm.)	*d* Adenosine diphosphate (μmol./gm.)	*e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	
20° C.						
6 pairs Test		19·9	1·20	1·17	0·91	162 ± 23
6 pairs Control		16·3	2·13	1·05	1·68	
6 pairs Test	0·57					154 ± 19
6 pairs Control	6·68					
Mean difference	− 6·11	+ 3·62	− 0·93	+ 0·12	− 0·77	
Standard error of mean difference	± 0·37	± 0·31	± 0·12	± 0·068	± 0·26	
0° C.						
6 pairs Test		17·4	2·17	0·92	1·66	109 ± 15
6 pairs Control		17·3	2·21	1·03	1·77	
5 pairs Test	2·65					82 ± 4·1
5 pairs Control	6·36					
Mean difference	− 3·71	+ 0·1	− 0·04	− 0·11	− 0·11	
Standard error of mean difference	± 0·60	± 0·87	± 0·09	± 0·06	± 0·26	

Table 3. CHANGES IN PHOSPHATE-CONTAINING COMPOUNDS AS A RESULT OF A SINGLE CONTRACTION AT 20° OR 0° C. CAUSED BY 1·0–1·2 SEC ELECTRIC STIMULATION
(The muscles were frozen *in situ* on the support. Other details as in Table 1. For further details see ref. 2)

Notes	Fraction						Work done by the muscle (gm. cm./gm.)
	a Creatine phosphate (μmol./gm.)	(*a* + *b*) Creatine phosphate + the inorganic phosphorus (μmol. P/gm.)	*c* Adenosine triphosphate (μmol./gm.)	*d* Adenosine diphosphate (μmol./gm.)	*e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	*f* Total organic phosphorus — the creatine phosphate (μmol. P/gm.)	
20° C							
12 pairs Test*	11·25	24·93	2·77	0·87	1·14	15·36	190 ± 11·1
12 pairs Control	13·32	25·70	2·77	0·91	1·20	16·53	[47·7 ± 4·4]†
Mean difference	− 2·07	− 0·77	0·00	− 0·04	− 0·06	− 1·17	
Standard error of mean difference	± 0·38	± 0·51	± 0·053	± 0·049	± 0·14	± 0·33	
0° C.							
20 pairs Test	11·46	22·21	2·82	0·71	0·96	15·50	125·3 ± 20·8
20 pairs Control	11·14	21·96	2·80	0·70	0·93	15·70	0 ± 0·0
Mean difference	+ 0·32	+ 0·25	+ 0·02	+ 0·01	+ 0·03	− 0·20	
Standard error of mean difference	± 0·20	± 0·39	± 0·040	± 0·032	± 0·078	± 0·27	

* In this series the total acid-soluble phosphorus in the test muscles was less than in the control muscles. Fraction (*a* + *b*) represented 61·9 per cent of the acid-soluble phosphorus in the test series and 60·9 per cent in the control series. For further details see ref. 2.
† The control muscles contracted somewhat on freezing. This did not occur with control muscles at 0° C.

Table 4. CHANGES IN PHOSPHATE-CONTAINING COMPOUNDS AS A RESULT OF A SINGLE CONTRACTION AT 0° CAUSED BY 1·3–3·5 SEC. ELECTRIC STIMULATION AFTER 20 MIN. PRETREATMENT WITH 5×10^{-4} *M* 2 : 4-DINITROPHENOL
(The muscles were frozen *in situ* on the support. Other details as in Table 1)

Notes	Fraction						Workdone by the muscle (gm. cm./gm.)
	a Creatine phosphate (μmol./gm.)	(*a* + *b*) Creatine phosphate + the inorganic phosphate (μmol. P/gm.)	*c* Adenosine triphosphate (μmol./gm.)	*d* Adenosine diphosphate (μmol./gm.)	*e* An unknown fraction ('Dritte', ref. 6) (μmol. P/gm.)	*f* Total organic phosphorus– the creatine phosphate (μmol. P/gm.)	
12 pairs Test	0·58	21·18	1·76	0·91	0·31	12·44	109·8 ± 4·7
12 pairs Control	0·62	20·77	1·75	0·87	0·29	13·14	0 ± 0·0
Mean difference	− 0·04	+ 0·41	+ 0·01	+ 0·04	0·02	− 0·70	
Standard error of mean difference	± 0·100	± 0·45	± 0·048	± 0·040	± 0·073	± 0·306	

adenosine triphosphate-level must fall during contraction.

In the case of the caffeine contracture, a decrease of adenosine triphosphate and creatine phosphate and an increase in adenosine diphosphate and inorganic phosphate occurred at 20° C. At 0° C. the results were similar to those with potassium chloride (Table 2). The results show that the methods used were capable of detecting changes in the concentrations of these compounds.

In the case of contracture due to electrical stimuli (12 stimuli per sec. by condenser discharge and direct stimulation of the muscle), no change in adenosine tri- and di-phosphate took place at 20° C., whereas the concentration of creatine phosphate fell (Table 3). At 0° C. no adenosine tri- or di-phosphate or creatine phosphate disappeared; but there was a decrease in fraction (*f*) and an increase in inorganic phosphate. This was sufficient to account for the work done on the assumption that the inorganic phosphate was derived from an 'energy-rich' phosphate, and that the efficiency approached 100 per cent. The nature of the organic phosphate that released inorganic phosphate under these conditions is unknown. It is being investigated. It should be pointed out that the period of contraction on electrical stimulation was 0·9–1·2 sec. and that creatine phosphate breakdown occurred after electrical stimulation for several seconds even at 0° C. When potassium chloride or caffeine was the stimulant a much longer period of incubation of 15 sec. or $2\frac{1}{2}$ min. was required because, *inter alia*, of the relatively slow penetration of these agents.

These experiments support the view that muscular contraction can occur without decomposition of adenosine triphosphate or creatine phosphate[2]. However, the expected decrease in the concentration of creatine phosphate present, assuming 100 per cent efficiency, was only 3 per cent of the total creatine phosphate present. Statistical analysis shows that the chance that this decrease occurred but had escaped detection was only 28 per 1,000. Nevertheless, it was thought desirable to find conditions where the expected change in the concentration of creatine phosphate would be greater on a percentage basis. Pre-incubation for 20 min. at 20° C. with 5×10^{-4} *M* 2 : 4-dinitrophenol produced such conditions. This treatment reduced the creatine phosphate content of the tissue from about 11 μmoles per gm. to 0·6 μmoles per gm., but the muscles still contracted vigorously even at 0° C. (though they were unable to relax). In this material the expected decrease in creatine phosphate concentration was 50 per cent or more; yet there was again no significant change in the adenosine tri- and di-phosphate and creatine phosphate fractions, while the fraction *f* decreased and the inorganic phosphate increased (Table 4). It should be noted that the low level of creatine phosphate rendered any rephosphorylation of adenosine diphosphate from this source thermodynamically highly improbable.

To exclude the possibility that creatine phosphate or adenosine triphosphate was resynthesized at the expense of respiration during the duration of the experiments (1·3–3·5 sec.), the rate of recovery of creatine phosphate, after electrical stimulation for 1 min., was measured. At best, resynthesis was thirty times lower than required for the non-disappearance of creatine phosphate. A similar large discrepancy was obtained from calculations based on the rates of respiration of stimulated muscle and maximum possible values for the efficiency of oxidative phosphorylation.

The results show that, though a breakdown of creatine phosphate (and under some conditions even of adenosine triphosphate) can be observed after contractions lasting several seconds or more produced by electrical stimulation, potassium chloride or caffeine, such a breakdown did not occur in the rapid contractions at 0° C.

In conclusion, it may be said on the basis of the electrical experiments at 0° C., especially those in the presence of dinitrophenol, that muscle has been shown to do work without the fission of energetically equivalent quantities of adenosine triphosphate or creatine phosphate. Inorganic phosphate was, however, liberated during contraction, from an unidentified precursor in just sufficient quantities to supply the required energy, provided the phosphate undergoing fission was 'energy-rich'.

It follows that there is a source of energy in living muscle which either can synthesize adenosine triphosphate from the diphosphate at a rapid rate (like creatine phosphate), or which is closer to the process of contraction than the breakdown of adenosine triphosphate. Whether this source is the 'phosphate-bond energy' of an unidentified compound or an entirely different kind of source such as ionic concentration gradients[10] remains to be investigated.

A full account of this work will be published elsewhere.

In the following communication, Dr. W. F. H. M. Mommaerts presents results obtained independently which are concordant with those presented here and elsewhere[2,6,8].

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Is Adenosine Triphosphate broken down during a Single Muscle Twitch ?

THE widespread assumption that muscular contraction is caused by enzymatic hydrolysis of adenosine triphosphate is based on two types of not entirely direct evidence[1–3]. On one hand, biochemical research has demonstrated that metabolic processes such as respiration and glycolysis, which indirectly support muscular activity, do so by virtue of the synthesis of adenosine triphosphate. On the other hand, various interactions between adenosine triphosphate and muscle proteins have been described, culminating in the contraction (induced by adenosine triphosphate) of actomyosin threads and extracted muscle fibres discovered by Szent-Györgyi. Yet a direct demonstration of the role of adenosine triphosphate in living muscle has not been given, notwithstanding A. V. Hill's[4] call for such a straightforward approach.

In the present work, of which a full account will be submitted to the *American Journal of Physiology*, an attempt has been made to demonstrate the breakdown of adenosine triphosphate and of phosphocreatine during the course of a single twitch. Experiments were carried out on symmetrical pairs of leg muscles of the turtle, *Pseudemys elegans*, one of which was stimulated, while the other acted as the control. At a chosen moment, early or late in the contraction, the muscles were suddenly immersed in liquid propane, cooled to −185° C., by means of a mechanical device effecting this immersion in about 6 m.sec., the twitch itself lasting 2–8 sec. at low temperature. The muscles were loaded so as to perform approximately maximal work and their movements were recorded on a revolving drum. In all instances, the cooling procedure caused immediate stopping of the muscle at the moment of immersion, whereas temperature measurements inside muscles, with a thermocouple and cathode ray oscillograph, showed precipitous cooling without delay.

It was anticipated that if the contraction of muscle were caused by a fission of adenosine triphosphate or phosphocreatine, this fission would amount to 0·3–

0·5 μmol. per gm. of tissue[2,3]. In designing the analytical procedures, it was held that it would be difficult to prove or disprove the occurrence of such a degree of breakdown of adenosine triphosphate or phosphocreatine by direct determination of these substances, since they occur in amounts which are large in proportion to the change anticipated to take place in one twitch. It was decided, instead, to determine the possible breakdown products, adenosine di- and mono-phosphate and creatine. In addition, creatinine was also determined, although its formation would be rather improbable; finally, pyruvate was determined to cover the possibility of a rephosphorylation of adenosine diphosphate by phosphopyruvate formed, for example, from phosphoglycerate. The analyses of creatine and creatinine were carried out colorimetrically, by the Voges–Proskauer and the Jaffe reactions, respectively. All the other analyses were carried out by differential enzymatic spectrophotometry: adenosine monophosphate with adenylate deaminase; pyruvate with lactic dehydrogenase and reduced diphosphopyridine nucleotide; adenosine diphosphate by phosphorylation with phosphopyruvate and pyruvate phosphokinase, followed by assay of the pyruvate so formed. The results of assaying inosinic acid as a possible end-product (measured with 5-nucleotidase, nucleoside phosphorylase and xanthine oxidase) are still subject to some experimental uncertainty, but are in all probability negative.

In Table 1, results of these analyses are collected for various times throughout the contraction and the relaxation phases. It is seen that in no case was any significant change found in the amount of adenosine mono- or di-phosphate or creatine. Creatinine and pyruvate were likewise unchanged. Fluctuations of the individual pairs—always within 0·1 μmol. and usually within 0·05 μmol.—are entirely random, and a systematic variation of the expected magnitude is therefore excluded.

It may be said with certainty that a breakdown of adenosine triphosphate or phosphocreatine could not have been reversed by metabolism, since both aerobic and anaerobic recovery are known to occur only well after a single twitch. The experiments described were carried out anaerobically, in a mixture of nitrogen and carbon dioxide or in helium; a few aerobic experiments gave the same result.

Table 1. CHANGE IN CONCENTRATION OF THE MAIN REACTION PRODUCTS (IN μMOL PER GM.) DURING THE COURSE OF MUSCLE TWITCH

	Δ ADP	Δ AMP	Δ Creatine
Early contraction	− 0·07		+ 0·07
	0·00		
	+ 0·04	0·00	+ 0·01
	− 0·07		
	+ 0·06		− 0·03
		− 0·04	+ 0·04
Ascending phase	− 0·08		+ 0·06
		0·00	− 0·03
	− 0·03	0·00	0·00
	− 0·06	+ 0·01	+ 0·07
		− 0·01	
	− 0·02		− 0·03
	+ 0·03		
Peak of contraction	0·00		− 0·05
	+ 0·02	0·00	0·00
	− 0·01	− 0·03	+ 0·07
	− 0·02	0·00	− 0·10
			− 0·09
	+ 0·01		+ 0·03
	+ 0·05	0·00	− 0·03
Relaxation	− 0·02	0·00	0·00
	+ 0·03	0·00	− 0·09
			+ 0·10
	− 0·19		0·00
Mean change during contraction phase	− 0·01	0·00	+ 0·01
Mean change during relaxation phase	− 0·01	0·00	− 0·01

Since we are at present investigating the possible role of other nucleotides, it is considered premature to discuss in full the possible implications of these results for our understanding of muscle. However, the possibility of a new "Revolution in Muscle Physiology"[6] is clearly discernible.

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OBITUARY

Dr. R. S. Wilson

ROBERT SHARP WILSON, Fellow of the Research School of Physical Sciences in the Australian National University, died in Canberra on October 4 at the age of thirty-eight. He was a leading member of the team working under Prof. M. L. Oliphant on the design of a 10-GeV. proton synchrotron.

Born in Lancashire, Wilson graduated at Cambridge in 1938 and continued with research in nuclear physics at Liverpool under Sir James Chadwick. Throughout the war years he was a scientific officer at the Telecommunications Research Establishment, Malvern. At the beginning he worked on the development and use of radar in night-fighters for air interception. Later he became a valued member of the Radio Countermeasures Division engaged on denying to the enemy much of the advantage of his radar and radio systems. This work had a significant effect in reducing Allied losses, both in air operations over Germany and in the invasion of Europe.

In 1945 Wilson joined Prof. Oliphant at Birmingham, where he was responsible for the radio-frequency system of the 60-in. cyclotron. While there he completed his thesis for Ph.D. (Liverpool), making an analysis of the theory of cyclotrons. In 1951 he was the first Fellow to be appointed in the Research School of Physical Sciences of the newly established Australian National University. Here he investigated the possibilities of various radio-frequency systems for the several high-energy particle accelerators that were under consideration, and at the time of his death was working on the system chosen for the 10-GeV. air-cored synchrotron. He visited laboratories in the United States and Britain in 1953 in order to study the latest developments in synchrotron design and report on the possible value to the Canberra machine of the revolutionary strong-focusing system.

Wilson was much valued for his clear thinking on policy and his fundamental approach to the physics of the problems with which both he and his colleagues were associated. He lived up to and helped to spread the best traditions of physics as taught in Britain.

Dr. Wilson has left a wife and three sons.

J. W. BLAMEY

NEWS and VIEWS

Australian Atomic Energy Commission: Prof. C. N. Watson-Munro

The Australian Atomic Energy Commission has announced the appointment of Prof. C. N. Watson-Munro, professor of physics in Victoria University College, New Zealand, to the position of Chief of Research and Development. The Australian Government has already approved a programme of construction of a nuclear research reactor and research laboratories in New South Wales, and these will be the first objective of the scientific team to be built up under the direction of Prof. Watson-Munro. Prof. Watson-Munro, who is thirty-nine years of age, was born in New Zealand and educated at Victoria University College, Wellington. During 1936–39 he was employed by the New Zealand Department of Scientific and Industrial Research as a geophysicist; he published a paper on a reconnaissance magnetic survey of the New Zealand thermal regions (now being used for the production of heavy water) and one on a radioactive survey of New Zealand rocks and soils. In 1939 he transferred to radar work, and after a year in 1941 with the American radar team at the Massachusetts Institute of Technology, he became director of the New Zealand Radar Development Laboratory. In addition to meeting the needs of the New Zealand Armed Forces, this Laboratory supplied the Royal Navy with thirty radar sets and the U.S. Forces in the Pacific with ten mobile radar sets. Prof. Watson-Munro went into the Pacific war theatre with the sets supplied to the United States and was given the honorary rank of major.

In mid-1944, Prof. Watson-Munro led a group of New Zealand scientists sent to join the British–Canadian group of atomic energy workers in Montreal and at Chalk River. He took a leading part in the design and construction of the first Canadian heavy-water pile (ZEEP) and was responsible for the control equipment. In 1945 Prof. Watson-Munro went to England and was in charge of the design and construction of the first pile in the United Kingdom (GLEEP). He returned to New Zealand in 1948 to take over the position of deputy secretary of the Department of Scientific and Industrial Research in charge of all the physical, geophysical and engineering activities of that Department. He was also scientific adviser to the Armed Forces and attended two meetings of the Commonwealth Defence Scientific Advisory Committee. He took up his present appointment to the chair of physics at Victoria University College in 1951.

Division of Fisheries, C.S.I.R.O., Australia: Dr. H. Thompson

Dr. Harold Thompson, the founder and for seventeen years the chief of the Division of Fisheries of the Commonwealth Scientific and Industrial Research Organization, Australia, is to retire shortly at the age of sixty-four. Dr. Thompson is a Scot, born in Aberdeen in 1890, and from 1920, after service in the army during the First World War, he was for ten years scientific adviser of the Fishery Board for Scotland, gaining a D.Sc. of the University of Aberdeen in 1927 for his work on the natural fluctuations in the stocks of haddock. In 1930 he became director of fishery research in Newfoundland, a post which he left six years later to take up his present appointment in Australia. Although the Second World War halted many of the advances which he had planned, Dr. Thompson gave valuable service during this period as comptroller of fisheries in the Department of War Organization of Industry. The programme of research and exploration was resumed in 1946 and has continued with much benefit to the Australian fisheries and world fisheries science. The Division has contributed considerably to the establishment and extension of the whale, tuna, crayfish and shark fisheries; it has shown the need to relax the fishing pressure on certain kinds of fish, while indicating others that might be used to take their place, and it has made considerable strides in the study of the movement and fertility of Australian sea-water masses on which all marine life depends. Dr. Thompson leaves behind him a large body of knowledge of Australian fisheries and a thriving Division to carry on his work.

Industrial Power from Nuclear Energy

A Friday Evening Discourse was delivered at the Royal Institution, London, on December 3 by Sir Christopher Hinton, deputy controller of atomic energy (production), Ministry of Supply, his subject being "Industrial Power from Nuclear Energy". In his address, Sir Christopher explained that, whereas in the burning of hydrocarbon fuels to obtain heat only the extra-nuclear electrons of the atoms are disturbed, the production of heat from atomic fuels involves nuclear transformations, the most easily performed such transformation being nuclear fission. The only naturally occurring element which can be induced to carry out a chain reaction, whereby neutrons emitted from the fission of a nucleus cause fission in further nuclei, is the 235 isotope of uranium, and this process is used in the atomic pile, in which most of the large quantity of energy evolved is in the form of heat. The uranium pile reaction forms the artificial element plutonium, which is bred by neutron irradiation of the uranium-238 isotope and subsequent radioactive decay, and is also fissionable. To effect a balance between the neutrons used for fission and the neutrons used for breeding plutonium, a moderator is used, which slows down the emitted fast neutrons, making them more readily available to carry out the fission process. The graphite-moderated air-cooled piles at Windscale are not designed to utilize the heat evolved, the waste heat being ejected up the stacks; but the graphite-moderated carbon dioxide-cooled piles at Calder Hall will produce heat of high enough grade to raise steam suitable for electricity generation. A further type of reactor, called a breeder reactor, is envisaged, which will use enriched fuel and fast neutrons and which, besides producing useful heat, may produce fissile material in excess of its fuel consumption. Although the estimated cost of nuclear electricity is some 50 per cent above the cost of electricity produced by the most modern power station, Sir Christopher considers that the real cost should fall as techniques improve and a reasonable price is quoted for the fissile material bred in the piles. Thus he envisages the future programme as consisting of a chain of thermal reactors producing plutonium as a by-product, followed by the use of this plutonium in the fast reactor or breeder pile.

University College, London: Restoration of War-damaged Buildings

On November 30 a celebration was held in University College, London, to mark the restoration of the original College buildings in the main quadrangle, which were destroyed by enemy action during 1940–41. The present visitor to the College will find it difficult to realize the degree of damage which was suffered, so remarkable is the recovery that has since been made. Nearly fifty thousand square feet were totally destroyed and another fifty thousand were almost completely gutted by fire. The destruction included all the historic buildings of the College and much else, including the Physics Laboratory and the Great Hall. Fortunately, the College has been able to extend its site between Gower Street and Gordon Square to an area of twelve acres, and this has already given opportunities for the beginning of long-delayed expansions. The first block of the new Physics Building, a handsome and effective series of laboratories, has been completed. Industry has contributed to a preliminary stage in the development of the Chemistry Department. The College authorities feel that the most pressing need of the moment is for a new Great Hall, since at present the only assembly room is the Gustave Tuck Theatre, which, though a beautiful building, houses less than two hundred. As the provost of the College, Dr. B. Ifor Evans, pointed out at the celebration, University College, London, has a very worthy place in the history of university education in Great Britain. Founded in 1828 as a centre for university instruction and research without any restrictions of race or religious faith, it has grown during the past century and a quarter in a notable way until its present student population is three thousand five hundred. Though the standing of a university institution does not rest solely on its architecture and setting, it is worthy of notice that the concepts of the College's original founders were matched by those of the architect, William Wilkins. He provided the College on its then newly acquired site in Gower Street with what John Summerson has described as its "tremendously grand portico raised on a great podium with steps"; to this were added later the Flaxman Gallery and the Donaldson Library, and a quadrangle was formed with the Slade School, the Bartlett School of Architecture and buildings for the Faculty of Arts and the School of Egyptology.

Advisory Committee on the Protection of Birds

The Home Secretary has appointed the following to be members of the Advisory Committee on the Protection of Birds for England and Wales: Sir A. Landsborough Thomson (*chairman*), Miss P. Barclay-Smith, Mr. P. E. Brown, Colonel R. S. Clarke, Mr. J. M. Craster, Mr. James Fisher, Mr. William Foster, Mr. Nigel Laing, Captain S. T. A. Livingstone-Learmonth, Mr. G. R. Mountfort, Mr. E. M. Nicholson, Major-General A. G. O'Carroll-Scott, Mr. Peter Scott and Mr. H. N. Southern. The Advisory Committee is appointed under the Protection of Birds Act, 1954, which came into force on December 1. The Act protects all wild birds, their nests and eggs, subject to specified exceptions; in particular, owners or occupiers of land may take action against specified harmful birds, and specified sporting birds may be shot outside the close season. The Act also restricts the sale and importation of birds and eggs and enables sanctuaries to be created.

Commonwealth Bursaries Scheme of the Royal Society and Nuffield Foundation: Awards

Awards under the Commonwealth Bursaries Scheme of the Royal Society and Nuffield Foundation have been made to the following: Dr. A. d'A. Bellairs, reader in anatomy, St. Mary's Hospital Medical School, London, to study material in South Africa during June–September 1955, in connexion with his work on the morphology and development of the vertebrate skull; Dr. D. A. Brown, senior lecturer in geology, Otago University, to study type-collections of the fossil Cyclostomatous and Cryptostomatous Polyzoa principally in London and Cambridge during 1955; Prof. S. N. De, professor of pathology, Nilratan Sircar Medical College, Calcutta, to study at University College Hospital Medical School, London, during June–September 1955, the mechanism of action of the cholera vibrio; Dr. A. J. Matty, lecturer in zoology, University of Nottingham, to visit Bermuda during March–September 1955 to extend his observations on the thyroid gland of bony fish; Dr. T. A. O'Donnell, lecturer in chemistry, University of Melbourne, to study inorganic fluorides at Cambridge during 1955; Dr. J. C. Smith, demonstrator and lecturer in chemistry, University of Oxford, to visit Pretoria and Melbourne during January–September 1955, to study methods of research on the chemistry of fats and waxes; Mr. W. Thomson, of the Rowett Research Institute, Aberdeenshire, to study sheep nutrition projects in Australia and New Zealand; and Prof. A. Wood, professor of geology, University College of Wales, Aberystwyth, to extend his researches, in Australia during January–May 1955, on the wall structure of the Foraminifera, to type and topotype material. This is the second group of awards under the scheme, which was instituted in 1953 to provide facilities for increasing the efficiency of scientists of proved ability by enabling them to pursue research, learn techniques or follow other forms of study in natural science in countries other than their own in the British Commonwealth.

Central Glass and Ceramic Research Institute, India: New Bulletin

The Central Glass and Ceramic Research Institute, which was opened in Calcutta in 1950, has now issued its first quarterly *Bulletin*, "devoted to the cause of the advancement of glass, ceramic and allied science and industries" (1, No. 1; August 1954; pp. 44; annual subscription Rs. 6 or 12*s.*; single issues Rs. 2 or 4*s.*). It is stated that each *Bulletin* will include a discussion of important current topics relating to the ceramic industry, and in India, as in the United States, the ceramic industry is taken to include the manufacture of glass and vitreous enamels in addition to pottery, clay building materials and refractories to which the term is confined in Britain and Western Europe generally. The *Bulletin* will also contain technical articles, manufacturers' experience, articles on production and quality control, new developments, answers to inquiries, trade statistics, news and reviews, books and abstracts. In this first issue there are two technical articles. The first deals with glass containers suitable for distilled water and is by Atma Ram (director of the Institute), S. P. Krishnaswamy, P. Roy and Sudhir Sen; original work is reported in a well-written manner, and definite recommendations are made for the benefit of the Indian glass manufacturer. The second technical article is on saggars for use in the pottery industry, and is an abridgment of a paper previously published in the *Journal of Scientific and Industrial Research* [India]. The *Bulletin* is well produced, and provides a good illustration of the change in outlook that is taking place in India at the present time.

Insects and the Diseases of Conifers in New Zealand

In "New Zealand Forest Research Notes" (1, No. 8; October 1953. Wellington: Government Printer), the forest pathologist, G. B. Rawlings, discusses insects of *Pinus radiata* forests in New Zealand, giving a list of all the insects known to have any connexion with *Pinus radiata* forests in the country. *P. radiata* is an introduced exotic species of conifer and has been widely planted. Introduced exotics, whether forest or agricultural, planted as pure crops on a large scale in many parts of the world, have proved to be very subject to attack by fungus or insect pests, some of which are of local origin, and the others introduced. With the presence of extensive pure crops in the countryside, the danger becomes greatly aggravated, and heavy losses may be entailed by the dangerous attempts to provide within short periods rapid-growing crops to supply either an existing demand or to obtain high financial returns. There are countries where the introduction of exotics (New Zealand is an instance) to increase the area of forests in the country is fully justified. The Forest Department of New Zealand commenced planting conifer exotics early in the present century. Private companies took up the work, with the result that many large areas of exotic conifers, such as *P. radiata*, for example, exist in pure blocks. Coleoptera and Lepidoptera (for example, *Tortrix*) may prove exceptionally dangerous, attacks once started spreading with great rapidity and getting the upper hand. An annotated list has been compiled with the main objective of recording all insects known to have any connexion with *P. radiata* forests in New Zealand. As the author writes, it is important for the forest officer to understand at least the rudiments of the life-histories of the insects, because species thought to be unimportant may suddenly become significant under certain conditions. It is not only in Europe where the forest officer has had to face sudden outbreaks of this type; the more dangerous are new countries where forestry conditions are not so well understood, and unknown and untried exotics have been introduced.

Society for the Promotion of Nature Reserves: Handbook for 1954

The handbook for 1954 of the Society for the Promotion of Nature Reserves (pp. 64+8 plates; from the Society, c/o British Museum (Natural History), London, 1954; 5*s*.) includes the annual report and financial statement for the year ended March 31, 1954. The lease of Wood Walton Fen to the Nature Conservancy has greatly reduced the Society's outgoings, and its membership has increased. Further, it is no longer necessary to keep in being the many regional investigation committees set up some years ago, some of which have been converted into committees of local natural history societies or trusts. At the annual meeting of the Council on July 1, 1954, the president, Lord Hurcomb, emphasized the ability of the Society to stimulate public interest in, and support for, the Nature Conservancy and said that the Society also endeavours to extend such interest and support to the protection of flora and fauna and scenic beauty elsewhere, in close association with the International Union for the Protection of Nature and the British Co-ordinating Committee for Nature Conservation. The Society is also able and ready to give financial support for the preservation of areas which may not on scientific grounds justify in present circumstances the limited funds of the Nature Conservancy but need and merit protection before they are lost for ever. Specific examples of how this has been done in Lincolnshire are given in a lecture on the Lincolnshire Naturalists' Trust, delivered by Mr. A. E. Smith at the annual meeting of the Society on July 1 and which is published in the handbook. The handbook also includes an illustrated account, by Mr. E. J. Mason, of the island of Steep Holm, in the Bristol Channel, and the Steep Holm Trust; a note by Mr. F. H. W. Green on the progress of the Nature Conservancy in the acquisition and safeguarding of sites of special scientific interest; a note on the Nature Protection Conference at Beirut; and an illustrated account, by Dr. L. Machwa, of experiments which the Lower Austrian Nature Protection authorities have made with propaganda posters on Nature protection.

Exhibition of Historic Astronomical Books

The exhibition of historic astronomical books which is currently being held at the Science Museum, London (see *Nature*, August 14, p. 298), is one of a series designed to illustrate science and technology and their histories by means of the written word or pictorial representation, as distinct from the actual apparatus or products. In addition to those in the Science Museum's own possession, the Royal Astronomical Society has lent many valuable books. The catalogue of the exhibition (Museum Book Exhibition No. 3: Historic Astronomical Books. By G. H. Adams and H. R. Calvert. Pp. 29. London: H.M.S.O., 1954. 2*s*. net) contains the titles of seventy-five books, the first of which is Newton's "Philosophiæ Naturalis Principia Mathematica" (1687) and the last Struve's "Stellarum Duplicium et Multiplicium Mensuræ Micrometricæ" (1837). No books published within the past hundred years have been included, for which reason modern works (such as those of Einstein, Eddington, Jeans and Lockyer) which rank as historic books are not mentioned. When books are published in a language other than English, a short title, sufficient for identification, is first given in the original language, followed by an English translation of some or all of the original title. An alphabetical index of authors appears at the end of the catalogue.

Announcements

Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, has been granted leave of absence for the current academic year by the University. Prof. Dirac is now visiting the Tata Institute of Fundamental Research at Bombay, where he is staying until early in 1955, after which he is proceeding via Japan and Vancouver to the United States for a short visit, and then to the National Research Council of Canada at Ottawa.

Erratum. In the article entitled "Differentiation of Growing and Non-growing Bacteria by a Staining Technique" in *Nature* of November 13, on p. 921, col. 2, line 35, the time of staining should read "30–60 sec.", not "30–60 min." as printed.

NEW NATURE RESERVES IN ENGLAND AND WALES

THREE new nature reserves in England and one in Wales were declared by the Nature Conservancy on November 24, and a further two acres were added to the Bridgwater Bay Nature Reserve, by the declaration of Steart Island, off the mouth of the River Parret, on the termination of an existing tenancy. Steart Island, which is separated from the mainland at high tide by half a mile of water, is the roosting-place for hundreds of geese, mainly white-fronted geese, and is the only known area in Britain where moulting shelduck gather each summer; for this reason it is hoped to keep the island entirely undisturbed.

Cwm Idwal Nature Reserve, the first Welsh nature reserve, and the first to be declared in a national park, is a natural amphitheatre rising to above 3,200 ft. in the heart of Snowdonia National Park, about four miles north of Snowdon, and this 984-acre area has been leased to the Conservancy by the National Trust, subject to existing farm tenancies. Its wide variety of volcanic rocks carries an interesting flora, dating from immediately after or even before the latest Ice Age. Green spleenwort, lloydia, purple saxifrage, water lobelia and quillwort are found there. The University College of North Wales, Bangor, will continue to use Cwm Idwal for botanical, research and teaching purposes, and the Conservancy's own work will probably include work on the inter-relation of vegetation and soils and the effect of grazing on some of the important plant communities. Climbers and mountaineers accustomed to visit the area will find no change in access; but formal applications must be made for research in the Reserve or for collecting specimens of animals or plants.

Blelham Bog Nature Reserve, lying on the north-western edge of Blelham Tarn, three and a half miles south-west of Ambleside, is a rare example of the development of sphagnum bog from wet wild woodland, very little of which now remains. The vegetation is mainly *Sphagnum–Molinia–Myrica* bog with unusual species such as great sundew, white beak-sedge and downy sedge and many of the bog mosses characteristic of this type of transitional environment. Of the caddis flies found there, *Limnophilus xanthodes* McLachlan, extremely rare elsewhere in the Lake District, is fairly abundant. Access will not be restricted; but permits will be required for the collection of animals or plants in the Reserve.

The chief interest of Hartland Moor Nature Reserve, which covers 178 acres close to the Conservancy's Research Station at Furzebrook and is about one and a half miles south-east of Wareham, Dorset, is the domination of the vegetation in parts by the rare Dorset heath (*Erica ciliaris*). Other rare bog plants are also found in the Reserve, and there are interesting local variations in the flora, probably related to differences in the drainage. Public access will not at present be restricted; but permits will be required for collecting.

Arne Nature Reserve is a small section of Big Wood, about two and a half miles east of Wareham, and is one of the two known places in the country which show the natural transition from dry woodland to salt marsh—a brackish tidal condition. Parts of the wood probably represent the remains of the primitive broad-leaved forest; but it also contains such interesting features as the rare royal fern (*Osmunda regalis*) in a natural habitat. There are valuable potentialities for scientific research, notably into the effects of water-logging and the transition between salt marsh and either woodland or heathland. Cord grass (*Spartina townsendii*) is present on the seaward fringe, where studies will be linked to the experiments on coastal vegetation at Bridgwater Bay. Permission to visit will be required, and also authority to undertake research or collect specimens.

INSTITUTE OF PERSONNEL MANAGEMENT

ANNUAL CONFERENCE

AT the forty-first annual conference of the Institute of Personnel Management, which was held at Harrogate during October 8–10, the opening speaker was Admiral Sir Denis Boyd, principal of Ashridge College. On the general theme of leadership, Sir Denis said that he is convinced that people cannot be trained in its most important aspects. In leadership there is a combination of technique and personality; the technique can and should be taught to everyone in any kind of authority, the crux of the technique being administration. Problems are not solved by inspired decisions, he continued, but by constant thought, intelligent anticipation, waiting, foresight, patience and organization—that is, administration. The delegation of responsibility is the key to wise administration. Among the attributes of leaders are enthusiasm, austerity, sincerity, courage and humility.

Sir Miles Thomas, chairman of the British Overseas Airways Corporation, discussed the changing pattern of British industrial management. First, he said, there was the development of specialized management—the breakdown of management into a variety of techniques. In the early days of British industry and up to the early years of the twentieth century, the 'boss' of the firm was the owner. He alone carried the risk of losses and reaped the reward of profit; it was his financial credit, and that of the bank, which determined how easily he could get fresh capital for expansion. The owner naturally had the undisputed right to 'hire and fire' when and how he liked and, within broad limits, to pay just as much or as little regard as he felt inclined to working conditions or to wages.

Gradually, the demands of technical development, commercial competition and, above all, of the pressing need to raise more capital to keep pace with the growing scale of operations and expansion, produced two changes almost simultaneously. First, the owner found that, to obtain the necessary capital, he was compelled to turn the concern into a joint stock company, with ownership in the hands of the stockholders, while he himself was appointed managing director. Secondly, the scale of the managerial problem presented by the growth in size and complexity of the business meant that no longer could he, even as managing director, deal with every side of the business himself. From this situation there emerged the manager as a person and a position to be respected. He became the final authority from whom originated instructions on policy and on their execution. Inevitably there grew up specialists in the various branches of management. Production and sales were the first to be clearly separated, and these were followed by various dichotomies and drafting processes until, by the end of the First World War, the familiar pattern of production, sales, finance, research, planning and buying was becoming the general rule.

This division of labour at the highest level called at once for a better quality of general management than had hitherto been required. The second feature of the industrial and commercial management scene was the changing balance of emphasis and importance between the several elements of specialist management. The period immediately after the First World War was mainly one of developing the selling power of British goods. Consumers had to be found and shown that their interest was best served by buying a particular line of goods. Above all, the sales manager had to have sufficient authority to see to it that the technical or production departments produced the goods he wanted. In response to the developing authority of the sales department, powerful incentive was also provided for the development of research in industry, both of a fundamental nature and in the various technological processes. This era of the growing power of sales management was succeeded by the development of financial management. The growing complexity of the financial structure of the big joint stock company, the stringent requirements of the various Company Acts and the ever-pressing pressure of the Inland Revenue, produced a demand for experts in this field to be represented in the executive management of most concerns of any size.

The end of the Second World War saw the emergence into a new importance of the latest development of specialized management—personnel. Due to the immensely significant social and economic changes in the years immediately following the Second World War, there was at once an overwhelming and critical demand from men and women in industry to be regarded each as individuals with rights and responsibilities. This meant that the element of executive management which should be the last which any managing director wishes to delegate became rapidly of vast and specialized importance in the form of a personnel or employee relations department. This further specialization of management into personnel or staff management shows the emergence of the conception of the responsibility of industry to society.

There seem to be three main ways in which developing economic and social patterns have emphasized the importance of personnel management since the War. First, the significance of the individual has been underlined in a purely practical way. It has been generally appreciated that the application of large sums of money and intense research effort by the best technical brains available to securing and devising exactly the right piece of equipment to perform a certain job can be rendered largely nugatory if the men and women who operate it are so ill-suited to the task that they do not get the best out of it. Secondly, society's demand for equality and justice generally bears directly on the personnel manager's job. In this context there is also the vastly important field of relations with the trade unions. Thirdly, the personnel function has been heavily emphasized by the vast range of problems involved in getting more out of a group of people than the sum of their individual efforts.

Mr. C. J. Geddes, president of the Trades Union Congress, considered the role of trade unions in the future. During and after the Second World War, he said, there has been a profound change in the attitude of the trade union movement, and an attempt is being made to avoid a clash with employers and management. In the immediately foreseeable future, however, the fundamental purpose of the trade union movement will not change, nor will officials cease to strive in every possible way to get every farthing they can for their members. They will not abandon their right to use force. The driving spirit of the trade union movement does not rest with the leader, nor is the policy determined by the leader, but by the individual member.

There has been no fundamental change in the outlook, purpose or objective of the trade union movement, continued Mr. Geddes. The trade union leader is no longer a bitter enemy of the employer; but he is not yet his friend. There is not the slightest hope in the foreseeable future of the trade union movement agreeing to a national wages policy, not only because of the extreme difficulty of trying to devise one, but also because the trade union movement would largely sacrifice its purpose if it did so.

Will the trade unions demand a greater share in the management of industry? Mr. Geddes thinks they will, and it may be one of the major differences between the trade union movement and the employers in the immediate future. This does not mean that trade unions are going to demand that they must have joint control, but that they should become more and more equal with management and have much more information about the operation of particular industries.

Looking at the industrial scene, Mr. J. B. Priestley, the author, declared that there is a danger that our highly industrialized urban life may rob men of so many of the primary satisfactions that, in their sense of frustration and resentment, they may create a society so violent that it will explode in our faces. There are certain things men and women want: the English love to use their energy intermittently—they do not want to use the same amount every day, or to be harnessed to something keeping a regular tempo. He hoped that, as industry develops, it will be possible to make machines gear themselves to men and not men to machines. Everything—even employment and hours of work—is too regular: people do the same dullish job too long. We are in danger of creating a highly industrialized society which has lost all feeling for the soul or for any notion of man as a spiritual being—a society that might imitate the cruelties of ancient Rome to release its feelings of frustration.

The second danger in this industrial age, continued Mr. Priestley, is that the future organization of human affairs may deteriorate because we are not producing good human beings to take charge of them. We spend thousands of pounds on education, but to what end? It is no good pouring money into a school unless we are going to spend money and take time and trouble over the street outside the school; environment will always defeat education. Looking at Britain as an environment, it is important to think of the forces playing on the people personnel managers have to handle: we should think of the way such people are not encouraged to think for themselves at all. The reason why young working people are not showing any sort of enterprise is the recent creation of a complete mass working-class culture.

To keep industry going, we need a fair proportion of young men and women who are individuals with initiative, who think for themselves and have some sense of mental and spiritual development. We should do everything to make that possible, because we do not want our great-grandchildren to be living in an ant-heap and to be indistinguishable from the robots they might be making to serve them.

A valuable feature of the Conference was a number of 'brains trusts' sessions at which experienced personnel officers answered questions on such varied themes as work and health; management training courses; wage differentials; and discipline and full employment. T. H. Hawkins

NUTRITION AND THE ALIMENTARY TRACT IN MAN

THE Scottish Group of the Nutrition Society held a conference in Dundee on October 23 on "Disorders of the Alimentary Tract and their Nutritional Effects". In discussing disorders of fat absorption, Dr. J. M. French (Department of Pharmacology, University of Birmingham) said that fat absorption is defective in many clinical conditions, often as part of a generalized absorptive defect. Assessment of the degree of defect of fat absorption cannot be made by microscopic examination or percentage fat in the wet or dry fæces, and some type of fat balance must be employed. A continuous study of fat absorption, using the rapid daily fatty-acid estimation of Kamer, Huinink and Weijers, is essential if results of treatment or other procedures are to be assessed in a reasonable period of time. The accumulation of data with the same rapidity by the use of balances at intervals is precluded by the great day-to-day variability shown by subjects with defective fat absorption. The continuous method is especially applicable to such problems as the effective replacement therapy of pancreatic insufficiency with various types of pancreatic extract.

Wheat and rye gluten as a causative factor in cœliac disease, originally demonstrated in Holland by Dicke, Weijers and Kamer, has been amply confirmed in Britain. Although many adult cases of idiopathic steatorrhœa have a history of cœliac disease in childhood, the response of the adult to a wheat gluten-free diet is disappointing. Five cases of complete recovery have been recorded, however, suggesting that it is the basic factor. Failures may be due to superimposed vitamin deficiency, sensitivity to factors other than wheat and rye protein, or increased bacterial growth in the rich medium provided by the slow absorption of food. Evidence for the latter in tropical sprue has been provided by the use of intestinal chemotherapy.

Specific infection, dietary deficiency and tropical conditions are unsatisfactory as theories for the primary cause of tropical sprue. Considerable evidence has been accumulated to suggest that oxidative rancidity of unsaturated cooking oils may start tropical sprue, the intestine being irritated by some chemical constituent. This evidence is provided by the fact that sprue is rare in tropical countries such as Africa where saturated fats are consumed, but common in India and the Far East where cooking oils, such as rapeseed, sesame and mustard oil, are consumed. The high incidence in India among European and Indian troops during 1942–45 coincided with a change in dietary fat intake both in quantity and type, which would be in conformity with this theory. Experimental support is given by work in rats, which rapidly develop diarrhœa, steatorrhœa, emaciation, anæmia and death, if fed on rancid unsaturated fats.

Dr. R. H. Girdwood (Department of Medicine, University of Edinburgh) spoke on the occurrence of vitamin-deficiency conditions related to disorders of the alimentary tract. Conditions that interfere with vitamin intake include destruction of the area of the stomach that secretes the 'intrinsic factor'; rapid passage of vitamins particularly as a result of fistulæ; stagnant or blind loops of small intestine; and disease of the intestine or mesenteric glands.

Clinical impressions of specific vitamin deficiencies are misleading, and biochemical loading tests are not very satisfactory. Nevertheless, a differential urinary folic-acid excretion test is of diagnostic value in showing poor absorption of folic acid in conditions such as idiopathic steatorrhœa. After total or partial gastrectomy operations, or even after a gastro-enterostomy, megaloblastic anæmia may develop; steatorrhœa may also occur, but serum vitamin B_{12} tests show that the deficiency is of vitamin B_{12} and not folic acid. Where an anæmia is the result of a stagnant loop, it may not respond to any vitamin therapy, and presumably toxins are being absorbed from the loop.

The interpretation of studies of vitamin balance is complicated by the metabolism of the microbes found in the alimentary tract. Strains have been demonstrated both to synthesize and to absorb such vitamins as cyanocobalamine; their net influence is still uncertain, and may vary in different conditions.

Dr. D. A. K. Black (Department of Medicine, Royal Infirmary, Manchester) discussed the effects of alimentary disease in mineral metabolism. In general, chronic alimentary disease leads to mineral malnutrition as a result of deprivation and malabsorption of food minerals, while in acute catastrophes the loss of alimentary secretions is the predominant feature. Disease of the alimentary tract is the principal cause of potassium depletion, and has been demonstrated in pyloric stenosis, gastro-enteritis, ulcerative colitis and steatorrhœa and even as a consequence of excessive use of laxatives. This may result from deprivation of food intake, which is usually of the order of 100 m.equiv. daily, increased loss in the stools, and loss by vomiting. The potassium content of alimentary secretions is about one-tenth of the sodium content, so that in acute disturbances sodium depletion predominates; nevertheless, significant loss of potassium may occur, in chronic disease partly because colonic absorption of potassium is much less complete than that of sodium and partly because renal loss of potassium is greater than that of sodium when there are comparable body deficits of the two ions. The catabolic response to surgery leads to further loss. When potassium has to be given by intravenous injection, it should not be of greater concentration than 40 m.equiv./l.

It is generally agreed that fæcal excretion of iron represents unabsorbed iron. Impaired absorption has been observed in the steatorrhœa syndrome even in patients with neither achlorhydria nor overt diarrhœa. Moderate impairment can often be countered by oral administration of iron salts, but severe cases require intravenous injections.

The pathogenesis of osteomalacia in association with steatorrhœa is complicated. First, the presence of excessive fatty acid in the bowel leads to the formation of calcium soaps the calcium of which is not available for absorption; this can be improved by a low fat diet. Also, vitamin D is poorly absorbed, and further improvement of absorption can be induced by parenteral vitamin D or very large doses by mouth. The prolonged treatment of peptic ulceration with large amounts of milk and alkalis can lead to calcium intoxication and, in severe cases, renal failure associated with calcification of the renal tubules.

Prof. R. B. Hunter (Department of Pharmacology and Therapeutics, Queen's College, Dundee) reviewed the method of clinical presentation of fifteen cases of idiopathic steatorrhœa recently studied in the Therapeutics Unit, Maryfield Hospital, Dundee. In less than half these cases was diarrhœa the predominant symptom though all complained of tiredness and loss of appetite. The patients learned to control their own diarrhœa by reducing their fat intake. Cases of apparent iron-deficiency anæmia with malabsorption of fat, macrocytic anæmia or megaloblastic anæmias responding to folic acid were shown. Two cases of extreme calcium deficiency were considered in detail, and the problems of finding an effective means of calcium replacement in the face of impaired alimentary absorption were considered.

Food allergy was discussed by Dr. J. A. Milne (Department of Pathology, University of Glasgow), who said that, in order to discuss food allergy, it is necessary to consider first certain basic facts concerning allergic reactions and the immunological basis of allergy. When an antigen first enters the body, it stimulates the formation of specific antibodies. Some of these antibodies tend to persist in their free state in the circulating blood (circulating antibodies), and this would appear to constitute immunity. Others become incorporated into the substance of cells and become 'sessile' antibodies or fixed antibodies, and so the allergic state is established. Why some people develop sessile antibodies and thus become hypersensitive is completely unknown. Various sites may be affected—for example, the nasal mucosa and conjunctiva, the skin, etc.—and tissues so affected are known as 'shock organs'. What actually takes place when a tissue containing sessile antibodies comes in contact with its specific antigen is not known. There is considerable experimental and clinical evidence to suggest that histamine or a closely related substance is released.

Proof of the existence of food allergy depends on the demonstration of a cause-and-effect relationship between the ingestion of a given food and the production or accentuation of the patient's symptoms. The use of skin tests, either by the scratch or intradermal technique using concentrated extracts of foods, may occasionally be of help, although on the whole the results tend to be disappointing. Fortunately, many persons with food allergy, as well as having sessile antibodies, have some circulating antibodies. This allows the use of the Prausnitz–Kustner reaction for diagnostic purposes.

The ideal treatment of food allergy is, of course, the avoidance of the offending food, if this be known. The most widely used drugs at present are the antihistamines, and the results with them other than in papular urticaria in children are rather disappointing. Cortisone and adrenocorticotrophic hormone have been used with good results, although the symptoms tend to recur with increased severity once the drug is withdrawn.

FERROELECTRIC PROPERTIES OF SINGLE CRYSTALS

A COLLOQUIUM on the ferroelectric properties of single crystals, arranged by the Radio Components Research and Development Committee, was held at the Signals Research and Development Establishment, Christchurch, Hants, during September 16–17. Some sixty scientists attended in response to invitations, the Armed Services establishments, the universities and industry being represented in fairly equal numbers. The Bell Telephone Laboratories, New Jersey, which had supplied a number of large crystals for investigation by British workers, were represented by Dr. B. T. Matthias, who has achieved international reputation in this field. W. Bol and S. Duinker, representing Philips, Eindhoven, were also present.

The first paper, presented by C. F. Oxbrow (Christchurch), was prefaced with a short account of the fundamentals of the structure of barium titanate and their relation to electrical properties. Representative figures measured at Christchurch for the Bell crystals were saturation polarization, 22·5 μcoulombs/cm.^{2}; hysteresis loop area, 1·4 × 10^{-3} joules/cm.^{2}; permittivity along *c*-axis, 300 at room temperature. The optical properties of the Bell crystals were then described. These crystals, plates 1 × 1 × 0·02 cm., had a large area with the optic axis normal to the plate but were crossed by occasional laminar wedges of twinned material inclined at 45° to the plate. Seen by polarized light, these wedges produced broad interference bands on a uniform background. These twin domains were removed by the application of an electric field. A colour film of this type of domain change was shown, and inferences drawn on domain magnitude and growth. The paper concluded with a description of measurements to determine the refractive index n_0 accurately, the methods described being particularly applicable to these crystals. A modification of Chaulnes's method led to a value $n_0 = 2·49$.

P. Parsons (General Post Office Research Laboratories) exhibited photographs of the Bell crystals showing the crinkling due to the laminar domains as seen by ordinary light, the changes brought about by heating to the Curie point, and the re-establishment of the original domains by an electric field. Electrical measurements were also described. The charge/voltage hysteresis loop was particularly square; the coercive field was of the order of 1·1 kV./cm. at 50 c./s. but only 500 V./cm. for direct current; in the region of the Curie temperature an electric field gave well-defined double or constricted loops. The behaviour of domain walls is evidently dependent upon the rate of change of field because measurements showed a sharp peak in the differential permittivity at a bias field equal to the coercive field. The frequency of the small measuring field was 100 kc./s. and that of the large bias field 50 c./s. These results contrast with the substantially field-independent value measured at Christchurch using d.c. bias.

D. Gibbs (University of Bristol) discussed domain changes. 90° walls which separate regions with polar axes at 90° are easily observed. 180° walls separate antiparallel regions and are observable by polarized light only when additional cross-stress is applied. 180° wall change, equivalent to domain reversal, takes place by nucleation and growth of spike-like domains in the direction of an applied field[1]. Both 90° and 180° wall changes are possible in single crystals. In ceramics the electrical stress set up normally precludes 180° wall changes, and a parabolic (x, D) relation $x = kD^2$ due to 90° wall movements is obtained. Measurements at Bristol of electric displacement D and thickness-strain x produced values of k up to 5×10^{-8} e.s.u. In very pure barium titanate ceramic a flattening of the (x, D) curve at the vertex could be explained by 180° wall changes occurring at low field. In this pure ceramic a kink appeared in the side of the familiar D/E hysteresis loop if the applied a.c. field was suddenly increased. The kink grew out at a rate dependent on temperature, and this could be evidence of the nucleation period involved in 180° wall changes.

Problems which have arisen in growing single crystals of barium titanate were discussed by J. Herbert (Plessey, Ltd.). A pure intimately mixed raw material was made by incinerating barium titanium oxalate. The Verneuil oxy-hydrogen blow-torch method was tried. Lack of success in growing large tetragonal crystals was due to the growth of crystals in the hexagonal habit. To obtain barium titanate in the tetragonal form by crystallization from a melt of titanium dioxide and barium oxide, it was necessary to use a flux. Barium chloride yielded nearly perfect crystals of barium titanate in the form of thin plates, but the yield was small. Potassium fluoride yielded crystals in the form of 'butterflies', pairs of triangular plates joined along one edge. A lively discussion followed between Dr. Matthias (Bell Laboratories), Mr. Rhodes (Standard Telecommunications Laboratories) and Mr. Herbert on the merits of the potassium fluoride method as used by J. P. Remeika[2] in growing the excellent crystals described by the earlier speakers. Dr. Matthias also said that Mr. Remeika had succeeded in converting by heat treatment the hexagonal into the cubic form and vice versa. Evidently the fluoride method should be used for obtaining flat plates, while other methods such as the Verneuil might provide shapes suitable for piezoelectric investigations.

D. Campbell (Plessey, Ltd.) described major differences between crystals grown from barium chloride and potassium fluoride solvents. The potassium fluoride crystals had a surface strain layer which gave a square-net pattern under polarized light; the pattern disappeared and then returned when the crystals were heated and cooled through the Curie temperature (120° C.). The strain layer was etched away by phosphoric acid. Above the Curie temperature the optical activity of the chloride melt crystals completely disappeared, whereas some activity persisted in the case of those from fluoride melt. X-ray photographs indicated the normal contraction of c/a ratio with temperature in agreement with observed birefringent changes for the 'chloride' crystals. The 'fluoride' crystals had very complex photographs at 85° C. Hysteresis loops were directly dependent on complexity of structure. The American fluoride-melt crystals had ferroelectric constants agreeing with those of the chloride-melt crystals although the hysteresis loops were much more square.

In summarizing his work on sodium niobate, Dr. L. E. Cross (University of Leeds) reviewed previous work and anomalies between optical, electrical and X-ray measurements examined. His method of preparation and selection of single crystals for examination was described. Details were given of measurements of birefringence, type and arrangement of internal twins and dielectric constants over the temperature range −195° C. to +650° C. Owing to excessive conduction, observations of the effect of high electric field were given for the range −190° C. to +20° C. only. Summarizing, above 340° C. sodium niobate was not tetragonal but had orthorhombic symmetry, and there were two further changes before it became cubic at 638° C. The anti-ferroelectric structure at room temperature was confirmed, and there was some evidence of an additional ferroelectric polarization at low temperatures.

Two further papers on theoretical aspects of ferroelectricity were contributed by Drs. H. F. Kay and A. Devonshire (both of the University of Bristol). Dr. Kay dealt with the crystal structure of perovskite materials, with emphasis on $(Cd,Ca,Sr,Ba)TiO_3$, $(Li,K,Na)NbO_3$ and $(Li,K,Na)TaO_3$. Present knowledge is still only sufficient to indicate which materials are likely to be electrically unstable and the probable effects of substitutional replacements. The concept of ionic packing determines the probable type and magnitude of distortion at room temperature in the TiO_6 octahedra characteristic of the perovskite structure. These factors can be correlated to the probable type and frequency of twinning. In barium titanate the barium ion is so large that the structure can be broken down into sheet-like Ti-O groups, accounting for the polar character. The process is essentially ionic, since recent electrical measurements of saturation polarization agree with the value obtained from X-ray data on ionic shifts. The change in character of the distortion was traced as ion size was reduced progressively from barium through strontium until finally a tetrahedron-like formation was met in non-ferroelectric cadmium titanate. The substitution of lead produced anomalies which can be partially understood. Similar arguments are in general applicable to the alkali niobates and tantalates. In sodium niobate the structure is complex, and the unit cell quadrupled. Nevertheless, its field-dependent ferroelectric behaviour can be explained.

Discussing atomic models, Dr. Devonshire said that, while physical measurements are usually conducted at constant pressure, the constants immediately derived from atomic models are those for constant volume. For the perovskites the distinction is drastic. Thus in barium titanate the ferroelectric transition at constant pressure is discontinuous, a first-order transition, while calculations indicate that at constant volume the change would probably be second order. In contrast to ferromagnetics, the dipole interaction in ferroelectrics is long-range. Various types of model were considered by Dr. Devonshire: the type appropriate to potassium dihydrogen phosphate, in which an ion can take up two or more equilibrium positions; and that appropriate to barium titanate where the field in which the ion moves is anharmonic. The former gives with temperature a rapid change of χ, the reciprocal susceptibility or dielectric stiffness, while the latter gives a small change. Thus, the respective values of $\partial\chi/\partial T$ are 28·0 and 0·75. The Mason model for Rochelle salt was also considered. Here two sets of ions moving in unsymmetrical fields provide, as required for this material, a polar state stable only between two temperatures. A model for anti-ferro-electricity might be built on similar lines.

Both sessions were terminated by general discussions, Dr. Matthias presiding on the first day and C. G. Garton (Electrical Research Association) on the second. The subjects at both discussions were the practical uses of barium titanate crystals, with particular emphasis on digital storage. The fundamentals of storage and methods of investigation were described. Dr. Matthias said that the Bell Laboratories are concentrating on investigations into the serious deterioration in polarization properties caused by the protracted application of unbalanced pulse trains. Mr. Oxbrow said the deterioration is amplitude-dependent and is serious only if pulse amplitudes of the order of the coercive field are used. I. Carter (Ferranti, Ltd.) reported that, after the decay, a low-frequency property, sufficient storage effect exists for high-speed operation. Also, the initial state can be restored by periodic application of a small d.c. bias. Dr. A. Robinson (Ferranti, Ltd.) compared the merits of dielectric and ferrite storage. The advantages of barium titanate storage are compactness and a more convenient impedance for use in valve circuitry. Ferrite storage has the advantages of a more advanced state of development and, although offset by clumsiness, the versatility of variable 'turns-ratio' coupling. Very recent experiments with barium titanate indicate polarization times as low as 0·5 μsec., so that it might permit greater speeds of operation than ferrite.

A. C. Lynch (General Post Office) said that confirmation by Merz[1] that 180° walls do not move laterally has removed the fear that the polarizations of adjacent crystal areas might interfere. B. de Ferranti (General Electric Co., Ltd.) suggested that the non-linear characteristic of barium titanate capacitance versus field should be used in a dielectric amplifier. This would necessitate further investigation of noise in ceramics and single crystals. I. Ross (Services Electronics Research Laboratory) mentioned a possible use in infra-red switching, provided that the change in the 45° laminar domains is adequately fast. Measurements have been made of the infra-red transmission of one of the Bell crystals.

C. F. OXBROW

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[1] Merz, W. J., *Phys. Rev.*, 95, 690 (1954).

[2] Remeika, J. P., *J. Amer. Chem. Soc.*, 76, 940 (1954).

SHIFT WORK IN INDUSTRY

THE Institute of Personnel Management (2–10 Hill Street, London, W.1) has issued a broadsheet surveying the issues which affect the application of shift systems in industry. The broadsheet has been prepared by F. P. Cook, of Courtaulds, Ltd., but is based upon information obtained from a large number of different industries.

Among the conclusions brought out in the survey is that the economic advantages of shift work are greatest where capital charges and overheads are high in relation to labour costs. The greater the proportion of the total cost of production that is occupied by labour costs, the less the economic advantages of shift work become. When shift work is first introduced in a discontinuous process where employment has previously been on day work, the double-day shift system is probably the most advantageous for all concerned—for management because it is a second shift which offers the greatest alleviation to fixed charges, and for employees because the physical and social disadvantages are much less than those of shift systems which involve night work. The appeal of shift work to employees depends largely on how attractive it is made financially. Although it is only one factor, shift work can prove a sound economic way of meeting the natural urge towards shorter hours of work and higher earnings.

Quite apart from the ballot which is usually required by law before women and young persons can be employed on double day-shift work, the investigations show that full explanation and consultation are needed before any successful shift system can be introduced. Of all shift systems, those involving night work are most likely to have a deleterious effect on health; this is especially applicable to systems which involve permanent night work. Any unfortunate effects will vary with individuals, the nature and hours of their work, and their habits outside the factory, so that it would be hard to establish a general rule, even if more evidence were available. For most employees, shift work involves a balancing of material gain against social loss; thus, in pursuing the possible economic advantages of the extension of shift work, which can only be a gradual process, those in authority must take the possible social drawbacks into account.

Mr. Cook concludes that one of the temptations of these complicated times is to over-simplify, and this is typified by the search for the single solution to any problem. In personnel management, recent years have seen the fashionable development of joint consultation, job evaluation, communications, financial incentives, financial enlightenment, merit rating of management development, and work study. Despite the creation of much pseudo-technical supporting jargon, not one of these is a cure-all by itself, and together they can be no more than further aids to the vastly complicated business of modern industrial management. The extension of shift work will not alone revive the fortunes of a nation or concern; but, in the right circumstances, it can help.

FORESTRY COMMISSION

REPORT FOR THE YEAR 1952–53

IN the operations of the Forestry Commission during the year 1952–53*, economy in spending was a guiding factor in deciding the programme of work. In order to carry out the expanding programme of planting and thinnings in the young plantations with the funds available, it was necessary to postpone work such as building new houses and new roads. Many of the forest services of the British

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* Forestry Commission. Thirty-fourth Annual Report of the Forestry Commissioners for the Year ended September 30th, 1953. Pp. 84. (London: H.M.S.O, 1954.) 3s. net.

Commonwealth have found themselves in this predicament, which is by no means a new one. The rate of acquisition of land is still giving the Commission concern. The net additions of the past two years including acquired plantations have been substantially less than the areas planted. In 1951–52 they were less by eight thousand acres; this year by fourteen thousand acres. The total area of land acquired at September 30, 1953, was 1,909,400 acres. This comprised 1,181,400 acres classed as "Forest Land", which is either already planted or will be in due course, and 728,000 of "Other Land", which includes nurseries, rough grazing and agricultural land and other land unsuitable for planting. Twenty-six new forests were started during the year, nineteen in England, two in Scotland and five in Wales. The area planted was 67,610 acres, exceeding 1951–52 by almost six thousand acres. More than 118 million trees were used for the plantations and for replacing failures in recently planted ones. Fire damage was not high during the year.

The dedication scheme pursues its somewhat chequered course, dedication deeds being completed on 227 estates covering a total of 76,810 acres of woodland while another 139,730 acres of woodlands are in an advanced state of preparation; the total area thus approached a quarter of a million acres at the end of the year under review. It might be suggested as a matter for consideration, and to allay the difficulties of acquiring land, whether the Commission could not be advised to lay down a fixed minimum of land considered essential to be managed as State Forest and trust the private proprietor, with the Commission's advice and help where necessary, to work up to the balance of forest considered to be necessary for the requirements and protection of the population. France furnishes a good example. A considerable percentage of the French forests are privately owned and well managed. A question was once put to a senior French conservator of forests on the management of certain privately owned forests and whether the conservator ever gave advice, as they had a common boundary with the Government forests. He replied the private owner knew as much about forest management as he did. It may be concluded that British forest proprietors may in time attain as a body the same equality of knowledge as their French opposite numbers.

E. P. STEBBING

MANUFACTURE OF THE TEN-TOLA PRIMARY STANDARD WEIGHT FOR PAKISTAN

By DR. G. F. HODSMAN

Research Laboratory, L. Oertling, Ltd., St. Mary Cray, Kent

THE first primary standard of mass to be produced commercially in Britain for many years, the ten-tola primary standard for the Karachi Mint, Pakistan, has recently been completed by L. Oertling, Ltd., in conjunction with Johnson, Matthey and Co., Ltd. (see *Nature*, August 14, p. 206). The standard of mass has been prepared to an exacting specification for the Pakistan Government, and its manufacture involved a number of special problems which are of general interest, especially to those concerned with precision weighing.

In order that a self-consistent system of weights can be established throughout the world, weights must be related through individual manufacturers' standards to some recognized ultimate standard of mass. It is not yet possible to rely on any natural phenomenon for such a standard, as is possible, for example, with length, which can be related to wavelengths of light. Recourse must of necessity be made to the mass of an actual piece of material, which in the case of metric weights is the International Kilogramme, located at the Bureau International des Poids et Mesures at Sèvres, near Paris. Most countries, including Britain, have primary standards of mass, which form the basis of their own weight system, the primary standard in Britain being the Imperial Pound. The weight system in Pakistan is based on the tola, which is defined as 180 grains (7,000 grains equals one imperial pound); the recently completed primary standard of 10 tolas thus has a mass of 1,800 grains (about 120 gm.).

A satisfactory primary standard must fulfil a number of requirements, the most important of which is stability, and its construction must be such as to ensure constancy and reliability of mass over a period of many years. The Imperial Pound, for example, is believed to have remained constant within one part in five million during the past seventy years. It is the achieving of this stability which presents the manufacturer with some of his most difficult problems.

The primary standard should be as near its nominal mass as is reasonably possible in order to avoid the difficulties surrounding the use of small 'make-weights' when comparing the standard with sub-standards. The standard should also be of reasonable size in relation to the sub-multiples and multiples in common use. For this reason, the 10 tola has been chosen as the primary standard as being a better intermediate value than 1 tola, which would involve difficulties in standardizing large multiples.

The Pakistan standard is made from an alloy containing 90 per cent platinum and 10 per cent iridium—an alloy which experience has shown to be exceptionally stable and durable. Since both these metals have a high density, the weight occupies a small volume and consequently has a small surface area, which also enhances stability. The density of the weight must not be less than 21·50 gm./ml. at 20° C. to ensure that it is sufficiently free from cavities and inclusions, which might affect its stability.

The alloy billet was forged by the firm of Johnson, Matthey and Co., Ltd., in Hatton Garden, London, and was subjected to gamma-ray examination to reveal any major internal defect. It was then roughly turned and polished and subjected to a density determination by the National Physical Laboratory at Teddington. The billet used for the weight was free from all inclusions and achieved a density of 21·54 gm./ml., which indicates a high degree of freedom from inclusions.

The shape of the final weight is a simple cylinder with a height and diameter of approximately one inch, the under-surface being relieved over its central portion, to provide an annular seating for the weight and to minimize the risk of foreign matter adhering to the under-surface when the weight is in use.

The mass of the weight was required to be adjusted within ± 0·005 grain (that is, ± 0·3 mgm.), which is about three parts per million of nominal value; the actual mass of the weight was required to be known within ± 0·0002 grain. In addition, a high degree of surface finish is necessary, for any imperfections in the surface are centres of potential corrosion and dust location. The problem facing the manufacturer, therefore, is gradually to improve the surface finish, removing smaller and smaller amounts of material as the nominal value is approached so that correct mass and optimum polish are achieved simultaneously. If the correct mass is achieved before optimum polish, the surface defects cannot be removed and the weight becomes scrap metal. If optimum polish is achieved before correct mass, it is difficult and sometimes impossible to reduce to correct mass without damaging the surface. The simultaneous achievement of these twin conditions is a process requiring exceptional skill by the polisher, together with a series of accurate weighings. It is a process which occupies many months of painstaking and patient work using successively finer and finer polishes. The manipulation of the weight during the long period of adjustment, with the ever-present necessity of avoiding damage throughout every second of this time, imposes a considerable strain on the adjuster.

Primary standards are standards of mass and, therefore, when compared in air with standards of different density, allowance must be made for the different buoyancy effects on the two sides of the balance. For the adjustment of the Pakistan standard, a secondary standard made from an alloy of 80 per cent nickel and 20 per cent chromium was used as a counterpoise. This counterpoise was prepared, finished and adjusted in the same way as the standard and was calibrated for mass and density by the National Physical Laboratory. The Pakistan standard was then compared with this nickel–chromium standard on a reference balance built by L. Oertling specially for the work. The balance was capable of indicating weight differences of 0·01 mgm. with a load of 120 gm. in each pan. At the final adjustment stages, Gaussian weighings were used, the platinum standard being allowed forty-eight hours to become stabilized after each adjustment and before re-weighing.

The final certification of the weight by the National Physical Laboratory records a value of 1800·0007 grains for the mass, the deviation from nominal value being only 0·0007 grain. This deviation is about one part in three million and is comfortably within the permitted tolerance.

THE *O* CHROMOSOMES AND THE DISTRIBUTION OF THE DENTAL FRICATIVES IN EUROPE

By R. W. THOMPSON

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IN their well-known introduction[1] to genetics, Darlington and Mather bring up once more the question of the relationship between race and language. Their thesis is that the 64·5 per cent line for the *O* chromosomes (in the *A*—*B*—*O* series) coincides with the boundary which separates those Europeans who pronounce a *TH* sound (as in English *think* and *then*; *AIP* notation [θ] and [ð]) from those who do not. Their story is ingenious, as are their sketch-maps. Unfortunately, they have simplified the issue and arrived at conclusions which we are not yet in a position to accept in the light of present knowledge. They themselves would appear to regard their paragraphs on this subject as mainly speculative.

Let us agree with Darlington and Mather's definition of *TH* as a 'dental fricative', unvoiced [θ] as in English *think* and voiced [ð] as in English *then*. Sounds with approximately the same values as these exist in other European languages but are often developments from a completely different phonetic base. For example, the [θ] of Spanish in *cielo* is derived from a primitive *k*-sound, whereas that of English *thin* descends from a postulated primitive *t*. While [θ], [ð] do not occur in many of the European languages, there is no reason for believing that normal Europeans have any *congenital* difficulty in pronouncing them. Children rapidly learn to discard myriads of sounds which do not conform to the type found in the language used by their parents.

At this point we shall look at the map of Europe and see what the position is in several of the areas where Darlington and Mather have registered the presence of the dental fricatives.

In the west, in Ireland it is claimed that the dental fricatives are extant. For some reason, West Kerry is marked 'extant variable'. The facts are that this group of sounds is absent from popular speech over most of Ireland, and only parts of the north-east could be labelled 'extant variable'. Orthography often confuses the layman. It should therefore be remembered that forms such as stage-Irish 'butther', 'Pathrick', 'murdher' represent a special group of sounds for which there is no provision in standard English spelling. They are 'velarized dental plosives' (voiced or unvoiced) and are produced by pressing the tip and blade of the tongue against the upper incisors. In the formation of these sounds the breath is cut off as in the production of English [*t*] and [*d*]. In the pronunciation of [θ], [ð] the flow of breath is continuous. The velarized dental plosives in the English of Ireland are examples of Gaelic 'substratum'. Children of Irish parentage, born in London, seem to have no difficulty in pronouncing [θ], [ð] in the English manner. One feels that the children of those who 'could not frame to pronounce' the word 'shibboleth' (Judges, xii, 4–6), if taken early enough, could have been taught to palatalize initial *s* in spite of the arrangement of their chromosomes.

Turning again to Spain, where orthographic *c* (before *e* and *i*) and *z* = [θ] in the standard language, we see that the phenomenon has not yet covered the whole country. Throughout Catalonia and Valencia in the east, the mother-tongue of the people shows *c*, *z* = [*s*], [*z*], respectively. Yet when Catalans or Valencians are obliged to speak the national language in the school or upon official occasions they are quite capable of pronouncing the *c* and the *z* in the Castilian fashion. In the south of Spain both these letters are pronounced somewhat like an English [*s*] in many districts, although written *s* is sometimes rendered as [θ]. Which means that *si señor* may sound like *thee thenyor*. Now so far as the relationship between the use of [θ] and blood group genes is concerned, in Spain we must realize that (according to the recent researches of the late Amado Alonso[2]) the final passage of earlier *ts* and *dz* (written *c*, *ç*, *z*) > θ was not complete in either the dialect of Castile or in the national language until the late sixteenth century. By about this same time these sounds had passed to [s] in America, southern Spain, and in the Judæo-Spanish of the descendants of the Jews expelled by Ferdinand and Isabella in 1492 and living in North Africa, the Balkans and elsewhere. Are we not justified in regarding the apparent coincidence of linguistic and genetic phenomena as irrelevant?

Portugal apparently lies beyond the 64·5 line and according to Darlington and Mather the only traces of *TH* are to be found in two areas. In one they claim that it disappeared before 1000 B.C. and in the other it is said to be 'extant variable'. Yet the facts speak differently. In peninsular Portuguese intervocalic *d* is often pronounced [ð] as in the other Hispanic languages and dialects.

In the Greek of Demosthenes[3] the group χ, θ, φ was pronounced [*kh*], [*th*], [*ph*]. In modern Greek (and, indeed, from early in the present era) they have the following values: χ = something like the two chief *ch* sounds of modern German; θ = [θ]; φ = [*f*]. One asks if before the passage of *t* + *h* > [θ] the *AB*/*O* blood group genes fought a bloody underground battle in the bodies of the Ancient Greeks.

The fundamental question is whether or not any race is incapable of or averse to pronouncing any given sound. From my own experience in various countries, such a theory cannot be proved. Here in Jamaica, when I listen in on the radio I cannot tell if the speaker is black, white or of mixed race. In Jamaica the educated black or brown man will say 'think', 'the', 'then' as easily as an Englishman. The poor-white farmer says 'dis', 'dat', 'dese', 'dose', 'ting', 'tink' just like his dark neighbours. The black man says 'tink' because his father did and not because of a certain arrangement of genes. The first of his ancestors to speak a kind of English, lacking [θ], [ð] in his own West African dialect, substituted a *t*- or a *d*-sound, the nearest equivalents he could find. In the same way, a Frenchman or a German may produce 'seenk' for 'think' and 'zees', 'zat', 'zeese', 'zose' for 'this', 'that', 'these', 'those', but not because he has anything wrong with his chromosomes. Indeed, if he were to allow his children to be brought up in Britain he would find that it was no more difficult for them to pronounce in the English way than for an English child, reared in France or Scotland, to say "*de bon vin blanc*" or "*It's a braw, bricht, munelicht nicht, the nicht*".

We admit that the speech organs of various races vary in shape, as does the texture of the hair, the colour of the skin or the form of the lips or nose. The only influences these variations could have on the production of speech is on 'timbre', and even this, as may be inferred from my remarks above, is not significant over the radio.

Finally, it does not seem that any valid conclusions can be drawn from the apparent coincidence of isogenic lines for blood-group frequencies and isophones for the distribution of *TH* = [θ], [ð] in Europe, in the light of our present knowledge of race and historical phonetics in that continent. Most linguists will continue to feel that human environment is a more powerful influence on language than heredity.

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[1] Darlington, C. D., and Mather, K., "The Elements of Genetics", 259 (1949).

[2] Alonso A., "Estudios Lingüísticos" (*Temas hispanoamericanos*) (Madrid, 1953).

[3] Meillet, A., and Cohen, M., "Les Langues du Monde", New ed., p. 43, note (Paris, 1952).

MEASUREMENT OF RHODOPSIN IN THE LIVING HUMAN EYE

By Dr. W. A. H. RUSHTON, F.R.S., and Dr. F. W. CAMPBELL

Department of Physiology, University of Cambridge

THE photopigment rhodopsin has long been known to be the chemical basis of scotopic (twilight) vision, and its bleaching and resynthesis have generally been held to underlie the phenomenon of light- and dark-adaptation. It has never been possible, however, actually to measure the rhodopsin-level in the living human eye, except for the incidental observations of Brindley and Willmer[1], who, however, were unable to avoid rapid bleaching of the pigment by the light used to measure it.

In order to work at substantially lower luminance-levels, a photocell technique has been developed. Successful applications[2-4] of the method to the cat and albino rabbit (where the back-reflexion of light from the eye is strong) encouraged us to proceed to the far more difficult case of the human eye, and we now appear to be able to measure changes in the rhodopsin-level with an accuracy of about 5 per cent of the full dark-adapted amount, each measurement taking 5–10 sec. to make.

Light from a bright source passes through a rotating colour-wheel so that the light transmitted is alternately orange and blue-green (Fig. 1). This passes through a hole in the silvering of a cover-slip and is focused upon the cornea in a 2° pencil. Light reflected from behind the small illuminated patch of retina passes back through the dilated pupil and, after reflexion in the mirror, is focused upon the cathode of a photomultiplier cell (type 931 *A*), the output of which gives the signals alternately for orange and blue-green light. These two signals are separated by passing through a commutator mounted upon the shaft of the colour wheel. Condensers connected to the grids of two cathode followers act as reservoirs for the levels of the two signals, and a galvanometer across the cathodes gives a null indication when the levels are equal.

Nearly all the light entering the photocell has passed twice through the rhodopsin of the retina. This will scarcely affect the orange signal since rhodopsin is nearly transparent to orange light, but it absorbs maximally in the blue-green, so a change in the rhodopsin density will upset the null balance of the galvanometer. This may be restored by a corresponding change in the position of a purple wedge in the path of the incident light. The amount of purple wedge added is proportional to the amount of visual purple lost, which may thus be read directly. The technique is seen to have the usual advantages of a null method; it is relatively unaffected by changes of light source, of signal amplification and of small eye movements, though all these have been kept as steady as practicable.

If a fairly bright light is shone into the eye, rhodopsin is bleached, at first quickly and later more slowly as less and less pigment remains to absorb the light. Fig. 2 shows this curve measured in terms of the setting of the wedge. There are four different experiments: ○ and × show the bleaching of a 2° area of the retina 20° temporal to the fovea (the two experiments were similar but were performed three days apart to show the degree of repeatability);

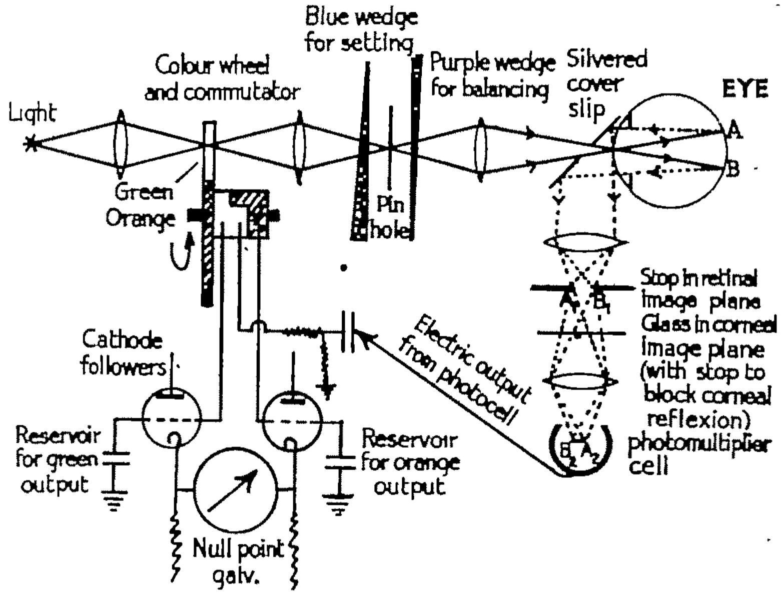
Blue wedge for setting
Colour wheel and commutator
Purple wedge for balancing
Silvered cover slip
EYE
Light
Green
Orange
Pin hole
A
B
Stop in retinal image plane
Glass in corneal image plane (with stop to block corneal reflexion)
photomultiplier cell
B_2 A_2
Electric output from photocell
Cathode followers
Reservoir for green output
Reservoir for orange output
Null point galv.

Fig. 1. Rotary rhodopsinometer

experiments ● and — were similar, but the areas measured were the fovea and the blind spot, respectively. The actual level of the plotted results is arbitrary; what is significant is that there is no bleaching in the fovea and blind spot. They are the only areas in the retina devoid of rhodopsin and they are the only places where we have found no bleaching. This leads us to believe that it is the bleaching of rhodopsin that we are measuring; the spectral sensitivity also corresponds to what would be expected from the bleaching of rhodopsin[4].

The sensitivity has been measured by finding the bleaching-rates in lights of different colours. As is well known, the scotopic visibility of any colour corresponds very closely to its power of bleaching rhodopsin. So the subject (W. A. H. R.) first matched the various coloured lights under scotopic conditions, and then his retina was bleached by exact multiples of these matched intensities (some 10^5 times as strong). Each colour gave the same rate of bleaching within 20 per cent as measured by the displacement of the purple wedge, though of course the orange light appeared enormously brighter than the blue due to the activation of the cones.

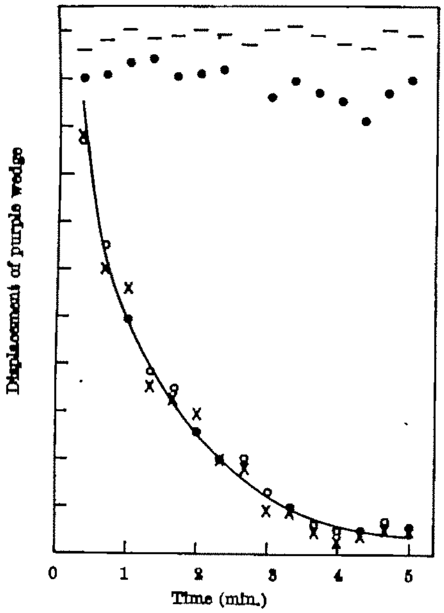

Fig. 2. Bleaching produced by bright light
O, measurements on June 21, 1954 (20° temporal); ×, repeat measurements on June 24, 1954; ●, measurements in fovea; —, measurements in optic nerve head

Rhodopsin-Level and Visual Function

It has been widely held that a principal cause of light adaptation is the bleaching away of rhodopsin so that only a small fraction of the pigment remains to absorb the necessary quanta. Among many who have opposed this, Granit *et al.*[7] have not found the expected correlation in animals' eyes. Baumgardt[8] has calculated that insufficient quanta are absorbed to produce significant bleaching at the low luminances where the bleaching hypothesis was often used, and Rushton and Cohen[9] showed experimentally that some fifty-fold change of threshold was produced by less than 2 per cent bleaching of rhodopsin. This latter experiment has recently been repeated and confirmed by Wald and Hubbard[10].

All this work gives an upper limit to the amount of bleaching possible by assuming that no regeneration occurs, for there has been no reliable way of estimating the rate of regeneration. The present technique allows us to measure the rhodopsin-level directly and rapidly in various conditions of illumination. Work upon the kinetics has only just begun; but the following results are at once apparent. (*a*) The rhodopsin-level is in fact not appreciably altered by brief light adaptations such as those used by Rushton and Cohen[9]. (*b*) After strong bleaching, the subsequent return of the rhodopsin-level to its full concentration follows an exponential curve with half-return constant of about 7 min. (*c*) At moderate room illuminations there is not more than 10 per cent of the rhodopsin bleached when equilibrium is reached.

This seems to establish that unless fairly bright photopic illumination is used, there is no appreciable change in the density of retinal rhodopsin. Thus changes in visual sensitivity cannot be due to an alteration in the chance of a quantum being absorbed; it must be entirely due to a change in the efficacy of the quantum when it is absorbed.

We are indebted to the W. H. Ross Foundation and the Medical Research Council for defraying the cost of the apparatus.

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[2] Rushton, W. A. H., *J. Physiol.*, 117, 47*P* (1952).
[3] Rushton, W. A. H., *Pub. Inst. Biofisica, Rio* (1953).
[4] Rushton, W. A. H., *Acta Physiol. Scand.*, 29, 16 (1953).
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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Infra-Red Spectra of Coals

In the past, the infra-red spectra of solid materials which cannot readily be dissolved or prepared in very thin sheets have been determined by the use of suspensions of the substances in liquid paraffin ('Nujol'). We have reported spectra of some coals obtained in this manner[1], and observed that prolonged grinding is necessary in order to reduce the loss of radiation by scattering.

We have recently experimented with the new technique described by Schiedt[2] and Stimson[3], in which the substance to be examined is compressed with potassium bromide to give a translucent disk, and we have found that careful preliminary grinding of the coal and effective mixing of the coal and potassium bromide are of considerable importance. The influence of grinding time has been determined by preparing disks after milling 0·3 gm. coal for measured intervals of time in a high-speed miniature ball-mill. Fig. 1 shows the spectra of an anthracite milled for 5, 13 and 20 hr. It will be noted that after 5 hr. milling, the general level of absorption is high; after 13 hr., radiation scattering by the coal particles is high from 3,500 to about 1,500 cm.$^{-1}$ but the general level of absorption is lower. After 20 hr., the general level of absorption shows little further change, and radiation scattering, even at the high-frequency end of the spectrum, appears insignificant. Bergmann has recently reported[4] coal spectra obtained by this method; but there is evidence that scattering is still appreciable in the region 3,500–2,400 cm.$^{-1}$ although the general level of absorption is low. This is probably due to insufficient grinding of the coal sample.

In examining a series of coals, we have consequently adopted the policy of milling each for such time that further milling produced no change in the spectrum; in the case of the anthracite, the time involved was 20 hr., whereas for a bituminous coal 5 hr. was sufficient. Fig. 2 shows the spectra so obtained from five coals, each predominantly vitrain, of ash content less than 1·5 per cent, covering the range from class 100 (anthracite) to class 900 (bituminous). The spectra were recorded on a Grubb–Parsons infra-red spectrometer using a sodium chloride prism. A detailed interpretation of these spectra will be reported elsewhere in due course, but a few general observations follow.

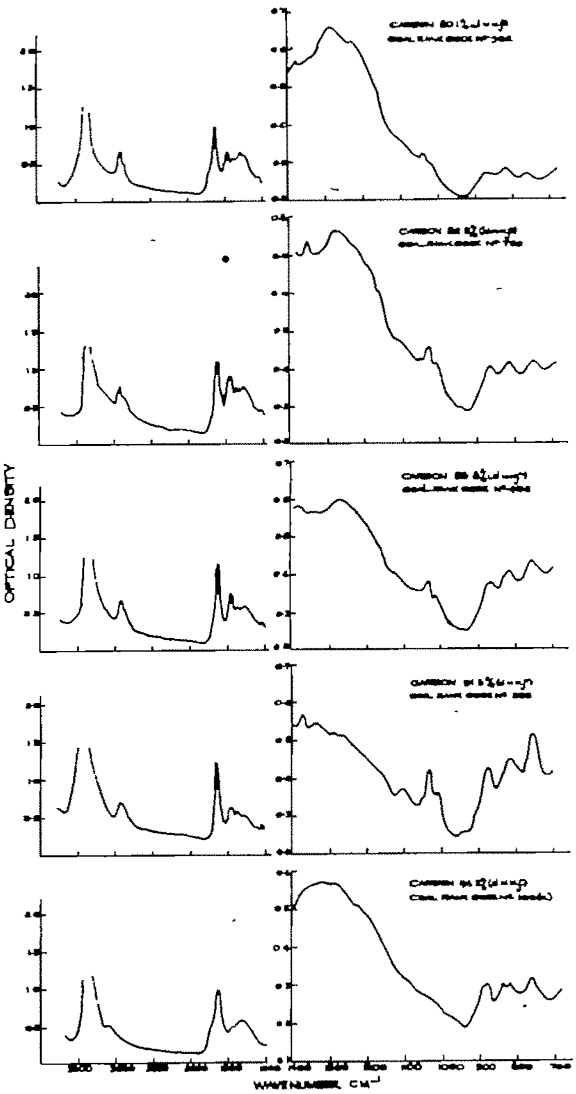

Fig. 2. Infra-red spectra of coals of different rank

The sample disks of all the coals contain the same amounts of coal and potassium bromide (weight of disk 350 mgm., thickness of disk 1·5 mm., coal percentage 0·5) and the spectra may be compared one with another on a reasonably accurate quantitative basis. This represents a considerable improvement on the 'Nujol' technique, where comparison between spectra was only qualitative.

It may therefore be stated that there is little variation in the general level of absorption throughout the range of coals in Fig. 2. The contrary assertion, that the general level of absorption

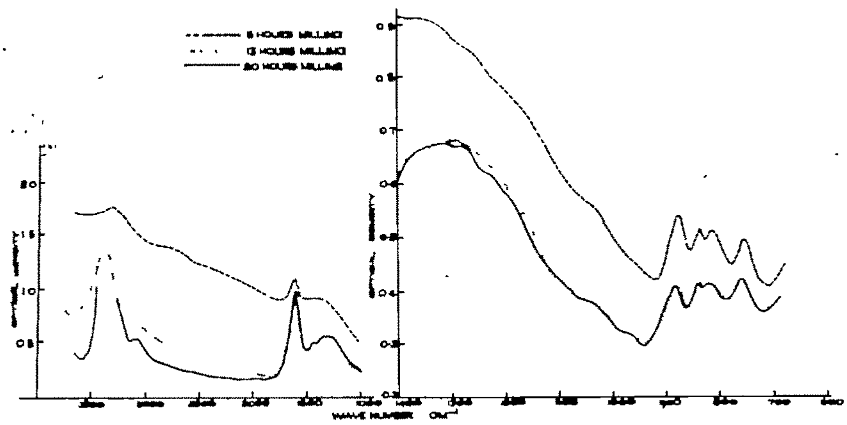

Fig. 1. Infra-red spectra of anthracite and effect of milling-time

rises with the carbon content, has previously been made[5,6], on the evidence of spectra derived from 'Nujol' mulls. It now appears that what was interpreted as a high general level of true absorption in the anthracites was actually a high degree of scattering, caused either by inadequate grinding or by subsequent aggregation of particles in the suspension.

The regions of the spectra about 2,850, 1,450 and 1,370 cm.$^{-1}$, which are obscured by the paraffinic CH absorptions from 'Nujol', are now observable. On the other hand, we have found it necessary to record the spectrum fairly soon after a disk is made, because disks which have been stored for some time show additional absorption peaks at 1,110, 1,043, 997 and 918 cm.$^{-1}$, the intensities increasing with time. The cause of this phenomenon is being sought.

Thanks are due to the National Coal Board for permission to publish this communication.

R. R. Gordon
W. N. Adams
G. J. Pitt
G. H. Watson

National Coal Board,
Central Research Establishment 1,
Stoke Orchard, Glos. Oct. 8.

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Heats of Reaction during Carbonization as deduced from Temperature Surveys of a Coke Oven

Metallurgical coke is made by carbonizing coal in an oven that consists essentially of two heated walls spaced some 40–45 cm. apart. Coal is charged into the already heated oven, and the isotherms in the coal are found to be substantially pairs of planes parallel to the oven walls. With the passage of time, both components of any pair of isothermal planes will advance through the charge to the centre of the oven. As the dimensions of the walls are large with respect to their spacing, the system may be regarded for the purpose of analysis as one-dimensional and, if the thermal properties of the charge are known, the temperature distribution at any time should be determinable by solution of the one-dimensional case of the heat-flow equation.

This was attempted for the case of a 10-cwt. experimental coke oven charged with three different coals. Temperature histories were recorded for different points across the oven, and the thermal properties of the coals used were measured in the laboratory. Thermal conductivities showed large changes with temperature (Fig. 1), but the product of density and specific heat showed only relatively small (10 per cent) changes during carbonization.

Numerical solution of the heat-flow equation using the experimental data would have been exceedingly tedious, so an analogue method of solution due to Liebmann[1] was used. In this method time is treated in iterative steps, the solution over each time-interval being obtained from an electrical resistance analogue in which the electrical parameters (conductance, voltage, etc.) are adjusted to correspond to the values appropriate to the thermal parameters (conductance, temperature, etc.) for that step.

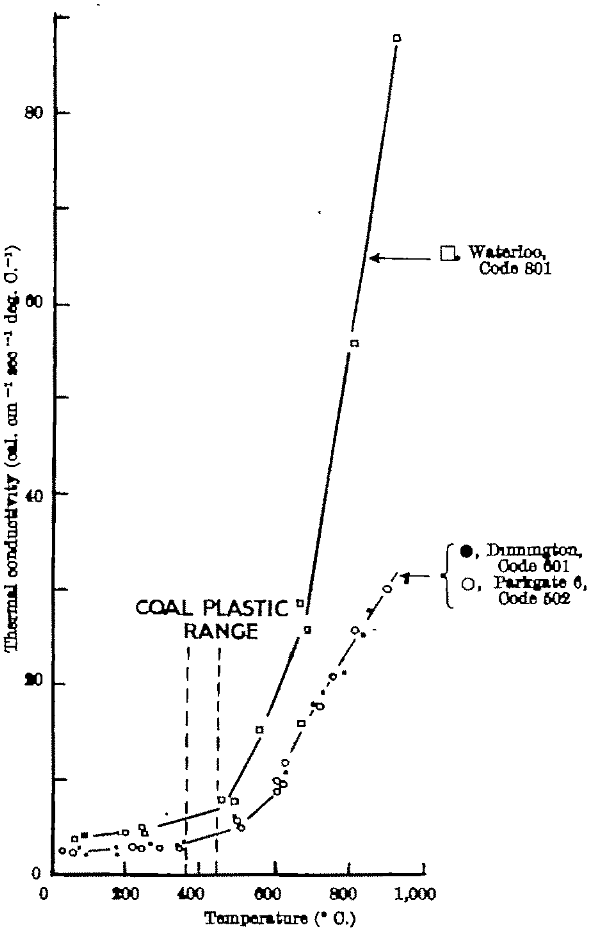
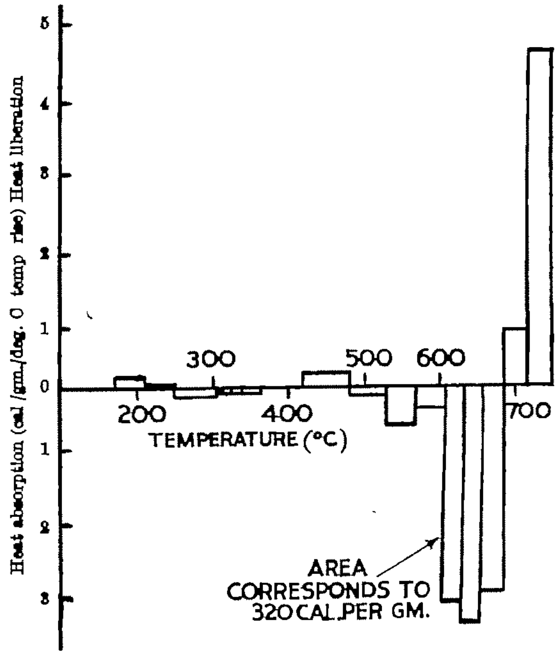


Fig. 1. Thermal conductivity as a function of temperature for the three coals used



Rate of heating: about 3 deg. C./min. Coal: Parkgate 6, N.C.B. Code 502

Fig. 2. Heat of reaction in cal. per gm. per deg. C temperature rise as a function of temperature for a coking coal (Parkgate 6)

It is found in all cases that the calculated temperatures are first higher, but later lower, than those observed experimentally, the change-over occurring at about 740° C. These discrepancies are larger than can be explained by gas convection or radiation effects in the coke oven, and are believed to be due to the carbonization process being on the average endothermic below a temperature near 700° C. and exothermic above this temperature. To estimate the magnitude of the heat absorption/liberation, the analogue computing technique due to Liebmann is sufficiently flexible to be used in reverse. The computer was made to follow the observed temperature histories and note was taken of the heat absorption/liberation that had to be postulated in order to make it do this. A typical result of such a calculation for a rate of heating of 3 deg. C. per minute is shown in Fig. 2. It was found that heat is absorbed in the range 150°–700° C. Of the three coals tested, Parkgate 6 absorbs 320 cal. per gm., Dinnington absorbs 170 cal. per gm. and Waterloo absorbs 780 cal. per gm. Above 700° C. all three coals are exothermic, releasing some hundreds of calories per gm. between 700° and 800° C. The calculation could not be carried beyond 800° C. owing to difficulties in experimental technique, but two of the coals (Parkgate 6, Dinnington) are known to be still exothermic above 900° C. This was seen from the experimental temperature surveys, which show that at about 900° C. the temperature throughout the oven becomes uniform, and at this point the temperature at the centre is still rising above that of the outside at a rate of about 0·3 deg. C. per min., eventually becoming some 50 deg. hotter than the walls.

I wish to thank the Director General of Research, National Coal Board, for permission to publish this communication. The views expressed in it are my own and not necessarily those of the Board.

D. J. MILLARD

Central Research Establishment 1,
National Coal Board, Stoke Orchard,
Cheltenham. Aug. 18.

[1] Liebmann, G., *Brit. J. App. Phys.*, 4, 193 (1953), and Proceedings of the General Discussion on Heat Transfer, London, 1951, p. 300, published jointly by the Institution of Mechanical Engineers and the American Society of Mechanical Engineers.

'Reaction Time' of Cast Trinitrotoluene as a Function of the Rate of Charge Cooling

FOR charge diameters greater than 1 in., the detonation velocity of 'confined' T.N.T., that is, T.N.T. cast in metal tubes, increases only very slightly with increasing charge diameter, indicating a very short reaction-time ($\sim 10^{-8}$ sec.) for the primary decomposition process of this explosive. The experimental results already reported[1] suggested that this small change might be associated with the existence of the 'surface chilled' layer which would be present in all heavily confined charges and would vary little in character with changes in charge diameter. It was decided, therefore, to re-investigate the velocity – charge diameter relationship for T.N.T. under conditions of charge cooling such that very different degrees of surface chilling were operative during the initial solidification phase.

The T.N.T. was cast in heavy seamless copper tubing with internal diameters of 1½ in., 2 in. and 3 in. using the following two casting techniques:

(1) *Ordinary 'clear cast' T.N.T.* Molten T.N.T. at 105° C. was poured into the cold casing and allowed to cool without interruption at room temperature. Casting-heads were employed, so that stirring during solidification could be dispensed with but cavitation effects avoided.

(2) *Ordinary 'clear cast' T.N.T. in heated cases—slow cooled.* The casings were first heated to 80–85° C. in a large steam-heated vessel. The T.N.T. at 105° C. was then poured in so as to fill completely the charge casing and casting-head, the steam turned off, the vessel covered and the charge then allowed to cool. Because of the large heat capacity of the containing vessel, cooling was very slow, complete solidification requiring 4–6 hr.

The degree of confinement (S) was maintained constant at the various diameters ($S = 3{\cdot}10$–$3{\cdot}28$ gm./sq. cm.). Two velocities were measured on each charge over 30 cm. intervals using the Dautriche[2] method, commencing at distances of 10 cm. and 20 cm. from the initiated end. This staggering of the timing intervals afforded a rough check on the stability of the detonation velocity along the charge. The results obtained are summarized in Table 1.

Table 1

Charge diameter (in.)	Density, Δ (gm./c.c.)	Type of cooling	Average velocity of detonation (m./sec.)
1	1·58	Ordinary	6,760
1	1·57	Slow	5,900
1½	1·59	Ordinary	6,710
1½	1·58	Slow	6,280
2	1·59	Ordinary	6,845
2	1·57	Slow	6,480
3	1·56	Slow	6,480

A much greater scatter among individual results was evident with the slowly cooled charges, as might be expected since uniformity of crystal size and orientation are more difficult to ensure from one charge to the next.

If U is the observed detonation velocity and R the charge radius, plots of $1/U^2$ against $1/R$ are approximately linear for both cooling rates, and on the basis of the theoretical treatment of Jones and Stickland[3] the slopes of these lines lead to estimates of the effective reaction-time for the two types of charges, that is, to the time occupied by the primary decomposition process that determines the extent to which lateral energy losses may occur, and hence the detonation velocity. The slowly cooled charges show a ten-fold increase in reaction time. The two lines obtained in the present experiments are but two representatives of an infinite number of possibilities between certain limits. Theoretically, these two limits are on one hand liquid T.N.T. in which the 'crystallites' are of molecular dimensions, and on the other hand a charge consisting of a single large crystal, in which case the reaction-time would probably be so long that the term detonation would no longer be applicable.

It is well known that the grain size of T.N.T. increases with decreased rates of cooling, and while the possibility of changes in crystal orientation must be borne in mind, in the absence of any direct evidence to show that such changes may significantly affect the velocity of detonation, it seems logical to relate the changes in reaction-time to changes in grain-size, the reaction-time decreasing as the internal surface is increased.

It appears that in cast-confined charges there is at the surface a fine-grained outer layer with a higher intrinsic detonation velocity (that is, shorter reaction time) than the core. The situation is somewhat akin to a composite charge composed of cylinders of different detonation velocities. The detonation velocity is then always that of the component with the highest detonation velocity, and whether the high-velocity component is on the outside or the inside it will still be the rate-determining factor for the charge as a whole. In the case of confined charges, the finely crystalline surface-chilled layer is probably very thin, and the effect produced, therefore, may be of an intermediate character[3]; but it will be out of all proportion to its size because it is the high-velocity component.

The dependence of reaction-time on grain-size in the case of cast explosives has an important bearing on the various theories put forward to account for the initiation of the decomposition at the detonation front. It is in accord with the hypothesis of heterogeneous explosive decomposition involving a reaction between a gaseous and a solid phase, the major part of the reaction involving the erosion of the crystallites by the hot gases arising from the already decomposed explosive.

We acknowledge our thanks to the Chief Scientist, Ministry of Supply, for permission to publish these results. This work was carried out during the latter years of the Second World War.

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Oxidation Changes in Natural Ilmenite

NAGATA has discussed the occurrence of three magnetic components of the Haruna and Asio rocks exhibiting thermo-remanent reversals[1]. The properties of the *B*-component appear to be very similar to those of a material recently examined in this laboratory. We have been investigating the impure ilmenite concentrate obtained as a by-product in the winning of rutile from beach sands on the east coast of Australia.

This concentrate may be refined magnetically to produce a highly magnetic fraction (containing magnetite and other highly magnetic materials and comprising about 2 per cent by weight of the total concentrate) together with fractions of weakly ferromagnetic material closely related to ilmenite which have volume magnetic susceptibility in the range $0·4 \times 10^{-3}$ to $1·1 \times 10^{-3}$ c.g.s.u. at low magnetizing fields. This variation in susceptibility is associated with a variation in apparent ferric to ferrous iron ratio, the range being 0·40–0·65, while the titanium (TiO_2) content is within the range (50 ± 2) weight per cent. Manganese is present to about 2 per cent by weight.

When any magnetic fraction of this 'ilmenite' is heated in air at a temperature in excess of 600° and below 800° C., an oxidation process occurs during which the apparent ferric to ferrous iron ratio rises to approximately 1·3 and, on cooling, the material shows much enhanced magnetic properties. The value of the initial susceptibility for a sample of firmly packed grains is approximately 2×10^{-3} c.g.s.u., about one-fifth of that for a similar sample of natural magnetite.

Observations have been made of the crystal structure and magnetic properties of this 'magnetic ilmenite' derived from different magnetic fractions of the original ilmenite, and no significant variation has been noted. Debye–Scherrer X-ray photographs were made for a particular fraction of the ilmenite and for the 'magnetic ilmenite' derived from this fraction, and these were compared. The pattern due to 'magnetic ilmenite' may be described as the superposition of a set of lines which were indistinguishable from the lines of the original fraction and of lines due to rutile. No difference has yet been noted by mineragraphic examination of the two sets of grains.

The Curie point of the 'magnetic ilmenite' is between 100° and 200° C., and the dependence on temperature of the magnetic properties is otherwise consistent with that for Nagata's *B*-component[1b].

Qualitative tests show that crystals of Norwegian ilmenite may similarly be changed to 'magnetic ilmenite', but the necessary temperature and time of heating will depend on the size of the crystals.

Prolonged roasting of the natural ilmenite at temperatures in excess of 800° C. results in the conversion of the iron to the ferric form. The final product is weakly ferromagnetic, and at low magnetizing fields the volume magnetic susceptibility is about $0·3 \times 10^{-3}$ c.g.s.u. The Debye–Scherrer X-ray pattern may be resolved into a set of rutile lines and a set of lines due to a tetragonal crystal with lattice parameters $a = 4·861$ A., $c = 6·625$ A., $c/a = 1·363$.

This investigation has been carried out in the J. I. Carroll Research Laboratory of this School and we wish to acknowledge the guidance of Prof. C. J. Milner.

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Flow Potentials in Hyaluronate Solutions

RECENTLY, it was found in this Institute[1] that solutions of potassium hyaluronate give elastic recoil when examined in a glass capillary by the 'œstroscope' technique[2]. This was ascribed to the long, flexible hyaluronate ions, which presumably form a lace-work all through the solution, knitted together by hydrogen-bond cross-links and adhering to the glass wall. The potassium ions are obviously more free to move, but in flowing, as soon as they tend to run in advance of the negatively charged hyaluronate polyions, a potential must arise to preserve electroneutrality.

In connexion with another recent finding in this Institute, that the endolymph of the inner ear in sharks contains a fair amount of hyaluronic acid[3], the possible occurrence of such flow potentials in hyaluronate solutions opened up an interesting possibility to account for the microphonic potentials detected in the inner ear by Wever and Bray[4] and thereby also to contribute to our understanding of the mechanism of perception in the inner ear.

To test the actual occurrence of such potentials we made a primitive model. From a screened capillary

U-tube in which a column of 0·5 per cent hyaluronic acid solution could be moved by gentle suction and blowing, the potentials between silver – silver chloride electrodes dipping through the two surfaces were led to the symmetrical d.c. input of a cathode ray oscillograph (*OSG* 41, Radiometer, Copenhagen; input impedance 1 MΩ).

In this way potentials of 6–10 mV. were obtained, positive at the advancing surface and persisting until the liquid is allowed to return towards its original position. In special cases much higher potentials (20–25 mV.) were found: namely, at the first displacement after filling with fresh solution, and when after blowing out the bulk of the solution we filled the tube with water, which slowly dissolved the adsorbed film. With pure water, and also with a 10 per cent gum arabic solution, potential shifts during the same manipulations were equal to or less than the noise-level of 1–2 mV.

A more detailed study of the potentials is planned, and we also hope in a later publication to give a detailed discussion of the significance of these potentials in connexion with the function of the inner ear.

We are indebted to the head of this Institute, Prof. J. A. Christiansen, for his interest in this work.

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Protective Effect of *d,l*-α-Octadecylglycerol-ether in Mice given Total Body X-Irradiation

Sandler[1] claimed that the protective factor against benzene poisoning found in yellow bone marrow is batyl alcohol or one of its esters. Since batyl alcohol is found in those organs which are said to contain a humoral factor that protects animals against the acute phase of irradiation injury[2], the following experiments were carried out. Sixty adult white male mice of an inbred strain (16 years) were irradiated with a therapeutic X-ray machine, 165 kV., 15 m.amp., filters 0·5 mm. copper + 1 mm. aluminium, target distance 60 cm., irradiation time 25 min., total dose 750 r. (air). Two hours after the end of the irradiation, thirty animals chosen at random were given 0·1 ml. of peanut oil subcutaneously, the others the same volume of peanut oil containing 2·5 mgm. *dl*-batyl alcohol per ml. These injections were repeated every second day until 1·75 mgm. of *dl*-batyl alcohol or a corresponding amount of the solvent had been administered to the animals. The 30-day lethality for the animals treated with batyl alcohol was seventeen out of thirty and for the controls twenty-six out of thirty. The difference is statistically significant ($P < 0·01$).

I have tried to find the optimal dosages for the synthetic alcohol and then for the naturally occurring alkoxyglycerol esters. From these experiments it can be concluded that in certain circumstances both these agents have a beneficial therapeutic effect on irradiation injury in mice; overdosage, however, increases the lethality. Further studies are in progress.

Simultaneously, but independently, Brohult *et al.* [following communication] have studied the effect of alkoxyglycerols in the treatment of leukopænia caused by irradiation.

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Alkoxyglycerols in the Treatment of Leukopænia caused by Irradiation

During irradiation therapy the blood-forming tissues are subjected to a great strain. At first this becomes noticeable in the form of a decreased white-cell count. This leucopænia sometimes necessitates an interruption of the irradiation therapy and consequently the time of treatment of the patient is prolonged.

Since the autumn of 1953, we have administered *per os* α-alkoxyglycerol preparations to some patients treated with irradiation. The alkoxyglycerols and particularly their esters are present in the lipids of several animal organs. One of the alkoxyglycerols, namely, batyl alcohol, is found in, for example, bone marrow fat[1], it forms part of the 'non-saponifiable' spleen lipids[2], and in the red cells[3]. It is also found in the liver lipids, and particularly in the liver lipids of sharks. Its presence in the red cells and in blood-forming organs is noteworthy.

The idea of administering extracts of erythropoietic tissues in disorders in the erythropoietic process is not new. Thus Marberg and Wiles[4] reported that the non-saponifiable portion of yellow bone marrow fat from cattle was effective in the treatment of agranulocytosis and leukopænia. Later Sandler[5] studied the erythropoietic effect of yellow bone-marrow extracts as well as batyl alcohol. Sandler states that a definite response in the reticulocyte count was obtained when batyl alcohol was administered orally to normal subjects.

We examined the effect in 1952 of giving the non-saponifiable portion of bone fats *per os* to some cases of leukæmia in children. We then continued with other preparations containing alkoxyglycerols and their esters in the form of concentrates. These concentrates had a higher potency than the bone-marrow preparations. The observations from some of these cases form the background of the experiments reported here.

To patients suffering from irradiation leukopænia, alkoxyglycerol esters were administered *per os* while the irradiation was continued. So far thirty-six cases have been studied. Of these, twenty-five responded to the therapy by an immediate increase in the white-cell count. In nine cases there was no further decrease in white cells after starting therapy. Only two cases showed a continued decrease in leucocytes.

A striking effect is illustrated by the following observations during the treatment of a nurse who had been occupied in radium therapy for some years. She had for more than a year a white-cell count of about 2,000 and was treated for five days with an alkoxyglycerol ester concentrate *per os* as the only therapy. Already after four days a white-cell count of 3,600 was reached. After withdrawal of medication, this level was maintained for five months with only one additional four-day treatment. A third period of four days of therapy followed after five months and resulted in a white-cell count of 4,200. Treatment for a few days obviously maintained the white-cell count on a normal level for a long period.

We thus conclude that treatment *per os* with alkoxyglycerols as well as their esters is a promising therapy against leukopenia caused by irradiation. The alkoxyglycerols might also give a more general protection of the blood-forming tissues against irradiation damages. A more detailed study of this subject, as well as of other effects of the alkoxyglycerols, will be published elsewhere.

Simultaneously, but independently, Edlund has studied the protective action of batyl alcohol on irradiated mice [see preceding communication].

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Exchange of ^{14}C-Glucose-1-phosphate with Uridine-diphosphate-glucose by the Galacto-Waldenase System

A TWO-STEP reaction, as represented by reactions 1 and 2, has been proposed[1] for the enzymatic transformation of galactose-1-phosphate into glucose-1-phosphate :

$$\text{Gal-1-P} + \text{UDPG} \rightleftharpoons \text{G-1-P} + \text{UDPGal} \quad (1)$$

$$\text{UDPGal} \rightleftharpoons \text{UDPG} \quad (2)$$

Reaction 2 has been experimentally demonstrated[1]. Kalckar *et al.*[2] have recently reported as evidence for the occurrence of reaction 1 the formation of 1 mol. of glucose-1-phosphate per mol. of uridine-diphosphate-glucose and of galactose-1-phosphate consumed, when these two compounds are incubated with diluted *Saccharomyces fragilis* extract.

If the proposed mechanism is correct, incorporation of carbon-14 glucose into the uridine-diphosphate-glucose should occur when this compound and ^{14}C-glucose-1-phosphate are incubated with *S. fragilis* extract. The experiments reported here have shown this to be the case.

Since phosphoglucomutase is present in the crude *S. fragilis* extracts, ^{14}C-glucose-1-phosphate could be replaced by ^{14}C-glucose-6-phosphate. This was prepared by incubation of glucose labelled uniformly with carbon-14 plus adenosine triphosphate with partially purified yeast hexokinase. A preparation purified by the method of Berger *et al.*[3] up to step 4 was used. ^{14}C-glucose-6-phosphate was precipitated as barium salt, which was then dissolved and re-precipitated with barium and alcohol. A preparation devoid of reducing power and inorganic phosphate was obtained.

^{14}C-glucose-6-phosphate and uridine-diphosphate-glucose were incubated with dialysed *S. fragilis* extract under the conditions specified in Table 1. The reaction was stopped by adding to the incubated mixture four volumes of alcohol and 0·02 ml. of *M* acetic acid solution. The protein precipitate was centrifuged and washed twice with 70 per cent alcohol. Supernatants and washings were mixed and the resulting solutions evaporated *in vacuo* to dryness. The residues were taken up in distilled water, deposited on a sheet of Whatman No. 1 filter paper, and chromatographed with the acid ethanol–ammonium acetate solvent[4]. Areas on the paper carrying the equilibrium mixture of uridine-diphosphate-glucose (75 per cent) and uridine-diphosphate-galactose (25 per cent) were located by ultra-violet light and eluted with distilled water. The amount of this equilibrium mixture in the samples was determined by measuring the absorption of an aliquot at 260 mμ in a Beckman spectrophotometer. The carbon-14-labelled equilibrium mixture was determined by measuring the radioactivity of an aliquot evaporated on an aluminium disk, with a thin mica end-window Geiger–Müller tube and a 'Tracerlab' scaler. As is shown in Table 1, after 30 min. of incubation, the radioactivity of glucose-6-phosphate was equilibrated with that of the above equilibrium mixture. The small amount of radioactivity found in the latter incubated without uridine-diphosphate-glucose must be due to the presence of small amounts of this compound in the dialysed extract.

When in the experiment described in Table 1, ^{14}C-glucose-6-phosphate was replaced by ^{14}C-glucose, no radioactivity was incorporated into the uridine-diphosphate-glucose.

Kalckar *et al.*[5] demonstrated the occurrence in *S. fragilis* extracts of reaction 3, catalysed by a specific pyrophosphorylase, which has been named 'uridyl transferase'[2] :

$$\text{UDPG} + \text{PP} \rightleftharpoons \text{G-1-P} + \text{UTP}. \quad (3)$$

The incorporation of ^{14}C-glucose into uridine-diphosphate-glucose might alternatively be explained by the reversal of reaction (3), were it not for the fact that in the absence of uridine-tri- or di-phosphate and adenosine triphosphate[6], a condition fulfilled by the dialysed extract, this mechanism is not operating. Thus our results are in favour of the mechanism represented by reactions 1 and 2.

Table 1. INCUBATION OF ^{14}C-GLUCOSE-6-PHOSPHATE AND URIDINE-DIPHOSPHATE-GLUCOSE WITH *S. fragilis* EXTRACT

Incubation at 37° C. of 0·33 μ*M* of ^{14}C-glucose-6-phosphate of specific activity 5,910 counts/min./μ*M*, 0·01 μ*M* of glucose-1,6-diphosphate, 0·3 μ*M* of uridine-diphosphate-glucose and 2 μ*M* of magnesium ions with 0·01 ml. of dialysed *S. fragilis* extract

Mixture	Incubation time (min.)	Spec. activity UDPG glucose counts/min./μ*M*	$\dfrac{\text{Spec. activity UDPG glucose (exp.)}}{\text{Spec. activity glucose-6-phosphate equilibrated with UDPG (calc.)}}$
Without uridine-diphosphate-glucose*	30	290	0·09
Complete	30	2,910	0·96
Complete	60	2,400	0·81

* UDPG added after the enzyme was inactivated

On the basis of the exchange experiment, a procedure was developed for the preparation of the equilibrium mixture of uridine-diphosphate-glucose and uridine-diphosphate-galactose with its hexose moieties uniformly labelled with carbon-14. As hexokinase is present in the *S. fragilis* extract, ^{14}C-glucose-6-phosphate could be replaced by ^{14}C-glucose and adenosine triphosphate. The equilibrium mixture was separated by chromatography on Whatman No. 3 filter paper using ethanol – ammonium acetate as developer, and was eluted with distilled water from the corresponding area and rechromatographed with methanol – formic acid[7]. When this rechromatographed product was chromatographed with ethanol – ammonium acetate, it gave only one spot showing absorption in the ultra-violet and radioactivity.

I am indebted to the Comisión Nacional de la Energia Atómica of the Argentine Republic and to Dr. W. Z. Hassid from the University of California for the provision of ^{14}C-glucose used in this work. I am especially indebted to Dr. L. F. Leloir for his continuous support of this work, and to Drs. C. E. Cardini, A. C. Paladini, H. G. Pontis Videla and J. L. Reissig for their helpful criticism.

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Alternate Pathways of Glycerol Oxidation in *Acetobacter suboxydans*

A PREVIOUS publication from this laboratory[1] has reported in detail the rapid oxidation of glycerol to dihydroxyacetone by resting whole cells of *A. suboxydans* 621, at *p*H 6·0. This conversion proceeds more slowly beyond the dihydroxyacetone stage. In cell-free extracts with triphenyltetrazolium chloride as the electron acceptor, glycerol is oxidized at a rate comparable to the oxidation of dihydroxyacetone, with the *p*H optimum about 8·5. This contrasting behaviour has been found to be due to the presence of two major oxidative routes for glycerol oxidation, one phosphorylative, the other independent of phosphate, as shown in Table 1. With cell-free extracts at *p*H 8·5, adenosine triphosphate is obligatory (in kinase systems) not only for the oxidation of glycerol but also for dihydroxyacetone, glucose, ribose or erythritol.

The pathway of dihydroxyacetone oxidation has been examined further, and found to possess the characteristics common to the Horecker pentose cycle[2], as follows: (1) Formation of dihydroxyacetone phosphate must first take place, either from glycerol-α-phosphate or from dihydroxyacetone plus adenosine triphosphate[3]. (2) Dihydroxyacetone phosphate is then converted through isomerase and aldolase to fructose diphosphate. (3) The latter loses one mole of phosphorus in the presence of magnesium to yield an acid-stable phosphate, presumably fructose-6-phosphate. (4) The latter reaches equilibrium with glucose-6-phosphate as measured by the resorcinol test[4] in the reverse reaction; (5) either of these compounds, when added, is oxidized by triphenyltetrazolium chloride and either tri- or di-phosphopyridine nucleotide to a material that gives a positive orcinol-pentose reaction. (6) Ribose-5-phosphate is converted non-oxidatively to sedoheptulose, triose and hexose derivatives in the amounts given in Table 2. The oxidative cycle is thus closed, with an expected *R.Q.* of 1·0 for dissimilation of dihydroxyacetone. This *R.Q.* has been obtained both in resting cells[1] and in the present cell-free extract.

Table 1. PHOSPHORYLATIVE AND NON-PHOSPHORYLATIVE OXIDATION OF GLYCEROL

ATP	Q_{O_2}					
	*p*H 6·0			*p*H 8·5		
	Whole cells	Cell free extract*		Whole cells	Cell-free extract*	
	Oxygen	Oxygen	Triphenyltetrazolium chloride	Oxygen	Oxygen	Triphenyltetrazolium chloride
–	10	22	0	0·6	0	0
+	10	23	0	0·6	12	9

* Cell-free extract; total soluble fraction, prepared as described previously (ref. 11).

Each Warburg vessel contained 50 μmol. malate buffer at *p*H 6·0 or 100 μmol. tris(hydroxymethyl) aminomethane (tris) at *p*H 8·5, 5 μmol. magnesium chloride, 0·2 ml. 20 per cent potassium hydroxide in the centre well. Concentration of adenosine triphosphate was 1 μmol./ml. wherever used. The whole-cell experiments contained in addition 40 μmol. glycerol, 10 mgm. cells (dry weight) and water to 3 ml. 3 μmol. diphosphopyridine nucleotide was added together with adenosine triphosphate at *p*H 8·5. The cell-free extract experiments with oxygen had 30 μmol. glycerol, 20 μmol. sodium fluoride, and 1 ml. cell-free extract in a total volume of 2 ml. The atmosphere was air. The tubes in the triphenyltetrazolium chloride experiments were incubated *in vacuo* with 5 μmol. glycerol, 50 μmol. tris, 10 μmol. sodium fluoride, 2·5 μmol. magnesium chloride, 5 μmol triphenyltetrazolium chloride, 0·1 μmol. diphosphopyridine nucleotide and 0·1 ml. cell-free extract in a total volume of 1 ml.

Q_{O_2} for whole cells = μatoms oxygen/mgm. dry cells/hr.; for cell-free extract = μatoms oxygen, or μmol. triphenyltetrazolium chloride/ml. cell-free extract (27 mgm. dry weight, 18 mgm. protein)/hr. Time intervals used to compute Q_{O_2} (usually 20–40 min.) were sufficient to permit conversion of up to 20 per cent of the added glycerol to dihydroxyacetone.

The pentose cycle thus appears to operate *in toto* in at least one microbial system, as well as in animal tissues[6] and plants[7]. Additional presumptive evidence for its presence in yeast[8] and *Escherichia coli*[3,9] is available, and preliminary observations in this laboratory indicate that this group of reactions may function in wheat smut fungi and pea aphids[10]. In

Table 2. NON-OXIDATIVE BREAKDOWN OF RIBOSE-5-PHOSPHATE BY CELL-FREE EXTRACT

Time (min.)	0	2	5	20	30
Sugar	μmoles sugar				
Pentose	10·0	8·9	7·3	4·4	0·8
Hexose	0·0	0·0	1·1	2·6	4·7
Sedoheptulose	0·0	0·4	0·7	0·9	0·6
Triose-phosphate	0·0	0·5	0·6	0·6	0·8
Total*	10·0	9·8	10·0	9·1	7·8

* Values for total sugars are given as pentose equivalents (μmol. carbon/5).

The tubes were incubated *in vacuo* with 10 μmol. ribose-5-phosphate, 100 μmol. tris buffer at *p*H 8·0, 20 μmol. sodium fluoride, 0·15 ml. cell-free extract and water to 2 ml. The reaction was stopped by adding 1·6 ml. of 10 per cent trichloroacetic acid. Pentose was assayed in the reaction mixtures according to Mejbaum (ref. 12), hexose and sedoheptulose with the sulphuric acid–cysteine reaction (ref. 7), and triose-phosphate as alkali-hydrolysable phosphate. Magnesium was omitted.

Acetobacter, however, the cycle is overshadowed during growth by the non-phosphorylative oxidation described above, which accumulates dihydroxyacetone more rapidly than it can be metabolized. Details of these and related oxidations in this organism will be presented elsewhere.

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Mechanism of the Formation of Red Melanin in the Silkworm

THE body-fluid of a mutant of the silkworm called 'Aka-Aka' (*rb*), which was discovered by me[1], turns red when exposed in the air, and the abnormal colouring of this mutant was supposed to be due to abnormal accumulation of 3-hydroxykynurenine[2]. I have recently investigated the mechanism of formation of this red colouring material.

Investigation by absorption spectroscopy and the relation of the decolorization to the reduction of the red colouring material proved that it was not a hallachrome, which is a red substance derived from tyrosine. Stepwise investigation of ultra-violet absorption spectra of the *rb* body-fluid during the course of the change of colour indicated that the absorptions at 270 mμ and 370 mμ which are characteristic of 3-hydroxykynurenine decreased and the whole absorption curve came to show the characteristics of melanin. Quantitative determinations of 3-hydroxykynurenine in the same samples by the diazo-oxide method[3] also indicated that the decrease of 3-hydroxykynurenine was parallel with the increase of red pigment.

The amounts of 3-hydroxykynurenine in the body-fluid obtained by crossing, for example, in *rb*/*rb* and +/+, were found to be 880 and 38 γ/c.c. respectively.

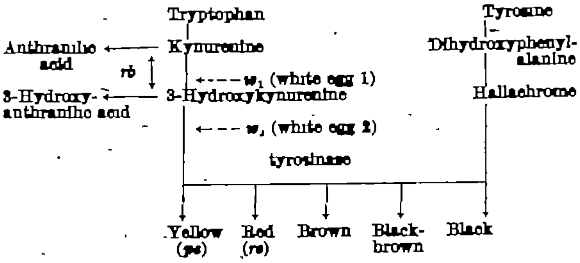
From the above facts, it will be clear that the body-fluid of silkworms turns red as 3-hydroxykynurenine accumulates in it, whereas it turns black if the amount of kynurenine is small. This conclusion was also affirmed by an *in vitro* test, in which the normal type body-fluid turned black when exposed to air; it turned red when 3-hydroxykynurenine was added.

Following up this idea, I have prepared melanin dyes of various colours from dihydroxyphenylalanine, 3-hydroxykynurenine and tyrosinase (potato) as follows:

Dihydroxyphenylalanine	3-Hydroxykynurenine	Tyrosinase	Colour	Precipitation
+	–	+	black	+++
2 mol.	1 mol.	+	black-brown	++
1 mol.	1 mol.	+	red-brown	+
0·5 mol.	1 mol.	+	red	±
0·25 mol.	1 mol.	+	red	–
—	+	+	yellow	–

While the increase of dihydroxyphenylalanine resulted in a black colour, 3-hydroxykynurenine produced a reddish colour.

Thus the mechanism of the formation of colouring materials in silkworm could be explained according to the following scheme, and the same mechanism can be applied to the formation of egg colour in the mutants called 'pink egg' (*pe*) and 'red egg' (*re*).



The absorption spectra were kindly measured by Dr. K. Ueno, of Dojindo and Co., Ltd.

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Primycin, a New Antibiotic

FROM the intestinal tract and the fæces of a strain of the larvæ of the wax moth (*Galeria melonella*), a micro-organism producing an antibiotic has been isolated. Morphologically, it belongs to the *Actinomycetes*, grows readily and spores abundantly on slightly alkaline nutrient agar, potato agar and asparagine agar, with an optimal yield of the antibiotic in a liquid medium containing 2–4 per cent corn-steep liquor and 1 per cent glucose. At 37° C. a surface culture on the latter medium begins to produce the antibiotic on the third day, with a maximal yield from the sixth to the ninth days. During growth the initial pH 7·4–7·6 of the medium rises to 8–8·5, accompanied by a steady decrease of carbohydrate and nitrogen concentration. At the peak of production a rapid lysis of mycelium takes place; but on further incubation the antibiotic concentration of the medium is not reduced.

The growth of *Staph. aureus* D. in a medium containing 5 ml. casein hydrolysate is inhibited by 0·01–0·03 ml. of the samples taken from surface cultures six to eight days old, diluted 1 to 10. Submerged cultures give an average yield somewhat below this level. On acidifying the filtrate of fermentation fluid (*p*H 2·5–2·8), a voluminous precipitate is formed which adsorbs the active substance to its surface almost quantitatively. The precipitate may be dried without loss of activity; its aqueous suspension is active at concentrations of 3–20 μgm. per ml. The substance is thermostable. The crude product contains 8–10 per cent ash, lipids and other organic substances, nitrogen 10–12 per cent, which can be removed by ether extraction. The active substance may be transferred quantitatively from the extraction residue to dry methanol, together with considerable pigment and inorganic phosphate impurities, which can be adsorbed with colloidal aluminium hydroxide. The active substance can be separated by adding ether to this partly purified and concentrated methanol solution. Solutions of this crude product inhibit the growth of *Staphylococcus aureus* D. in concentrations of 0·1–0·3 μgm. per ml. This crude product contains 5–32 per cent ash and 1·6–3·5 per cent nitrogen.

Further purification of this crude preparation was carried out by dissolving the precipitate in 20 per cent methanol and extracting this mixture repeatedly with butanol. The active substance was prepared by precipitation of the collected butanol extracts with ether. The effectiveness of the substance on this level of purity corresponds to 0·05–0·07 μgm./ml. By repeating this treatment further purification of the substance may be obtained, but the preparation still contains pigments in small amounts and 0·0–0·4 per cent ash. The active substance ('primycin') forms white micro-crystals when crystallized from methanol–butanol and melts at 166–168° C. with decomposition; analysis: C, 58·79; H, 9·56; N, 3·63 (Dumas); N, 3·58 per cent (Kjeldahl). These results correspond with the empirical formula $C_{19}H_{37}O_7N$, giving a molecular weight of 391·5. Ebullioscopic determination of molecular weight gave 329·9 (in methanol). The active substance has no characteristic absorption maximum either in the visible or in the ultra-violet region.

Primycin is fairly soluble in methanol (2·5 per cent), less soluble in higher alcohol homologues, sparingly soluble in pyridine, glacial acetic acid and water (50 mgm. per cent) and insoluble in other solvents. Its aqueous solution is sensitive to electrolytes, thermostable, strongly surface-active and adsorptive. In concentrated sulphuric acid it dissolves, giving first a yellow, then a red colour. It does not reduce Fehling's solution, does not react with aldehyde reagents and gives the Brunner–Pettenkoffer reaction. In a pyridine medium it can be acetylated. The acetylated (in pyridine) substance is inactive, but regains full activity after splitting off the acyl groups. Solutions of the purest product obtained so far inhibit the growth of *Staph. aureus* Duncan in concentrations of 0·02–0·06 μgm. per ml. It has *in vitro* a bacteriostatic effect on Gram-positive organisms, both pathogenic and non-pathogenic, as well as on Mycobacteria. In this order of magnitude it affects resistant strains too. The presence of serum reduces its potency to a quarter to a fifth of the initial potency. Its activity is increased at alkaline and reduced at acid reaction, with an optimal *p*H in the range 7·6–7·8. *In vitro* it is non-toxic to tissue cultures. So far as can be judged at present, it has also viricidal effects. Toxicity: *LD* mice, 2·5 mgm./kgm.; *LD* rats, 10 mgm./kgm.; *DT* rabbits, 10 mgm./kgm. In the rabbit a dose of 5 mgm./kgm. intraperitoneally is still detectable in the serum six hours after administration. Since in animal experiments it appeared to be toxic, only superficial infections of man have been treated with it, but good results have been obtained. On the basis of its chemical and biological properties, primycin is not identical with any of the known antibiotics.

A detailed account of this investigation is to be published elsewhere.

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Adrenocorticotrophic Activity of Melanophore-expanding Hormone Preparations from Beef Pituitary Glands

Since it has been claimed recently that adrenocorticotrophic hormone and melanophore-expanding hormone are identical, we assayed several melanophore-expanding hormone preparations from beef pituitary glands for adrenocorticotrophic activity.

The assays were performed according to a modification of the procedure of Saffran *et al.*[1] on melanophore-expanding hormone preparations of different potencies (respectively 25, 75 and 150 times standard posterior pituitary powder) which were prepared by Stehle[2] (we are indebted to Prof. R. L. Stehle for putting his preparations at our disposal). These preparations were found to possess relatively little adrenocorticotrophic activity, but there is a correlation between the two activities.

Preparation	Melanophore-expanding potency (I.U./(mgm.)	Adrenocorticotrophic potency (I.U / mgm.)	Range of adrenocorticotrophic potency (I.U./mgm.)	Ratio of melanophore-expanding to adrenocorticotrophic potency
1	50	0·024	0·015–0·039	2,080
2	150	0·065	0·034–0·126	2,310
3	300	0·167	0·106–0·241	1,800

The table lists the melanophore-expanding and adrenocorticotrophic activities of three melanophore-expanding hormone preparations. Preparation 1 was used as the starting material for preparation 2, which, in turn, was used to prepare 3. At the three stages of purification of the melanophore-expanding hormone, the ratio adrenocorticotrophic and melanophore-expanding activity remains essentially constant.

Our results show that potent preparations of melanophore-expanding hormone contain only traces of adrenocorticotrophic activity, so that it is impossible to conclude that melanophore-expanding and adrenocorticotrophic activities are entirely shared by the same molecule. The constancy of the ratio of the adrenocorticotrophic potency to the melanophore-expanding activity upon purification does not rule out the possibility that adrenocorticotrophic hormone is present as an impurity in the melanophore-expanding hormone preparation, but it also strongly suggests that melanophore-expanding hormone may possess some slight inherent adrenocorticotrophic activity.

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Salicyloylhydrazide: a Reagent of Wide Use in Organic and Histochemical Analysis

Present methods of demonstrating ketosteroids in tissues are generally regarded as being unsatisfactory. 2-Hydroxy-3-naphthoyl hydrazide[1] is the reagent most recently introduced for this purpose, yet it condenses only sluggishly with carbonyl groups and fails to distinguish between aldehydes and ketones. A number of phenolic hydrazides have since been tested. Of these, 2 : 4 dihydroxybenzoylhydrazide[2] is better in that it provides azo-hydrazones of different colours in the ketosteroid group[3], but it still lacks adequate condensing reactivity.

Salicyloylhydrazide[4] is at present under investigation, and the preliminary results now reported may prove of interest to workers both in histochemistry and in other fields. It has been found that the aldehydic salicyloylhydrazones fluoresce brilliantly in diverse colours under ultra-violet light, whereas the ketonic derivatives which have been studied exhibit a uniform dull blue fluorescence. Zinc acetate greatly intensifies the ketonic fluorescence, but has no appreciable effect on the fluorescence of the aldehydic derivatives. A similar but very much weaker reaction is obtained with cadmium salts. Neither the reagent nor the carbonyl compound separately shows any luminescence at low *p*H.

The colour and intensity of fluorescence of the salicyloylhydrazones may be further controlled in two fundamental ways: (1) chemically, by alteration of *p*H, by treatment with free halogens, and by chelation; and (2) optically, by using an instrument capable of offering a series of monochromatic beams of ultra-violet light of differing wave-lengths. Preliminary experiments, utilizing varying combinations of these two control procedures, indicate that it may be possible to devise a system capable of distinguishing individual components of a mixture of ketones.

Investigations have also been carried out to determine quantitatively the condensing reactivity of the reagent. In a typical experiment, dehydroepiandrosterone was condensed with salicyloylhydrazide in acetic acid solution and excess reagent removed by washing with dilute hydrochloric acid. The salicyloylhydrazone, in virtue of its being a phenol, was then converted to an indoaniline by coupling it with *p*-aminodiethylaniline (stabilized with sulphur dioxide), in the presence of periodic acid as oxidant. The intensely coloured blue-green indoaniline was extracted with ethyl acetate and the optical density read in an absorptiometer against a blank determination, using a suitable filter. A linear relation was found between the optical density and the amount of ketosteroid present over the range 5–50 μgm.

Quantitative estimation of ketosteroids by fluorimetry of the salicyloylhydrazones is being studied in order to achieve an analytical method of a more direct and simple character.

Although salicyloylhydrazide has been investigated in the first instance as a reagent for use in histochemistry, the indoaniline reaction for phenols and also the fluorescent reaction of zinc acetate with salicyloylhydrazones are obviously capable of much wider application.

In general, salicyloylhydrazide is superior to the previous hydrazides I have described[1,2] in respect of reactivity in condensation, in differentiating capacity and in lending itself to colorimetric determination of ketosteroids.

The detailed use of the foregoing procedures in histochemistry and in relation to the estimation of ketosteroids will be the subject of future communications.

I am grateful to Prof. J. Patterson for his guidance throughout and to Prof. R. J. Harrison and Dr. G. H. Bourne for histochemical facilities provided at the London Hospital Medical School. The optical experiments were carried out at the National Institute for Medical Research in conjunction with Mr. J. Smiles, to whom I am indebted for the special knowledge and advice he contributed.

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Lingual Proprioception in Pig, Dog and Cat

The muscle-spindles, shown by Cooper[1] to exist in the intrinsic tongue muscles of man and rhesus monkey, have not so far been satisfactorily demonstrated in other species.

Cooper has failed to find proprioceptive end-organs in the intrinsic musculature of the tongue in lamb and kitten, and this finding has been confirmed and extended by a histological survey of mammalian tongues in the course of this work.

However, the pattern of innervation in the tongues of pig, dog and cat suggests that proprioceptive impulses in these animals may be, at least in part, conveyed through a certain specialized form of receptor found in the intramuscular connective tissue, which is sufficiently constant in all three species to justify further attention.

Thick frozen sections, prepared by the diammine-silver ion method of Garven and Gairns[2], show that these end-organs are formed by a coil of axis-cylinder enclosed in an oval or pear-shaped capsule, which appears to be a terminal dilation of the neurilemma. The long axis of the capsule lies parallel to that of the muscle fibres. The endings occur mainly in the intrinsic muscles and are most abundant between the vertical and transverse groups, where they are closely associated with the strata of motor innervation in this region. A few endings were found in the inferior longitudinal muscle; none was noted in the superior longitudinal.

The structure and position of the intramuscular endings suggest that deformation of the capsule resulting from muscular activity, may initiate low-threshold stimuli of a proprioceptive nature.

While histological evidence points to the derivation of the nerve-endings from fibres of the hypoglossal, it must be remembered that no conclusive evidence has been produced regarding an afferent component in this nerve. Boyd[3] alludes to the presence of Froriep's ganglion in the pig; but our examination of the hypoglossal in six infant pigs failed to reveal sensory cells on its intra- or extra-cranial fibres. This may be due to the general inconstancy of the ganglion, or to the immaturity of the subjects, and will require further investigation. In two of the animals, a well-marked group of sensory cells was noted on the extra-medullary fibres of the eleventh cranial nerve.

The function of tactile receptors in the regulation of tongue position must also be considered. In the animals examined, well-developed end-organs in the form of modified Meissner corpuscles were numerous in the dorsal mucosa of the posterior third of the tongue, and a few of similar character were observed near the tip.

It is perhaps significant that in the middle third of the tongue, where intramuscular connective tissue endings are most evident, no tactile corpuscles could be identified.

The investigation of lingual proprioception in mammals is being further pursued, the work being assisted by a grant from the Medical Research Council of Ireland.

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Presence of Zinc in Nucleoli and its Possible Role in Mitosis

The nucleolus is now believed to be composed mainly of ribonucleoproteins (Caspersson[1], Brachet[2]), although Vincent[3], who succeeded in isolating large quantities of nucleoli from starfish oocytes, concluded that the bulk of the nucleolus is phosphoprotein. On the other hand, Jacobson and Webb[4], like Zirkle[5] before them, indicated that some nucleolar substances (ribonucleoproteins) are contributed to the chromosomes during the mitotic cycle. Doubt exists, however, as to whether it is correct to regard ribonucleic acid and proteins as the only constituents that are important. We may suspect that other nucleolar substances which are less obvious play important parts in mitosis.

In a forthcoming paper, it has been shown[6] that zinc is found in considerable amount in the nucleoli of starfish oocytes. When the suspension of isolated nucleoli of the starfish oocyte, *Astropecten scoparius*, was allowed to stand with a small amount of 6 mgm./100 ml. dithizone solution in carbon tetrachloride for several hours, a deep-red colour was produced in the latter layer. This suggested that complex formation was occurring between zinc and this reagent within nucleoli. The proof that zinc is responsible for this dithizone reaction came from observations on polarograms. When the ash of the isolated nucleoli was analysed polarographically in the presence of zinc-free sodium acetate (pH 4·8), it gave a wave with a half-wave potential at − 1·05 V., suggesting that zinc was obviously reacting.

We have now proceeded some way with the analysis of the behaviour of the zinc during the mitotic cycle. It was found that when a small quantity of a saturated solution of diphenylthiocarbazone (dithizone) in 60 per cent alcohol, which was diluted with an equal volume of a borate buffer (pH 8·4), was added to the fertilized sea-urchin eggs, *Clypeaster japonicus*, on the slide, a purple colour was instantly developed within the nucleoli. The nucleoli of other forms, such as starfish oocytes and the staminal hair cells of *Tradescantia*, also stained purple, in marked contrast to the nearly colourless nuclear substance and cytoplasm.

We have further found that if sea-urchin eggs are treated with a small amount of alcoholic dithizone, mitosis proceeds practically normally, and the fate of the purple-staining substance can be traced throughout the mitotic sequence. It was found that the whole spindle first appeared faintly purple at about the time when the nucleolus disappeared (late prophase or prometaphase). The chromosomes were also seen to stain purple within the spindle. Whether spindle fibres were stained cannot be stated, although purple striations were often observed. It is interesting that the living spindle is clearly visible under these conditions. At metaphase, when the chromosomes were gathered at the equator of the spindle, they stained most deeply and appeared in greater relief under the ordinary microscope. They remained so during anaphase and gradually lost their purple-staining component as they swelled in telophase. It was possible to follow the movement of the faintly stained masses of chromosomes as they were incorporated into daughter nuclei. It appeared that the staining substance was then transferred from the chromosomes into the nuclear sap and finally consolidated into the nucleoli. It is of special interest to observe that the spindle as a whole became suddenly colourless at the beginning of anaphase, though in the final telophase some purple striations reappeared in the spindle region. Whether the centres or the centrioles stain cannot be decided. Since, however, the middle-piece and acrosome of the sperm were also found to be dithizone-positive (Fujii[6]), it is likely that the centres contain zinc. No evidence was found that asters are dithizone-positive.

These observations on the behaviour of nucleolar substance during mitosis are, of course, open to objections, since the dithizone reaction is not very specific and the chromosomes are too small to draw any definite conclusions. But the evidence so far obtained suggests that zinc is present in nucleoli and that, upon the initiation of mitosis, it passes into the chromosomes and possibly also into the prometaphase spindle.

Lastly, we may suggest that the behaviour of the zinc is related in some way to the reversible denaturation of active proteins, which might be involved in the physical changes of chromosomes and of the spindle during mitosis, for we are obtaining evidence that a parallel exists between the unmasking of —SH groups and the release of zinc from some tissues. It is likely that zinc is only released in catalytic quantities from nucleoli or from chromosomes, and is acting as what Swann[7] calls a 'structural agent'. Structural changes of chromosomes during mitosis, which are interpreted by Kuwada[8] as due to hydration and dehydration, may also be explained by this hypothesis.

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Stability in Development and Relational Balance of X-Chromosomes in *Drosophila melanogaster*

Mather[1] has shown that asymmetry of sternopleural chaeta number in *Drosophila melanogaster* is subject to genetically controlled variation and is a valid measure of the capacity of the genotype to promote stabilization or canalization of the development of the individual. The following results show effects on asymmetry of X-chromosomes extracted from four different experimental populations.

Two of these populations have been maintained at a constant 25° C. and the other two have spent each day at 25° C. and each night at 15° C. (For the present purpose, however, these should merely be regarded as two different environments, for their mean temperatures are different and there is no check that any difference due to environments arises from the fluctuation in temperature rather than the mean.) The populations were all started at the same time from a combination of the same two laboratory stocks, one homozygous for w^e and the other for w. (The effects of selection on this locus have already been reported[2].)

After the populations had been maintained for sixteen months, w^e males were extracted from each of them and mated to Muller-5 females. The X-chromosomes from these males were then maintained by continually backcrossing the heterozygous w^e/Muller-5 females to stock Muller-5 males. It had been intended to control chromosomes II and III using balancers, but the appropriate crosses gave difficulty so that backcrossing was relied on to give reasonably uniform genetic backgrounds. After five generations of backcrossing, the X-chromosomes were tested by matings that would produce females homozygous for a particular X-chromosome (H flies), matings that would produce females heterozygous for X-chromosomes from the same population (intra-population heterozygotes: I flies) and matings that would produce females heterozygous for X-chromosomes from different populations that had been maintained in the same environment (extra-population heterozygotes: E flies). The experiment involved replicate cultures (apart from failures), three chromosomes from each population, and each chromosome or combination was tested in each of the two environments. The experiment was repeated after a further generation of backcrossing. Ten w^e/w^e females were counted from each culture, and the sum of their arithmetical asymmetries was used as the datum for analysis. (It should be noted that the measure of asymmetry used for this preliminary report differs from that used by Mather.)

Table 1

Type of female	Environment of test culture	Environment of population from which X-chromosomes were extracted 25° C.	Fluctuating	Total
Homozygotes (H)	Home Foreign	189 221	174 230	363 451
	Total	410	404	814
Intra-population heterozygotes (I)	Home Foreign	194 162	157 180	351 342
	Total	356	337	693
Extra-population heterozygotes (E)	Home Foreign	236 224	230 218	466 442
	Total	460	448	908
	Total, Home „ Foreign	619 607	561 628	1,180 1,235
	Total	1,226	1,189	2,415

Table 2

Source	Sum of squares	n	Mean square	Correct F	p
Type of fly (HIE)	242·0208	2	121·01	26·06	<0·001
Env of population (EP)	4·7535	1	4·75	1·02	—
Env of test culture (EC)	10·6028	1	10·60	2·26	>0·05
HIE × EP	0·8820	2	0·44	—	—
HIE × EC	70·6534	2	35·33	7·61	<0·001
EP × EC	21·6706	1	21·67	4·67	<0·05
HIE × EP × EC	22·1938	2	11·10	2·39	>0·05
Repetitions	12·0868	1	12·09	2·71	>0·05
Residual* (error)	1,106·4549	238	4·64		
Total	1,490·2188	250†			

* Differences between cultures (that is, within chromosomes) give a slightly larger mean square than all other residual differences combined. Hence a combined error is used.

† Of the 288 cultures, 37 failed.

Table 1 gives the pooled results, the environments of the test cultures being classified into 'home' (the same as that of the population from which the tested X was obtained) and 'foreign'. Table 2 gives the results of analysis of variance of the 288 culture results. There are two highly significant items, the HIE comparison and the interaction HIE by culture environment.

All three items involved in the HIE comparison are significantly different from one another. (This variation of asymmetry is not a result of variation of mean bristle number. The mean bristle numbers per fly are H 16·2335, I 16·2296 and E 16·2069.) The significant interaction arises because the homozygotes are specifically adapted to the 'home' environment, whereas I heterozygotes are as well-adapted to either environment as are homozygotes to the 'home' environment and E heterozygotes are as ill-adapted to either environment as the homozygotes to the 'foreign' environment.

We may assign 1 as a measure of the stability of homozygotes in their 'home' environment and 0 as a measure of their stability in the 'foreign' environment. The significant differences and the similarities can then be summarized as follows:

Type of fly	Culture environment Home	Foreign	Total
Homozygotes	1	0	1
Intra-population heterozygotes	1	1	2
Extra-population heterozygotes	0	0	0

A number of points emerge:

(1) The homozygotes are as stable in development as any other type in the home environment. This stability presumably depends upon an internal balance[3] and is not surprising since, if the X-chromosome is to contribute to stability, it must operate in the hemizygous male as well as in the female.

(2) The intra-populational heterozygotes are equally stable in the foreign environment (they are phenotypically flexible in the sense of Thoday[4], or homeostatic in the sense of Dobzhansky and Wallace[5]). Their stability in the foreign environment does not depend upon their internal balance since it is not reproduced by the homozygotes. Neither does it depend on some virtue of heterozygosity *per se* as Robertson and Reeve[6] have suggested, for it does not extend to the extra-populational heterozygotes. It clearly depends on the fact that the chromosomes contained in the heterozygotes have evolved in relation to one another through the operation of natural selection in a single population of outbreeding organisms producing relational balance in Mather's sense[3].

(3) Despite the fact that both the chromosomes involved have internal balances conferring stability to the same environment, the extra-population heterozygotes are unbalanced in the home environment: in this environment they show negative heterosis, underlining the conclusion that positive heterosis depends upon relational balance. These E heterozygotes are also no better than the homozygotes in the foreign environment, though no doubt some environment might be found in which the homozygotes are inferior.

Contemporary genetical research is rapidly producing example after example in which heterozygotes are proving to have smaller non-genetic variances than have corresponding homozygotes, and there is a danger that it may be concluded that heterozygosity necessarily promotes homeostasis. The present results indicate that, sometimes at least, relational balance is necessary, and that some homozygotes can be superior to comparatively unbalanced heterozygotes.

Mather (ref. 1, pp. 330, 331) has already discussed the relationship between selection, breeding system and stability of development and suggested that superior stability of heterozygotes is less likely in naturally inbreeding organisms. The present results provide an illustration of a similar principle.

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[6] Robertson, F. W., and Reeve, E. C. R., *Nature*, 170, 296 (1952).

Liberation of Amino-acids by Plant Roots in relation to Desiccation

PREVIOUS reports from this laboratory[1–3] have shown that in the rhizosphere, or zone of influence of the roots of growing plants, there is a preferential stimulation of bacteria requiring amino-acids for maximum growth. This communication concerns the production of amino-acids by roots of several kinds of plants in an attempt to explain, at least in part, the preferential effect noted on this group of organisms.

Although frequent mention is made of excretion of organic substances by roots, there is surprisingly little information as to the extent of such excretion or the nature of the substances liberated. There is certainly very little evidence of excretion of amino-acids by roots of non-legumes, although Kandler[4] has reported recently the liberation of amino-acids by excised roots of maize. The production of certain specific amino-acids by roots of legumes, as shown by Virtanen and his group, may be considered a special case, since it involves a symbiotic relationship with the nodule bacteria. It may be postulated that amino-acids are produced in the rhizosphere in amounts which would permit growth of amino-acid-requiring bacteria, by a number of agencies only one of which may be excretion from intact roots. They may also be liberated from sloughed-off root caps, root hairs or epidermal cells and by the decomposition of these root fragments, and of microbial protoplasm. In addition, they may arise through microbial synthesis, for there is some evidence that bacteria with simple nutritional requirements, also stimulated in the rhizosphere, liberate amino-acids which can be used by the amino-acid-requiring bacteria[5]. Preliminary experiments with six- to eight-week-old soybean, tomato and wheat plants showed that these could absorb known amino-acids through their leaves and that these acids were recoverable in the dilute mineral solution in which the roots were immersed. It was also noted that even roots of control plants, not fed amino-acids, contributed variable, though small, amounts of ninhydrin-positive substances to the mineral solution. When such roots were allowed to dry and then remoistened, a striking increase in amino-acids was observed. In normal field conditions, plant roots are subjected to desiccation and remoistening. In the light of the above observation, this may contribute significant amounts of amino-acids for the rhizosphere microflora and thus account in part for the preferential stimulation of amino-acid-requiring bacteria.

Further data on the nature of the amino-acids liberated and the extent of such production were obtained from plants grown in thoroughly washed sand moistened with a suitable mineral solution. After these plants were six to eight weeks old, the pots were divided into two lots, one of which was allowed to dry out and the other kept moistened. When the sand was dry and the plants showed signs of wilting, all pots were brought up to their original weight, and after one hour leached with water; 200 ml. was collected from each pot and the leach water filtered through paper. One portion was concentrated *in vacuo* for chromatographic and total amino-nitrogen analysis, and the remainder dispensed into test-tubes and sterilized after the addition of 0·1 per cent glucose. These tubes were inoculated with selected amino-acid-requiring bacteria. The results of amino-nitrogen analysis by heating with ninhydrin[7] and determining the intensity of the resulting colour at 540 mμ in a Klett–Summerson photoelectric colorimeter are given in Table 1. It is clear that appreciable amino-nitrogen was elaborated in sand which was dried and remoistened in the presence of the plant root system, but not in sand, treated similarly, after the plants had been removed. These results were confirmed by means of paper chromatography, which showed a variety of amino-acids in the leach water of treatment 2, including glutamic and aspartic acids, leucine, alanine, cysteine, glycine, lysine, phenylalanine and proline (isatin spray). Still further corroboration was provided by the observation that by far the best growth of the amino-acid-requiring bacteria tested occurred in the leach water of treatment 2. Similar experiments were set up with 50 per cent sand–soil mixtures with essentially similar results. Of interest, too, is the evidence of the presence of ninhydrin-reactive material in the leach waters of pots kept moist throughout the duration of the experiment, suggesting that even such plants may liberate amino-nitrogen, perhaps by sloughing off root fragments. Experiments under way with completely sterile systems indicate that small amounts of ninhydrin-positive substances are produced by roots under these conditions also.

Table 1. LIBERATION OF AMINO-ACIDS BY PLANT ROOTS

Treatment	Total amino-nitrogen* (optical density at 540 mμ)			
	Tomato	Soybean	Barley	Oats
1. Dried sand, remoistened after plants removed	5	0	0	0
2. Dried sand with plants; remoistened	67	209	193	287
3. Wet sand, after plants removed	5	10	0	2
4. Wet sand, with plants	10	10	0	2

* Average of triplicate tests

The presence of a reducing compound with an R_F value identical with that of glucose has also been observed in the leach waters (treatment 2, Table 1) of the four plants studied.

H. KATZNELSON
J. W. ROUATT
T. M. B. PAYNE

Bacteriology Division,
Science Service,
Department of Agriculture,
Ottawa.
Aug. 12.

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[1] West, P. M., and Lochhead, A. G., *Can. J. Research*, C, 18, 129 (1940).

[2] Katznelson, H., and Richardson, L. T., *Can. J. Research*, C, 21, 249 (1943).

[3] Lochhead, A. G., and Thexton, R. H., *Can. J. Research*, C, 25, 20 (1947).

[4] Rouatt, J. W., and Atkinson, R. G., *Can. J. Research*, C, 28, 140 (1950).

[5] Wallace, R. H., and Lochhead, A. G., *Can. J. Research*, C, 28, 1 (1950).

[6] Kandler, O., *Z. Naturforsch.*, 6b, 437 (1951).

[7] Koch, F. C., and Hanke, M. E., "Practical Methods in Biochemistry" (5th edit., Williams and Wilkins Co., Baltimore, 1948).

Variation of the Shells of *Murex tribulus* from the Great Bitter Lake, Egypt

On the shore of the Great Bitter Lake in the neighbourhood of Fayid, the most conspicuous member of the molluscan fauna is a gastropod which, according to the authorities at the British Museum (Natural History), belongs to the species *Murex tribulus*. The shells at once attract attention by their remarkable variability.

To the student of variation in animals, the shells are of particular importance inasmuch as the varying features are of such a nature as to facilitate accurate observation, exact measurement and reliable record. Among these features, apart from variation in size, shape and in the proportions of the various parts, the most conspicuous are the numerous blunt spines projecting from the shell and playing a main part in giving the shell its very characteristic appearance. It is these spines, too, which provide material of special importance to the student of variation.

The material for this study consists of a collection of some three hundred shells made by Sir John Graham Kerr while staying at Fayid during the early months of 1951 and 1953. The collection is now in the Science Department of the College of Notre Dame, Dowanhill, Glasgow.

The details of a typical shell are shown in Fig. 1 (upper). The spines are arranged in rows, each row corresponding to a varix, three large to each whorl of the shell. A ridge or rows of tubercles is continuous between each spine and the corresponding spine of the next whorl, those connecting the large spines being more prominent than those connecting the small ones. The body whorl of the shell is drawn out into the tapering anterior canal bearing spines, except at the extreme tip. This carries the siphon and therefore in life is lined by the mantle. Variation occurs in the length of the anterior canal between about 5 and 39 per cent of the total length of the shell, and markedly also in the length of the portion free from spines, this portion being so short in some cases as to give the shell a truncated appearance. Examination of the individual spines shows that they vary greatly—in length—from a mere tubercle up to about 12 mm., and in the angles at which they spring from the surface of the shell. Examination of a corresponding spine in the various shells showed that this angle varied between 22° and 53°.

An elaborate and detailed study of the whole collection has been carried out by Sister M. Josephine Parkes. Most regrettably, the publication of her valuable paper, illustrated by beautiful photographs by Dr. H. F. Steedman, of the Department of Zoology, University of Glasgow, has been held up for the time being.

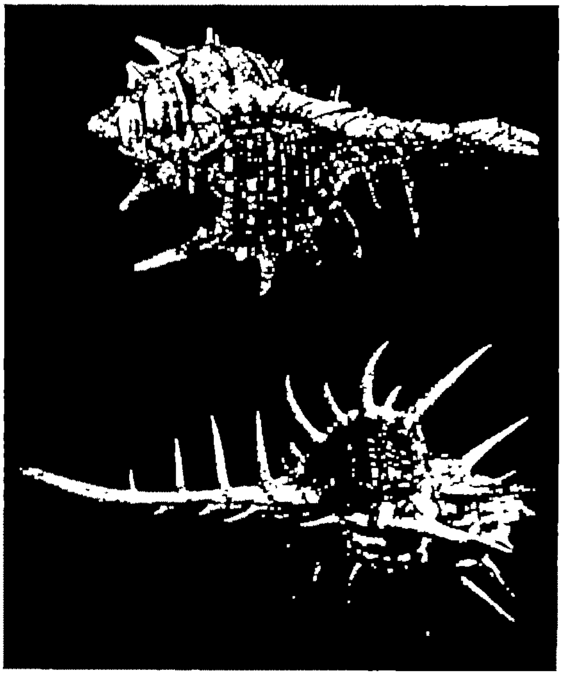

Fig. 1

The Bitter Lakes occupy part of the channel of what once formed a communication between the Red Sea and the Mediterranean. At the time of the cutting of the Suez Canal in 1869, the site of the Bitter Lakes was dry land; but the opening of the Channel into the Gulf of Suez admitted the waters of the Red Sea, and the Bitter Lakes came into being. As time went on they became colonized by immigrant organisms from the Red Sea and among these was *Murex tribulus*.

The collection and preliminary study of the shells from Fayid were made in ignorance of the Red Sea forms from which they were presumably derived. It was therefore with much interest that specimens from the Red Sea were later examined. In these the blunt spines of the specimens from the Great Bitter Lake were found to be sharply pointed, as shown in Fig. 1 (lower). This specimen came from the shallow waters between the coast and the coral reef at Hurghada. There these spines may well constitute a most effective armature against the voracious enemies among which this species lives.

I have to thank Mr. D. E. Morgan, of the Anglo-Egyptian Oilfields, Ltd., for facilitating the collection of 185 specimens from Hurghada on the west side of the Red Sea close to the opening of the Gulf of Suez, and 114 from Ras Matarma on the east side of the Gulf of Suez. To him and his colleagues and to many others who have responded to my appeal in *Nature*[1], I must extend my warmest thanks.

To the general zoologist, the facts summarized here are of great interest. *Murex tribulus* is an organism which by its perfect adaptation has been able to survive and flourish amid all the complexities and dangers incidental to the luxuriant and varied fauna inhabiting the coral reefs and their immediate neighbourhood. The Fayid specimens represent members of the species that have wandered into the placid environment of the Bitter Lakes with their comparatively sparse fauna; and the lesson they teach is how a species, freed from the shackles of the environment to which it has been through long ages adapted, gives way to the general instability of living substance and shows untrammelled variability.

MONICA TAYLOR

Notre Dame,
Glasgow.
July 7.

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[1] *Nature*, 171, 756 (1953).

A Hydropolyp in the Biological Cycle of a Freshwater Jellyfish

DURING investigations on the invertebrates of Lake Tanganyika we have been able to find all the stages of the sessile generation of the well-known Tanganyikan Trachymedusan *Limnocnida tanganyicae* Günther. We have also collected them in Lakes Mohasi and Sake (Ruanda), where the sexual reproduction seems to be more important. These hydropolyps are completely invisible when living and must be treated first with some fixative (Bouin's or Zenker's fluids); they are very minute (less than 0·5 mm. for one individual) and transparent.

Exceedingly voracious, they feed on midge larvæ. They live in quiet places (Gulf of Burton) in Lake Tanganyika, or in calm lakes (such as Mohasi or Sake). They attach themselves principally around the septa of *Phragmites* stems, and they are very often mixed with colonies of Bryozoa.

In Lake Mohasi, sexual reproduction takes place from mid-April to the beginning of September. In Lake Tanganyika it only begins at the end of May.

This finding shows that, contrary to the marine Trachymedusæ, most of the freshwater forms have a sessile sexual stage.

The complete study of this sexual generation will be published elsewhere.

J. BOUILLON

Institut pour la Recherche
Scientifique en Afrique Centrale,
Centre de recherche de Tanganyika,
Uvira.
July 12.

"Sixth Commonwealth Entomological Conference"

IN the account in *Nature* of September 18, p. 541, of the Sixth Commonwealth Entomological Conference, I am reported as saying that the results of insecticides used against tsetse fly suggest that tsetse populations "may be unable to recover after reduction below a certain level".

My point was quite different. It was that the tsetse population might be found to maintain itself permanently at *any* level (above, of course, a low minimum) to which the insecticide had reduced it. This idea, first put forward by me in 1937 (*Proc. Zool. Soc. Lond.*, 1936, 811, Section X), is now supported by some of the findings of the East African Colonial Insecticides Research Unit (Hocking, Parr, Yeo and Anstey, *Bull. Ent. Res.*, **44**, 627; 1953), and has the greatest practical importance as, for example, when a few flies straggle back across a barrier into country from which they had previously been evicted.

C. H. N. JACKSON
(Chief Entomologist)

Central Tsetse Research Laboratory,
P.O. Shinyanga,
Tanganyika Territory.

IT is regretted that, in the attempt to convey in a few lines the gist of long and complex discussions, Dr. Jackson has inadvertently been misrepresented. The relevant passage in his paper is as follows: "To my mind, the fundamental fact arising from all this work is that isolated tsetse populations by no means always tend to recover, when applications of insecticide cease." At an earlier meeting, Dr. Jackson had indicated more precisely the point he now emphasizes, namely, that the results of insecticide experiments seem to confirm his view that the size of tsetse populations is not controlled by density-dependent factors. The discussion, however, had been principally directed to the question, which he now dismisses in a parenthesis, of whether there was a ***minimum*** size of stable population of tsetse. It was suggested that a percentage reduction of the order that can be achieved by insecticides might, with an initially small population, result in a density so low that the fly could not maintain itself, particularly—as Dr. Jackson pointed out—if the environment were then altered by settlement. It was this thought, which was evidently felt to be of the highest practical importance, that the offending sentence sought to convey.

THE WRITER OF THE ARTICLE

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 13

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 4 p.m.—Dr. Donald Hunter: "Lung Disease due to Dusts".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof J. Z. Young, F.R.S.: "Memory" (Ramsden Memorial Lecture).

INSTITUTE OF METAL FINISHING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. H. Silman: "Recent Developments in Chromium Plating".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 8 p.m.—Prof. C. H. Waddington, F.R.S.: "The Philosophic Bearing of some Recent Ideas on Evolution".

Monday, December 13—Tuesday, December 14

PHYSICAL SOCIETY (in the Poynting Physics Building, The University, Birmingham)—Autumn Meeting on "A Survey of Field Theory".

Tuesday, December 14

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. G. W. Jull: "The Ruthemann Spectra of Electrons".

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP, SOCIETY OF CHEMICAL INDUSTRY, and the INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. Ewen McEwen and others: "The Drying of Wheat Grain".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Dr. F. M. Lea: "Experimental Science and Civil Engineering Research" (Unwin Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. W. Bowdler: "An Attracted-Disc Absolute Voltmeter"; Mr. M. H. Halne and Mr. M. W. Jervis: "The Use of an Electron Velocity Analyser to Stabilize a 50 kV. D.C. Voltage Source to a Few Parts in a Million"; Mr. M. W. Jervis: "A Precision Direct-Current Stabilizer".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. S. Mottram: "Compounding the Vinyl Polymers". 7 p.m.—Dr. F. M. Merrett and Mr. R. I. Wood: "Polymer-modified Natural Rubber".

Tuesday, December 14—Wednesday, December 15

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY (at the Cambridge Union Society, Bridge Street, Cambridge)—Third Crop Conference—"Crops for Home Feeding".

Wednesday, December 15

UNIVERSITY OF LONDON (at the Postgraduate Medical School of London, Ducane Road, London, W.12), at 2 p.m.—Prof. A. Wormall: "Isotopes in Medical Investigation".*

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. H. G. Reading: "The Stratigraphy and Structure of the Cotherstone (Stainmore) Syncline"; Dr. D. A. Robson: "A Sedimentary Study of the Fell Sandstones of the Coquet Valley, Northumberland".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 5 p.m.—Scientific Papers.*

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "The Ecology of Some Arthropod-borne Diseases of Man and Animals". Opening Speakers: Prof. P. A. Buxton and Prof. G. W. A. Dick.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Discussion on "Current Population Problems with particular reference to the U.N. World Population Conference". Opening Speakers: Mr. B. Benjamin, Prof. E. Grebenik, Dr. W. P. D. Logan, Prof. Brinley Thomas, Mr. J. Hajnal and Dr. J. A. Fraser Roberts.

EUGENICS SOCIETY (at the Rooms of the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Peter R. Cox: "Some Demographic Developments in Great Britain since the Royal Commission on Population".*

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Lecture Theatre of the Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Mr. R. A. Bull: "Modern Trends in Motion Picture Sound".

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. A. F. Hughes: "The Growth of the Neurone".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Prof. A. M. Taylor: "Photoelectric Measurement of Polarized Light".

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. C. H. Richards: "The Prevention of Corrosion in the Telecommunications Industry".

Thursday, December 16

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. M. F. Atiyah: "Recent Developments in Algebraic Geometry".

ROYAL AERONAUTICAL SOCIETY (at Church House, Great Smith Street, Westminster, London, S.W.1), at 5.15 p.m.—H.R.H. The Duke of Edinburgh—Tenth British Commonwealth and Empire Lecture.

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. H. H. Scholefield: "Melting and Casting under Reduced Pressure".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Group Discussion—"It is Often Stated, Usually by 'Scientists', that Industry is Slow to Apply New Scientific Discoveries and Data, both in Regard to Materials and Design. Is this True of the Internal Combustion Engine World?"

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. G. R. Clemo, F.R.S.: "Some Newer Aspects of the Organic Chemistry of Nitrogen" (Hugo Müller Lecture).

Thursday, December 16—Friday, December 17

INSTITUTE OF PHYSICS, STRESS ANALYSIS GROUP (in the Central Chemistry Lecture Theatre, The University, Reading), at 9.30 a.m. daily—Conference on "Stresses Due to Vibration".

Friday, December 17

BIOCHEMICAL SOCIETY (at Guy's Hospital Medical School, St. Thomas Street, London, S.E.1), at 2 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. C. S. Durst: "The Accuracy of Dead Reckoning in Air Navigation".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. F. P. Bowden, F.R.S.: "Recent Studies of Metallic Friction" (Thomas Hawksley Lecture).

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Strand, London, W.C.2), at 6 p.m.—Mr. B. C. Vickery and Dr. G. Malcolm Dyson: "Advances in Classification".

INSTITUTE OF PHYSICS, NON-DESTRUCTIVE TESTING GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. H. F. Priestley: "X-Ray Fluorescence Analysis".

Saturday, December 18

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. T. L. Bartlett: "The Black-Headed Gull".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (graduate, with teaching experience) IN PHYSICAL GEOGRAPHY, at Gadjah Mada University, Jogjakarta, Indonesia—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting "Indonesia" (December 17).

LECTURER IN PHYSICS—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (December 18).

LECTURER (with a degree in agriculture and some postgraduate experience) IN AGRICULTURE AND DIRECTOR OF THE COLLEGE FARM at Nafferton—The Registrar, King's College, Newcastle-upon-Tyne (December 18).

ASSISTANT LECTURER or LECTURER (well qualified in metallurgy, physics or physical chemistry) IN METALLURGY—The Registrar, The University, Leeds 2 (December 20).

LECTURER (graduate, with experience in industrial engineering and research) IN MECHANICAL ENGINEERING—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (December 20).

LECTURER IN BACTERIOLOGY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 20).

LECTURER (with a recognized degree or diploma in agriculture) IN AGRICULTURE—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford (December 20).

ASSISTANT (graduate in chemistry or biochemistry) IN BIOCHEMISTRY, at the Biochemical Laboratory of the Institute of Orthopaedics, Brockley Hill, Stanmore, for research work—The Dean, Institute of Orthopaedics, 234 Great Portland Street, London, W.1 (December 31).

DIRECTOR (with high scientific attainments, preferably in fields related to soils or crops, combined with administrative experience involved in the organization and running of a research institute or university department) OF THE EAST AFRICAN AGRICULTURE AND FORESTRY RESEARCH ORGANIZATION, Muguga, near Nairobi, Kenya—The Director of Recruitment (Her Majesty's Overseas Civil Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD 195/151/02 (December 31).

LAND DEVELOPMENT OFFICERS (with a degree or diploma in agriculture, and preferably with several years farming experience) IN the Department of Native Agriculture, Southern Rhodesia—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (December 31).

Research Assistant (graduate in natural science or in agricultural science, and a thorough grounding in entomology, plant pathology, systematic botany, and organic and inorganic chemistry) in the Department of Agriculture; and an Instructor in Agriculture (preferably with teaching experience and a degree or diploma in tropical agriculture) in the Education Department, to teach general tropical agriculture, both theoretical and practical, in close association with the Department of Agriculture—Public Service Commissioner, Western Samoan Public Service, Apia, Western Samoa (December 31).

Director of the Tea Research Institute of Ceylon—The Chairman, Tea Research Institute of Ceylon, St. Coombs, Talawakelle, Ceylon (January 1)

Lecturer in Bacteriology—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (January 8).

Lecturer/Senior Lecturer in Palaeontology, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 8).

Chair of Electrical Engineering, and Chair of Civil Engineering—The Registrar, The University, Sheffield 10 (January 15)

Drummond Fellowship for Research in Nutrition—The Hon Secretary, Drummond Trust, University College, Gower Street, London, W C.1 (January 15).

Senior Technical Officer or Principal Technical Officer (with a degree in science or equivalent qualifications, and with experience in the collection of samples and the complete analysis of coal), in the Coal Research Section, Commonwealth Scientific and Industrial Research Organization, North Ryde, New South Wales, Australia, to supervise the collection, preparation, testing and chemical analyses of coal samples, in connexion with the Sections survey of the physical and chemical properties of Australian coals—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W C 2, quoting 480/152 (January 15).

Chair of Mining Engineering at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, January 31)

Agricultural Engineer (with at least a first-class degree in agricultural engineering, and practical experience in farming methods), to be responsible for the development of the agricultural and engineering aspects of tillage and all phases of tobacco production, and the modification of existing equipment and machinery—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (February 15).

Aerodynamicists, Mechanical and Electrical Engineers, Physicists and Physical Chemists (with an appropriate first- or second-class honours degree or equivalent qualifications) at the Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.780/54A.

Chemist-Assayer (with an honours or special degree in chemistry, and at least two years postgraduate experience in silicate analysis and assaying) in the Geological Survey Department, Gold Coast Government, to assay ore of all kinds and carry out silicate analysis of rocks and minerals, and to participate in research in the interrelation of Gold Coast rocks and in geochemistry—The Adviser on Recruitment, Gold Coast Office, Melbourne House, Aldwych, London, W.C.2.

Demonstrator (with an honours degree in physics) in Physics, at the Royal Military College of Science, Shrivenham—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.840/54A.

Head of the Department of Biology, Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Laboratory Assistant (male) in the Human Physiology Division, Medical Research Council Laboratories Holly Hill, Hampstead, N.W.3—The Administrative Officer, National Institute for Medical Research. The Ridgeway, Mill Hill, London, N.W.7, quoting AD/49.

Physicist (with a good honours degree in physics) to assist in radium and X-ray problems, including rotational therapy, as well as radio-isotope work—The Director, Cancer Organization, Newcastle Regional Hospital Board, 3 Windsor Crescent, Newcastle-upon-Tyne 2.

Research Assistants (2) in the Iron Making Division, for work on problems concerning the preparation and smelting of iron ores—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Iron Making".

Research Fellow, to assist Dr. P. A. Gorer with work on the serological study of transplantation immunity—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

Senior Investigators and Research Assistants (with a degree in metallurgy, physics or engineering, or equivalent qualifications) in the Department of Industrial Metallurgy, for research on (*a*) the microstructure and properties of electro-deposits (under the direction of the Joseph Research Fellow); (*b*) the fatigue of light alloys; and (*c*) the production and properties of clad metals—The Acting Registrar, The University, Edgbaston, Birmingham 15.

Senior Lecturer or Lecturer (with teaching, research and/or industrial experience in electronics) in Physics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

Senior Radiation Chemist (with ample experience in radiation chemistry and able to tackle any industrial problem in this field), to be responsible for a small group of chemists; a Physicist (with experience in nuclear physics), to design new irradiation sources and investigate irradiated products; and a Biologist (preferably with experience in radiation damage work), to collaborate with industrial concerns on the irradiation of foodstuffs and drugs—The Establishments Officer, United Kingdom Atomic Energy Authority, Research Group, Harwell, Didcot, Berkshire, quoting 2/103/167.

Senior Technician (familiar with, and experienced in, laboratory techniques), to assist in research on the linear accelerator—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1, quoting "Senior Technician".

REPORTS and other PUBLICATIONS

(not included in the Monthly Books Supplement)

Great Britain and Ireland

University of London. University College Calendar, 1954–55. Pp. lxiv+482. (London: University College (University of London), 1954.) [1110

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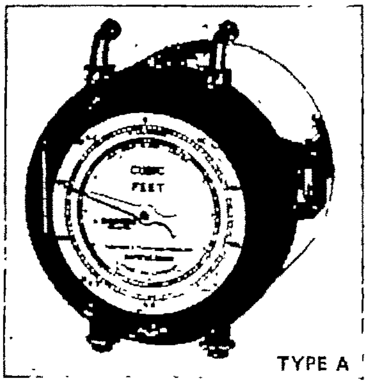

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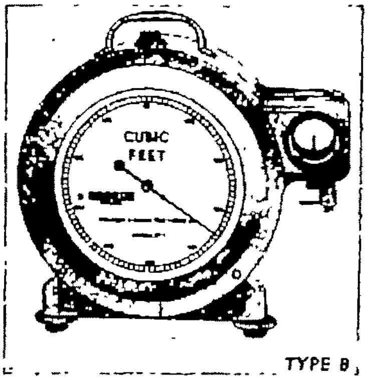

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Head of Department: J. H. Skellon, T.D., M.Sc., Ph.D., F.R.I.C.

The following special courses will be held in the Department during the Spring Term, 1955. 1. Paper Chromatography and Ion Exchange in Analytical Chemistry. Six lectures by I. Smith, B.Sc., A.R.I.C., on Fridays at 7.30 p.m., commencing January 14, 1955. The course will include: Demonstrations on modern apparatus and technique in paper chromatography as applied in qualitative and quantitative work. Ion exchange. Chemistry of exchangers. Frontal, elution and displacement analysis. 2. Radio-isotopes and their Applications in Analytical, Inorganic and Organic Chemistry. Four lectures by staff of the Radiochemical Centre, on Fridays at 7.30 p.m., commencing February 25, 1955. The course will include: Technique of radioactive tracer methods and applications in analytical procedure. Dilution analysis. Activation analysis. Selected applications of radio-isotopes in inorganic and organic chemistry. Fee for each course, £1 1s. 3. Laboratory Course in Oils, Fats and Waxes. Fridays, commencing January 14, 1955, and throughout the Session, from 2 to 5.30 p.m. The course includes: Modern methods of analysis of oils, fats and waxes. Practical methods used for investigating composition. Standard analytical procedure. Fee, £2 2s.

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NATURE

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THE UNIVERSITY GRADUATE AND INDUSTRY

IN 1948 Dr. P. Dunsheath, in his book "The Graduate in Industry", set out to explain the opportunities which a career in industry offers to the university graduate, and to discuss the bearing of university teaching on the fitness of university graduates for an industrial career. Since then, relations between the universities and industry in Britain have grown steadily closer ; five conferences on the subject have been arranged by the Federation of British Industries, four of them dealing solely with such problems, and the Congress of the Universities of the Commonwealth last year also discussed the matter. The relationship of the universities to industry has also been considered by the Advisory Council on Scientific Policy, and by two of the productivity teams which the Anglo-American Productivity Council sent to the United States.

Nevertheless, in 1952 the Advisory Council on Scientific Policy could still refer, in a report on the man-power situation in regard to scientists and technologists in Britain, to the lack of knowledge, both among parents and teachers, of industry and the careers it could offer. Quite apart from the prejudices against an industrial career, on which trenchant comment has been made in the House of Lords and elsewhere, it is clear from similar comments in relation to the shortage of science teachers that neither ignorance nor prejudice has yet been dispelled. At the Federation of British Industries Conference at Ashorne Hill in October 1952, the responsibility of industry for explaining more fully, to students and their parents, as well as to the universities, the nature and opportunities of a career in industry was freely recognized.

Two handbooks which have recently been issued by the Federation of British Industries may be said to be the outcome of that Conference*. One of these, "A Career for the Graduate in Industry", is intended for the university student and is being distributed to universities and schools to encourage students to apply for industrial posts. The Federation estimates that 20 per cent of the staff posts in industry are open to graduate competition, and the booklet describes to the undergraduate very briefly what industry is and how it works, indicating something of the opportunities which it offers both to the science graduate and the arts graduate. The pamphlet is not intended as more than an introduction : the undergraduate seriously thinking of an industrial career must make his own further inquiries, but he is given more than a hint how to set about them.

What the handbook purports to do it does admirably. The undergraduate is given a clear idea of the qualities which industry will look for in its recruits from the university—whether they possess an arts degree or a science degree—the prospects industry can offer, and the contribution which the university mind can bring to industry. There is a glimpse of the vocational satisfaction which is to be found in an industrial career, and a note on salaries enables the prospective entrant to assess salary prospects in comparison with those open to him elsewhere. In producing this handbook, the Federation of British Industries has done a useful job with imagination and a sense of proportion, and it should meet a need to which attention has been frequently directed in recent years. The second handbook, "Industry and the Graduate", which is being distributed to all member firms of the Federation of British Industries and its affiliated trade associations, also meets a declared need on which strong comment has been made in connexion with the utilization of existing scientific and technical knowledge by industry. The pamphlet is written to bring home to industry, and particularly to firms which do not at present employ university graduates, even in science or technology, the importance of a high standard of education and personality in management, and the increasing extent to which industry to-day must recruit from the university if it is to obtain its proper share of the ablest young men and women in successive generations of school-leavers. That task is also very competently done, but the pamphlet also raises a number of fundamental questions, some of which are commonly ignored in discussions of this subject.

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* Federation of British Industries. A Career for the Graduate in Industry. Pp. ii+24. Industry and the Graduate. Pp. ii+31. (London: Federation of British Industries, 1954.) 2s. each.

Discussing, for example, the educational changes affecting industry and, in particular, the disappearance of the financial barrier to university education, the pamphlet quotes figures to illustrate the serious extent to which industry's direct recruitment of the cream of school-leavers is now limited. Accepting the view, based on studies of the variation in intelligence over the community, that only about 9 per cent of boys of eighteen (having intelligence quotients of 120 or more) are generally suitable for senior posts of leadership—a standard about that required to obtain an honours degree—of 379,700 boys attaining the age of eighteen in 1912, some 34,173 would be suitable for leaders. For 1951, the corresponding figures are 305,700 and 27,513; but whereas in 1912, only 4,000 went to a university, 16,537 did so in 1951.

Thus while the number of those entering a university multiplied four times in the period, the number of school-leavers of the degree of intelligence which is desirable in leaders in any walk of life remaining for all types of employment, including industry, fell in the same period by almost two-thirds, from 30,173 to 10,976. If, moreover, we go further and consider the top 5 per cent in the intelligence-range, the situation is even worse. In 1912, out of 18,985 such school-leavers, some 14,985 were available for direct employment, whereas in 1951 the 15,285 school-leavers in that range were fewer than the university entry and none could be deemed available for direct industrial employment.

This situation is the direct result of the present otherwise admirable social doctrine in Britain that no barrier to higher education shall remain in the path of any young person who has the ability to profit by it. In spite, however, of the increasing tempo with which the most intelligent section of our youth is creamed off to the university, there will undoubtedly continue to be a few exceptions; but industry clearly can no longer rely on recruiting, from those left in the pool at the school-leaving age, boys and girls who possess the intelligence and the character desirable for leadership. To do so, the pamphlet suggests, is to risk disaster.

It may well be for consideration whether it is in the national interest to encourage all the more intelligent boys and girls to enter the universities, irrespective of whether they really desire a university education or are qualified, not so much intellectually as in other ways, to profit by a university education. It is obvious that the universities themselves are facing fresh problems from the change in the social structure represented among their students, quite apart from those arising out of the increase in the number of students. The ability to profit by a university education does not depend solely on intellectual ability, though without a certain level of intelligence a student clearly will be wasting his time at a university.

There is a problem here which merits further examination and on which the studies now being pursued by the University Grants Committee and also by Political and Economic Planning may in due course throw some light. It is, moreover, in this context that we should consider the possible exception to the selection process noted in this handbook. The incidence of the means test for the award of grants, coupled with income tax at its present rate, makes it impossible for the man with £1,500 a year or more to send more than one child to a university without great sacrifice in his standard of living. Even to send the first child involves considerable difficulties; and the pamphlet rightly suggests that the university stream is losing some good material. It should be noted, moreover, that the material that is being lost for such reasons is of a quality which, coming from homes where a tradition of culture and reading and good conversation is probable, might help to balance a deficiency which the University Grants Committee has already noted as causing difficulty in the universities. It is perhaps doubtful whether, as Dr. Eric Ashby has suggested, the universities have fully accepted the new responsibilities which these social changes entail. Even, however, when the universities have satisfied themselves as to the best methods of meeting these responsibilities and made the appropriate provision, there are other implications both for the nation in general and for industry in particular.

It cannot be accepted without further question that it is in the interest of the nation that so many students should go to a university at the public expense, not because they want to be scholars or professional men, or indeed to receive higher education at all, but purely because they are among the top 9 per cent of the nation's intelligence. There is still something to be said for a sense of vocation, and it is at least arguable that public money is spent to the best advantage in helping young people to qualify themselves for an occupation which they really desire to pursue. It does not even follow that all the nation's top intelligence will fructify best through university training, and it is still true that what is easily come by is apt to be correspondingly lightly esteemed.

That is one side. There is yet another, and two points made in the Federation of British Industries pamphlet bear closely on it. First, it will be noted that even in discussing the opportunities open to the graduate in science or technology, stress is laid upon the value of wider culture and informed opinion, in addition to detailed technical knowledge of the manufacture and performance of products, among representatives of a firm, particularly in overseas markets. Such qualities are fully as desirable among graduates, either in arts or in science, who seek to enter industry on the non-specialist or administrative side. Second, in advising on the recruitment of graduates, the pamphlet deprecates laying too much stress on academic distinction. It should not be taken for granted that only the first-class honours graduate is useful to industry. For many positions a man with second-class honours may be even more desirable, and for many others the graduate with a pass degree may be entirely adequate. Often, it is pointed out, the man who has been active in sport, debating society or other non-academic activity possesses qualities which more than compensate for any shortcomings in formal academic qualifications.

Something more is thus involved than the question whether the selection process is being pushed so far that the nation is not getting full return for the public expenditure involved. If indeed university education still satisfies Macaulay's criteria and opens, invigorates and enriches the mind, the waste is unlikely to be serious. Even, however, from the point of view of an industrial career, something more is rightly to be expected of a university graduate than clarity of thought and intellectual curiosity. Originality of thought and intellectual honesty, receptivity to new ideas, the capacity to assess evidence dispassionately, a sense of values and especially human values, and the ability to take the advice of experts and then to reach a decision—all these qualities are of prime importance to industry, especially on the managerial side; and provided the raw material is there, they can be developed by a university education.

The proviso is important. It is the real reason for viewing with concern the possibility that the universities are still missing some good material, as already suggested. Such material is at least as likely to possess the further qualities of integrity, intellectual and moral courage, and it is the more likely to use to the full the opportunities which a university affords of developing the extra-academical qualities than those who are channelled to the university purely on intellectual grounds and with no particular urge or sense of vocation. Often, indeed, it is the excessive importance attached to academic distinction by home influences, coupled with the denial of real opportunities for home and vacation study, rather than the indifference of the student, that is responsible for failure to profit to the full by the opportunities of a university life.

Increased university awards or maintenance grants are not in themselves the answer to this problem. If university standards are to be maintained, there must at least be example as well as precept, and that is one reason for giving very careful consideration to Mr. J. F. Wolfenden's argument that the universities would be doing a greater service to the community at large if they admitted to some of their places the young people who would be the leaders in other walks of life in addition to the learned professions, in place of some who are admitted to-day. The casualties might be no higher, and even those who failed would carry away something of value and might well have enriched university life. Otherwise there is more than a probability that the process of creaming off high intelligence to the university will involve also a levelling down, and that the equality of man will be realized at a low level rather than a high level.

Now Whitehead, in considering particularly the function of the university in preparation for a career in business or industry, has stressed also that here, too, that function is to promote the imaginative acquisition of knowledge, and he points out that the learned and imaginative life is a way of living. The combination of imagination and learning requires some leisure, freedom from restraint, freedom from harassing worry, some variety of experiences, and the stimulation of other minds diverse in opinion and diverse in equipment. Such conditions are not to be secured by purely financial means: there is also involved an attitude of mind, an outlook, an awareness of opportunities and a sense of proportion that it is difficult for the student to acquire if he comes from a home or a section of society where the purpose and functions of a university are not understood, or the whole climate of opinion has no conception of culture or the wealth and richness of human experience.

Dr. Eric James and Lord Montgomery may well be right in their emphasis on the importance of closer attention to the requirements of the really gifted student, who is destined to fill the highest posts when he reaches maturity. It may be essential to select early and to train such students specially; but on the argument itself they are a small class, and if they must be taught in small classes, industry will still in the main be concerned with recruiting its appropriate share of the top 9 per cent of the intelligence range. The problem remains of ensuring that that intelligence is so educated and trained, either before it enters industry or within industry itself, as to encourage not simply intellectual ability but also personality. It is the all-rounder with initiative and character, and not just professional training, technical knowledge, or academic distinction that industry most needs to-day. The Federation of British Industries has challenged its members to seek the talent they need in the quarters where it is increasingly most likely to be found. The pamphlet on "Industry and the Graduate", however, is an even more searching challenge to clear and constructive thought as to exactly where our present system of university awards is taking us, and whether some fundamental changes in the general attitude and thought about universities may be required. It may be that the present process of channelling so high a proportion of the nation's intelligence into the universities at the public expense needs reconsideration to ensure that we obtain the full benefit of such expenditure, and that there shall be no disastrous levelling down not merely in standards but also in talent, in enterprise and in vision.

RATS, MICE AND MEN

Control of Rats and Mice

Edited by Dennis Chitty and H. N. Southern. Vol. 1: Rats. Pp. xxxii+306+4 plates. Vol. 2: Rats. Pp. xvi+307–532+4 plates. Vol. 3: House Mice. Pp. xiv+226+8 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 105*s*. the set.

It has taken a Second World War to provoke a systematic study of those familiar commensals, the common rat and the house mouse. Now, they are being extensively investigated, both as pests and as animals in their own right; but before 1940 most of what passed for knowledge of rat or mouse biology consisted of myth or moral tale. Control, mostly ineffective, depended on alluringly advertised proprietary baits or contraptions, devised without any basis of critical research. The researches described in the three well-produced volumes under notice were carried out by members of the Oxford University Bureau of Animal Population, from the outbreak of war in 1939 to July 1947. Publication was not allowed during war-time and has been made possible now only by a private donation—a curious reflexion on the arrangements available for the dissemination of valuable knowledge. Much unpublished matter remains, and this is deposited at the Bureau.

Despite the delay, this is an important contribution to our knowledge of the biology of *Rattus* and *Mus*, and to the methodology of controlling their onslaughts on our food and our health. The first two volumes deal with work on rats, principally the common brown rat, *Rattus norvegicus* Berkenhout, but with some material on *Rattus rattus* L. The topics include the nature of the poisons used against rats; the biology of rats in relation to control methods; special observations on feeding behaviour; and some operational studies, including an account of experiments on rat control in Palestine and the Sudan. Each section reviews other relevant findings, notably from American work which, too, was stimulated by war; each has a bibliography. Some of the investigations described are inconclusive, and there are many loose ends; but bringing together such a body of work—an unusual enterprise, and one which might be copied elsewhere on a smaller scale—enables the many biologists and others interested in applied research and its organization to see what is involved in the investigation of three related pest species. On this general point, the introduction by the director of the Bureau, Charles Elton, is particularly worth study.

The procedures recommended for routine control by men with little training are necessarily highly simplified. D. Chitty and others show how laborious was the research which lies behind now familiar techniques such as prebaiting and change of bait and poison, and the actual selection of the poison and its concentration. About one thousand field tests, each usually lasting several weeks, were carried out, and some hundred tests were made on rats in cages. The results are, however, of interest to others besides the rat-catcher, the warehouse-keeper or the medical officer. These volumes contain original data on the closely observed behaviour of feral rats and mice—data of a kind which could not have been obtained from experiments on laboratory varieties. In its present form this information is adequately related neither to current ethological field studies nor to the psychology of white rats, and it presents a notable challenge to the student of mammalian behaviour. There is very full information on what the authors call 'new object reaction' in rats—an (innate ?) avoidance behaviour or 'neophobia' which clearly has much to do with the success of these animals. There is also information on poison 'shyness' or the refusal of a food which has caused illness—a phenomenon which should stimulate further study of the abilities of rats to select an advantageous diet.

On the ecological side, much has been learnt of rat population dynamics. Part of this work has been separately published; in these volumes the data on the growth and decline of rat numbers in different circumstances are scattered among several chapters, and are mainly related to assessing the effects of attempts at large-scale control. A. D. Middleton, for example, describes operational research on rat control on a group of farms—an encouraging instance of what can be done, at reasonable cost, with sound planning; and Elton and Laurie describe a sample census of rats and mice in corn-ricks in England, with results much less encouraging for those concerned with rural rat control.

The study of what actually happens to pest populations when control is attempted, in relation to the amount of damage they cause, is an essential basis for a rational system of control. The Bureau's findings make a useful starting-point for future operational research, but important generalizations on this topic are scattered through various chapters, or made only by implication: there is no point at which the threads of the argument on rat numbers are brought together in a unified statement.

There is greater unity in the third volume, on *Mus musculus* L., since the final writing was almost wholly the work of the editor, H. N. Southern. It was only with the Second World War that the house mouse was found to be a serious agricultural pest in Britain, but surveys from 1940 on showed it to be abundant on farms and highly destructive in ricks. In grain stores, of course, its activities can be devastating. Its behaviour is markedly different from that of the common rat: while the latter is conservative but 'suspicious', the mouse is mercurial and unpredictable. The Oxford work on this species has produced, for the first time, a sound basis for control by poisoning or trapping, and also a foundation for future studies of mouse biology.

The scientific worker on pest control must often, necessarily, be a jack-of-all-trades, though perhaps not necessarily with the proverbial corollary. Eight years of research by a team of such workers have, as would be expected, produced results of value to biologists working in a number of diverse fields, both 'pure' and applied. It is to be hoped that these volumes will be correspondingly widely used.

S. A. Barnett

ANALYSIS BY CHROMATOGRAPHY AND ION EXCHANGE

Inorganic Chromatography

By Orsino C. Smith. Pp. x+134+5 plates. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 37s. 6d. net.

Chromatographic Methods of Inorganic Analysis

With Special Reference to Paper Chromatography. By Dr. F. H. Pollard and Dr. J. F. W. McOmie. Pp. viii+192+4 plates. (London: Butterworths Scientific Publications, 1953.) 30s. net.

Ion Exchanges in Analytical Chemistry

By Prof. Olof Samuelson. Pp. xviii+291. (New York: John Wiley and Sons, Inc.; Stockholm: Almqvist and Wiksell; London: Chapman and Hall, Ltd., 1953.) 52s. net.

It is natural enough that, when subjects assume such prominence in scientific research as ion exchange and chromatography, there will follow attempts to systematize the known facts by the publication of text-books. These three books should be considered against the background of the vast amount of unco-ordinated data to be found in the scientific journals. The only reasonable answer to the problem is for the text-book writer to confine himself to a portion of the subject, and to avoid so far as possible the tedious repetitions to which the reader is constantly subjected.

Mr. O. C. Smith, clearly, is overwhelmed with the complexity of his subject, as this sentence from p. 96 of his book, "Inorganic Chromatography", shows. "In this work many combinations were found to exist, and where several factors are present they are a multitude; for instance, whether the solution is acid, neutral or alkaline: type of solvent: type of adsorbent: kind of reagents and whether the developer is used before the sample or after: and ad infinitum". This has, no doubt, led him to overlook the almost complete unintelligibility of the last sentence of his paragraph on "Adsorption on Paper" (p. 5). In his discussion of "Apolar Adsorption" (p. 9) he does not distinguish between alumina and silica, which are normally regarded as instances of adsorption and partition, respectively.

Chapter 4 of his book suffers from the arrangement: the paragraphs are headed by authors' names instead of subjects, and constant reference to the index is necessary. In Chapter 5, although most paper chromatography has been done on filter paper *per se*, he begins by a description of the preparation of alumina-impregnated paper, which is a special case. Chapter 8, "Laboratory Procedures", is useful, but would have been better if more attention had been paid to the standardization of adsorbents. There is no attempt to describe alumina in chemical or physical terms, and, as variable amounts of water are added and the initial activity is not stated, it is possible that the activity is varying throughout an experiment. The packing of a column by a wet slurry process will not necessarily give the same results as a dry column. Magnesium silicate is difficult to define chromatographically, and as Mr. Smith himself states in relation to starch (p. 118), the results obtained with different batches of material are not always reproducible.

As regards the other two books, by Drs. F. H. Pollard and J. F. W. McOmie and by Prof. Olof Samuelson, respectively, the exposition is clear and the presentation logical. Pollard and McOmie give a review of inorganic chromatography which is as comprehensive as is possible on a subject that receives additional published researches daily. There are occasional slight obscurities; thus, the table of "Order of Adsorption" (p. 7) is too compressed and the word "column" in the text is ambiguous. The new qualitative analysis schemes are ingenious and sound; but before the 'classical' analysis is scrapped we should ask ourselves whether there is, in fact, a real advantage in the chromatographic method. It may well be that many laboratories will adopt some part of the scheme as a supplement to their normal methods, and in this case they will find the tables in the appendix of Pollard and McOmie of great help.

Ion-exchange materials form the subject-matter of Prof. Samuelson's book, and with these substances the analyst is completely in the hands of the manufacturer. It is a good sign for Anglo-American co-operation that the tables (pp. 261–264) list ion exchangers of British and European manufacture as well as those of American origin. It is clear that a selection of examples must be made if the book is not to reach encyclopædic size, and therefore specialists in subjects such as alkaloids and proteins may find the information too sparse; however, a reasonable bibliography points the way to further sources.

The book by Pollard and McOmie and that by Samuelson should find a place not only in every technical library but also at the practical analyst's desk.

E. Q. Laws

INTRODUCTION TO VECTOR AND TENSOR ANALYSIS

Vector and Tensor Analysis

By Prof. G. E. Hay. Pp. viii+193. (New York: Dover Publications, Inc., 1953.) 2.75 dollars, cloth; 1.50 dollars, paper.

The emphasis in this book is mostly on vector analysis, which is covered by five chapters, whereas but a single chapter is devoted to tensors. This, I think, is unfortunate for three reasons: published studies in vector analysis have already been considerable; tensor analysis is the generalized and therefore broader aspect of the vector–tensor approach; and there is a far greater need for an elementary-to-intermediate standard of book on tensors really suited to beginners working in the applied sciences. Moreover, in respect of tensors particularly, it is likely that there will be some measure of disappointment in engineering circles that the book is confined to the classical approach instead of supplementing the latter by the method initiated and developed by Gabriel Kron primarily for engineers. The point is worth making because there should be a greater measure of mutual recognition by pure and applied scientists of each other's needs and aspirations, coupled with effective joint action to obtain the best of both worlds.

Chapter 1 describes elementary vector operations up to the level of differentiation and integration with respect to a scalar variable and to linear vector differential equations. Chapter 2 gives applications of vector principles to solid analytic geometry and to differential geometry. Chapter 3 relates to the application of vectors to mechanics within the scope of motion of a particle and of a system of particles.

Chapters 4 and 5 deal with partial differentiation and with integration respectively and include studies of the del operator, line, surface and triple integrals, Green's and Stokes's theorems, and irrotational and solenoidal vectors. Chapter 6, on tensor analysis, dismisses the subject in a mere thirty-seven pages, but nevertheless it manages to present a concise account of the main essentials of the classical approach. For example, it includes co-ordinate transformation, covariant, contravariant and mixed tensors, the metric and conjugate tensors, lowering and raising indexes, the Christoffel symbols, and the curvature tensor, in addition to stating other topics of a kindred nature.

There are 195 problems (without answers), and although the book is said to be for students of engineering and mathematical physics, one can scarcely imagine that many of them will find much satisfaction from solving the problems except as exercises in pure mathematics. The type-setting and printing are excellent, but the work bears some evidence of hasty proof-reading. Considered as a condensed text in the classical manner, the book can well be recommended; and while it may help the embryo mathematical physicist, I much doubt that it will do the same for the young engineer.

S. AUSTEN STIGANT

FOOD FROM FRESH WATERS

Fertilizers in Fishponds

(Colonial Office, Fishery Publication No. 5, 1954.) By C. H. Mortimer. With additional material and a foreword by C. F. Hickling. Pp. iv+56. (London: H.M.S.O., 1954.) 25*s*. net.

It is often remarked on the Continent of Europe that in Britain scarcely any freshwater fish are exploited for food. Indeed, many who went to Britain during and after the Second World War investigated the possibility of carp farming on the German model. But sea fish is so readily available everywhere in the British Isles and, if truth be told, so much more palatable than carp, tench and pike, that it seems unlikely that such an industry could be established, even if the summer climate should prove to be warm enough to allow farmed fish to attain an economic growth-rate.

Nevertheless, during the War we had to consider to what extent our own fresh waters could contribute to our food supply, and Dr. C. H. Mortimer prepared for the Freshwater Biological Association a bibliography of publications on the use of manures to increase the productivity of fish ponds. In the event, we never had to exploit our fresh waters, so this paper did not attract the attention it deserved. Soon after his appointment as fishery adviser to the Colonial Office, Dr. C. F. Hickling appreciated the contribution freshwater fish could make towards remedying the serious protein deficiency that exists in so many tropical and sub-tropical countries and, by example and precept, has aroused an interest in fish farming throughout the British Colonies.

The literature on the subject is scattered and scanty, so no doubt Hickling found Mortimer's bibliography useful, with the happy result that they have collaborated to revise and extend the earlier publication and have produced a paper that every fish farmer and every freshwater biologist in the world should have. It is a very good bibliography, but it is a great deal more than that. The first forty pages are in fact a critical review of the literature and are most readable and informative. Then follow 108 pages which contain 351 references, and in every case where the title of the paper is not an adequate description of it there is an abstract. These abstracts vary in length from one line to rather more than four pages, and the long summaries of the most important publications are sometimes illustrated by graphs and tables. So the reader may find the information he needs in the abstract and can certainly discover whether the full paper is worth consulting—a very important matter in parts of the world remote from libraries. Lastly, there is an adequate index, making the publication handy to use.

H.M. Stationery Office ought surely to issue publications of this kind in something more durable than a paper cover. This book will be in constant use and will inevitably have to be given a permanent binding, so why should not the publishers do their job properly ?

F. T. K. PENTELOW

PROPERTIES OF MATTER

Properties of Matter

By H. N. V. Temperley. Pp. vii+323. (London: University Tutorial Press, Ltd., 1953.) 21*s*.

An outstanding feature of this excellent book by Mr. H. N. V. Temperley, which is intended for the degree student, is its emphasis on essentials. The usual descriptive matter is greatly condensed; indeed, only one experiment (the determination of g) is described in full, but this is done in great detail to illustrate the general principles of correcting for experimental error. The reader is left to supply for himself (guided by a mathematical appendix) the intermediate steps in the derivation of formulæ; and the author deals very thoroughly with the applications of classical mechanics to the behaviour of solids, liquids and gases.

The book is interesting to read for two reasons. The first is Mr. Temperley's graceful economy of words; an author who is as careful of his writing as of the subject-matter compels attention, besides setting a good example. The second is his outlook; for, as he says, although no especially striking advance has taken place in the twentieth century in the field of classical physics, there is no sign of any slowing-down of progress, quite the reverse, and the subject is still a very long way from being a 'closed' one. He gives many examples of the recent applications of classical physics—work at very high and very low pressures, ultrasonic absorption and the second coefficient of viscosity, the propagation of shock waves, and the behaviour of metals under plastic flow, to mention a few. The effect of this is to assure the student that classical physics is not only the grammar of the subject that he must master, but is also in its own right a living branch of the subject, with a future as well as a distinguished past.

Each chapter has a bibliography and examples for solution, and there is a collection of examination questions, chiefly from Part I of the Cambridge Natural Sciences Tripos and the London B.Sc. examinations. One's only criticism is of the publisher's modest statement that the book is suitable for students preparing for degrees in science; it would be fairer to describe it as invaluable for degree students preparing to be scientists.

G. R. NOAKES

THE UNIVERSITY OF HULL

By Prof. BRYNMOR JONES

Pro-Vice-Chancellor

ON May 13, 1954, H.M. the Queen granted a Charter constituting and founding a University within the City and County of Kingston upon Hull under the style and title of "The University of Hull", and so came into being the third new university to be established in England since the end of the Second World War—the others being Nottingham (1948) and Southampton (1952). In the years between the two Wars only one university, Reading (1926), was created, and it is necessary to look to the early years of the century for a precedent for the creation of so many universities within a space of a few years, when Bristol and the mid-northern universities were founded.

The English civic universities are largely a product of the twentieth century. Their growth, both in number and in the variety of their teaching and research departments, reflects the great expansion in the opportunities for higher education and for specialized studies in the past half-century; while their standing to-day among the universities of the Old and the New World is an incentive and an encouragement to those new foundations which have been added to their number in recent years. Although it is natural and desirable that each university should derive much of its ethos from its immediate surroundings, the newer institutions must, if they are to prosper and grow, strive to take their rightful place as national institutions.

Foundation and Development of the University College

Until the University College of North Staffordshire was established in 1949, the University College of Hull was the youngest of British university colleges. It was founded in 1927 with a gift of £250,000 from the late Right Hon. T. R. Ferens—but for his munificence and vision, and his concern to establish a centre of higher education in the city where he lived and prospered, there would not be to-day a university to enrich its life and to illume the plain of Holderness. But while Thomas Robinson Ferens is rightly acclaimed and honoured as the founder, the new venture would have been more tardy in its growth, and less attractive in its appeal, if it had not been fortunate in winning generous support from other quarters—in particular, from the City and County of Kingston upon Hull and from Mr. G. F. Grant, a prosperous leather merchant and a close friend of the founder. The City Council gave a sum of £150,000 for the first two buildings—one housed the arts department and the administration, the other the scientific laboratories, the library, the assembly hall, and the refectory. These were erected in 1927–28 on land given originally by Mr. Ferens to the City, and transferred by the City Council to the College. The choice of the site on Cottingham Road for the new College was a most fortunate one, for adjoining it was a large area of open land. This the Council of the College gradually acquired, so that when the opportunity for rapid expansion came at the end of the War, the College had some seventy acres of pasture-land available for new buildings and sports fields. In addition to the capital sum for buildings, the City Council agreed to make an annual grant, and so did the Education Authorities of the East Riding, Lindsey, and Grimsby, and the endowment of the College was enlarged by a bequest of about £100,000 by Mr. G. F. Grant. A number of special gifts and bequests were received both for general and particular purposes, and especially for scholarships. In this, too, the College was fortunate, for in those days grants and scholarships were less numerous than they are to-day—indeed, it was not uncommon for potential students to move from one university examination hall to another, in the hope that by their learning they could win enough in the way of scholarships to keep them at the university.

Some thirty students registered for the first session in 1928. Gradually their number grew, but only in one year before the War did the student-body exceed two hundred. Although on the outbreak of the Second World War there was not, as in the First, the same precipitate exodus of university students to join the Forces, the number of students in the College soon began to fall, and, as the City increasingly became a favourite target for enemy aeroplanes, the number of students fell back to a hundred. At one period plans were made for the organized migration of these to a less vulnerable part of the country: fortunately, the need for this never arose, and, despite the severity of the raids on the City, the College escaped serious damage.

At the end of the War, the College began to prepare for the difficult years ahead. It soon became clear that the pressure for places at the universities would be great, for in addition to the normal complement of students from the schools, there were many thousands of ex-Service men and women to be accommodated. To meet this great influx of students the Government asked all university institutions to admit as many students as possible. Although, in the absence of faculties of medicine and engineering, the College could not offer teaching in so wide a range of studies, it realized that it could offer ample opportunities for study in its two faculties of arts and pure science. Unlike most universities, it had land for new buildings and, of more immediate value, it had accommodation in existing buildings for many more students than were housed in the 'thirties. This was especially true of the humanities and of law, the requirements of which fortunately are so much simpler than those in science.

The potentialities of the College were quickly recognized by the University Grants Committee, some of the members of which visited the College in the spring of 1945, and in the summer of that year the College became eligible for the first time for Treasury grants both for revenue and capital purposes. In the following eight years the capital grants from the Treasury for new buildings, the purchase and adaptation of existing ones, the erection of temporary accommodation, and the provision of furniture and equipment for teaching and residential needs, amounted in total to well over a million pounds. In about the same period the number of full-time students at the College rose from the region of a hundred in 1944 to a peak of 917 in 1950–51—a

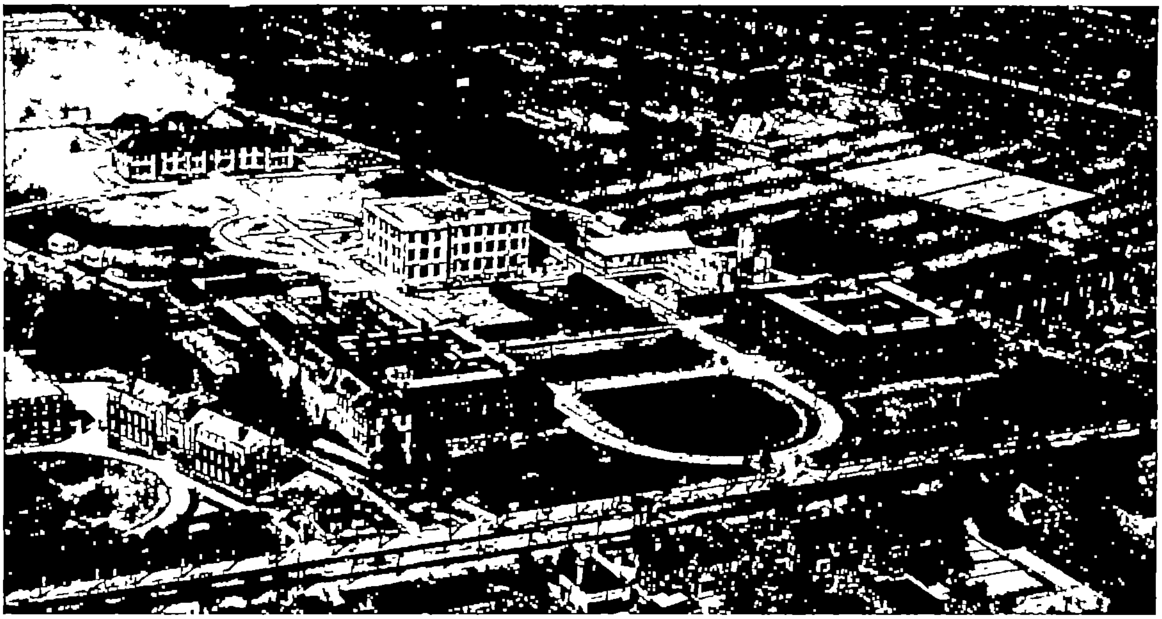

Fig. 1. Aerial view of the University of Hull. Centre block, new Chemistry Laboratories; right quadrangle, Science Buildings, left quadrangle, Arts and Administration; back, Students' Union. By kind permission of the *Hull Daily Mail*

total made up of 584 men and 333 women. In addition, many students were registered for part-time courses for diplomas and certificates, while some three thousand adult students each year attended evening classes and lecture courses both in Hull and in a large number of centres throughout the College area. An extensive scheme of tutorial classes and lectures for members of H.M. Forces was arranged by the Department of Adult Education in conjunction with Service Departments, and financed by a special grant from the War Office. To meet all these needs, the staff of the College was greatly enlarged. It now numbers about 135. Of these, twelve are engaged as tutors in adult education, and together they provide teaching in English, economics, history (including local history, and history of art), literature and drama, philosophy and psychology.

To meet pressing demands for accommodation, a number of temporary hutments were erected, and several of these were equipped as laboratories. While the furniture was of the best materials available at the time, the huts themselves were designed to serve for a limited number of years, for previous experience had shown that, in universities in particular, 'temporary' accommodation can all too often become permanent. Useful as these temporary laboratories have proved to be, they are no substitute for the well-built and well-equipped laboratories which teaching and research in modern science demand.

As licences were granted and building materials became available, work was started on permanent accommodation. The first was an addition to the original Arts building. This comprised in the main a number of lecture rooms for classes in the humanities; but it also allowed of an appreciable extension of the Department of Botany, which from the first days of the College had been housed on the top floor of the Arts building. The addition of new teaching and research laboratories, a lecture theatre, a herbarium, and some staff rooms has allowed for a welcome expansion of botanical studies. The Department has, too, a large experimental garden with a number of well-equipped glass-houses, stocked with a rich variety of plants, and especially of ferns.

A students' refectory seating four hundred, served by modern kitchens equipped with the latest mechanized apparatus, was built in 1950, and when this was finished, work was started on a Students' Union building. Together they form one of the most attractive centres for student life and activities in Britain. The Union has separate common rooms for men and women, and an excellently designed and furnished joint common room. In this building, too, is a Students' Council Room with the appropriate offices for Union officers.

The latest addition is the first section of a new science building to house the Department of Chemistry. This has a number of large and well-equipped teaching laboratories, rooms for research in the three main branches of the subject, three lecture theatres, and a large basement for stores. The completion of this building has made it possible to provide more accommodation for physics in the original science building by converting the laboratories used formerly by chemists for the use of physicists. There are two new laboratories for undergraduates, a number of research rooms and an additional lecture theatre. As a result, it was possible last summer to remove some of the temporary hutments. Along with the physical sciences, the biological sciences have also grown, and the Department of Zoology, like that of Botany, has had to be provided with more space. In addition to a new laboratory equipped specially for third-year students, the Department has now an up-to-date animal house and an aquarium. The erection of so many new buildings and the expansion of the work of the science departments have necessitated the building of a large new boiler house and of a modern workshop.

So far it has not been possible to house the Department of Geography in a permanent home of its own —a building for geography and geology is one of the needs of the new University. In the meantime, to cope with the greatly increased numbers in geography, a temporary laboratory was built. Of greater significance has been the creation of a chair of geography. The establishment of this new chair is a recognition of the intellectual value and practical importance of the subject, and of the work of the present head of the Department in building it up over a period of years.

When the University College was founded, the Council very wisely decided to establish only a limited number of departments, and to concentrate teaching and research to the major subjects. Thus, the emphasis was laid on philosophy rather than psychology, on geography rather than geology, and on classics, English, French and German as the main languages. But it had always been the intention that new subjects should be added, and new departments established. In the past few years many additions have been made. A Department of Social Studies was started in 1946, and two years later a lectureship in sociology was added. The range of teaching in the faculty of arts has been extended to include theology and music, and provision has been made for the teaching of Finnish and Swedish. Special appointments have been made by the Department of Economics and Commerce in public administration and in government. Geology has been added to the subjects in the faculty of science, and psychology, formerly attached to the Department of Philosophy, has been recently constituted into a separate department with a well-equipped laboratory of its own. Its courses are open to both arts and science students. The establishment of readerships in medieval history and in plant physiology have not only been of value to undergraduates with a special interest in these fields, but they have also helped to encourage research. There has been, too, a very substantial strengthening of the Department of Education, both in the number of its staff and in the provision of specialist teaching—including physical education, which has a modern gymnasium.

Along with the other university institutions, the College established an Institute of Education, with its own special library. It serves to promote the interests of education among those concerned for its practice and its administration in the College area, and it offers opportunities for further study, refreshment and investigation to teachers at all levels.

Research

Along with the expansion in the number of undergraduates, and the provision of more accommodation for teaching and specialist study, there have been welcome additions to the facilities for research in several departments. Considerable sums have been spent on new equipment, and the increase in the number of graduates engaged in research has become an important feature in the life of the College. A large number of research topics are being investigated by members of the staff in both faculties, and by research students working under their direction.

Library

The library, which has grown steadily over the years, was planned from the start as the centre of the academic life of the College, especially in the humanities. It has now some 120,000 volumes. In the first few years its growth was rapid; but, unfortunately, it has not kept pace with the increase in student numbers, or with the needs of specialist teaching and research. In part, this is due to the inevitable restrictions of the war years and to the greatly increased cost of both books and binding in the post-war years. Fortunately, monographs and

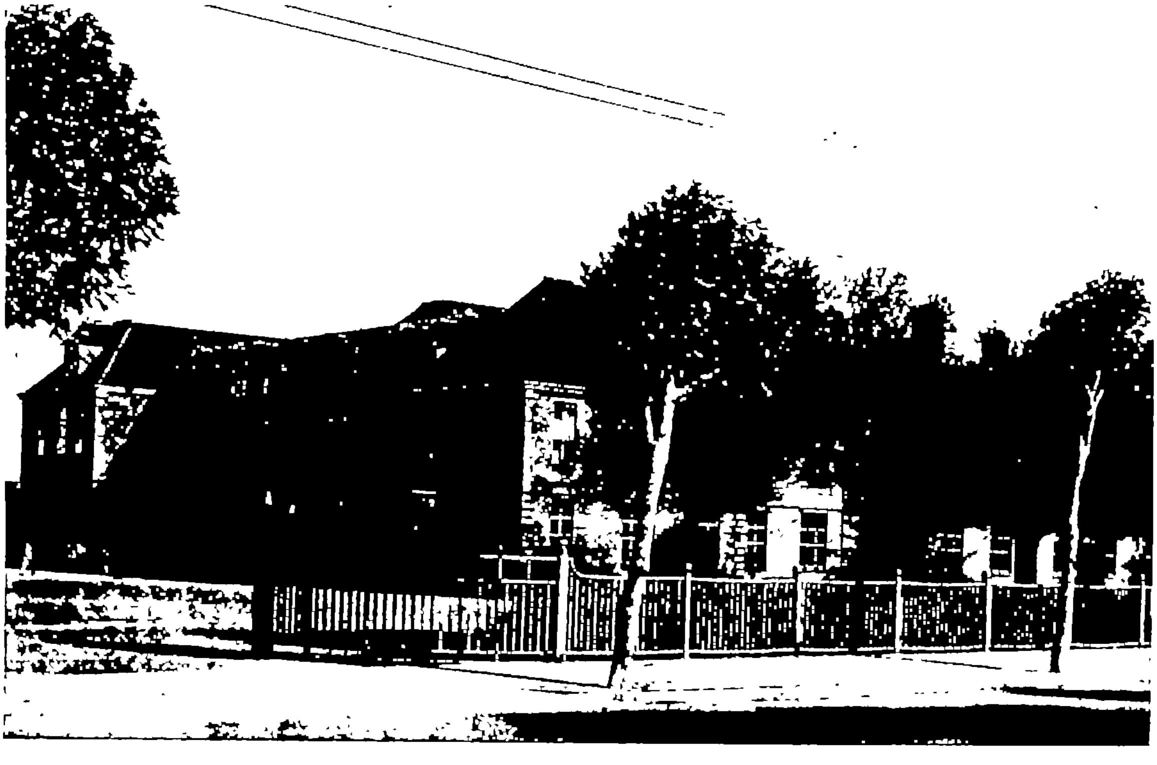

Fig. 2. Science Buildings

Fig. 3. Students' Union and Refectory

periodicals can be obtained on loan with reasonable ease from other university and industrial centres; but the building-up of the library on a large scale remains an urgent and pressing need in the years ahead.

The main part of the present library continues to be housed in accommodation on two floors of the science building intended ultimately for lecture rooms and staff rooms; but plans are well advanced for a new library building. The site for this is large enough to accommodate a building which will ultimately house a million books, and the plans make it possible for it to be built in sections. The stack in particular can be extended as the need arises. The main reading rooms and the rooms for administration will be built first, with such portions of the stack as are necessary for a term of years.

Halls of Residence

Two features have distinguished the College from most of the civic universities of Britain. In the first place, it did not evolve from a college of science, a technical college, a school of medicine, or a university extension college, but was founded as a new venture for the study of the humanities and pure science. No provision was made for medicine or for technology, although the incorporation of these was envisaged as a possibility at a later stage. In the second place, it has from its foundation required residence from all its students, with the exception of a small minority that lives at home. In this it resembles more the first Welsh colleges than the civic universities of England, where the majority of students live in lodgings or at home.

In the first year a hall for men was founded by Mr. F. Needler by adapting a large private house in the village of Cottingham—a distance of some two miles from the College itself. A hall for women was also established in Cottingham in Thwaite House, a large red-brick building standing in twenty-four acres of beautiful grounds. In the 'thirties two wings containing study-bedrooms were added to Needler Hall, to enable it to accommodate sixty-eight students. About the same time, Thwaite House was also enlarged by the addition of a number of separate study-bedrooms. In spite of these additions, both Halls continued to be regarded as temporary in character. The original plan of the College buildings envisaged the erection of halls of residence and athletic grounds adjoining the lecture rooms and laboratories; but, when the population of the College was growing rapidly in the late 'forties, it became clear that in the changed circumstances it would be better to keep the whole of the Cottingham Road site for academic developments. The advantages of this course have become apparent as new academic and social buildings have been erected. Although this has reduced the possibility of creating an academic, residential and athletic campus, it has assured ample space for further academic development, including, should the need arise, accommodation for one or more branches of technology or of medicine.

Once this decision had been reached, extensive additions were made to Thwaite Hall. These included more than a hundred study-bedrooms, a spacious reading room, and a finely proportioned dining hall.

The other hall for women—Cleminson Hall—comprises three large houses which have been adapted and modernized to constitute a hall for sixty-eight women. It has a light and exceptionally pleasant new dining hall, and its common rooms are unusual for the freshness of their decorations and furnishings.

Camp Hall is a temporary venture made up of a hutted camp, designed originally for families whose homes had been damaged in air raids. It has provided accommodation for three hundred men in separate study-bedrooms, each with its electrical heating. The hall has two dining rooms, and, in addition to the usual common rooms, it has a games room and a billiards room. This camp, acquired in 1946 and intended only for use as a hall for a limited number of years, has given yeoman service at a time when lodgings were hard to come by in a city severely damaged by air attacks. There is undoubtedly much that can be said against temporary buildings, both for academic and residential purposes; but in the immediate post-war period especially, they did enable the College to provide facilities for a large number of students who would otherwise have been deprived of the opportunity of a university education. The abolition of a large part of Camp Hall is now in sight, for work is well advanced on a permanent hall for a hundred and fifty men. This is to be known as Ferens Hall in honour of the founder of the College.

Athletics

The first section of an athletics centre, in close proximity to the Students' Union, was completed in 1950. In addition to the usual changing rooms for men and women, there is a squash rackets court. A first-class running track was constructed in 1952, and in the past two years some new records have been established in the course of the national athletic matches which have been held under the auspices of the Amateur Athletics Association.

Tennis courts have also been laid out in the grounds of the Halls at Cottingham.

The University

Such was the inheritance of the University when it was founded in May. The University College had been planned from the first as a university in the making: the Court of Governors, the Council, the Senate and the Boards of Faculties had from the foundation the customary powers. Indeed, it says much for the foresight of those who served on these various bodies in the early years that in the transition to full university status there was, in matters of government and control, so little need for change in established practice.

But in a number of other ways there was inevitably much new ground to be explored and many important decisions to be reached. This was especially true of the degrees to be awarded by the new university. For more than three years the planning of degree courses and syllabuses has been a major pre-occupation of the Senate and Faculty Boards. Before any firm decisions were made, a special Charter Committee set up by the Senate reviewed the degree structures of a number of universities, including those of the University of London, the examinations of which the students of the College have taken for more than twenty years. A number of criticisms and comments from schools and industry were assessed, and the experiments and changes proposed in other universities were borne in mind. The Committee found that it had to try to meet—or to balance—what seemed at first to be competing claims: the need of the country for more specialists in almost all branches of knowledge, and particularly in certain sciences, the dangers of over-specialization, and the plea both from industry and from schools that graduates should not be narrow specialists, but that they should at least be aware of the social problems which make their particular knowledge and skill so necessary in this age.

However well planned, only a part of all this can be covered by degree courses—for the rest, every university must rely on the inspiration of its teaching, on the enthusiasm and self-sacrifice which its staff brings to the discovery of new knowledge and to new ways of thought, and on its corporate life. But since the degree courses themselves must inevitably be the core of the intellectual training, their content and their relationship one to another are of first importance. While it is true that many undergraduates fail to broaden their mental outlook, it is equally true that the greatest single benefit a student can derive from a university education is the enlargement of his ability to go deeply into his chosen field. Such an experience should, and often does, provide a focus from which other and wider interests can readily be developed. Thus, while acknowledging the dangers of over-specialization, the Committee was at the same time alive to the value and importance of specialist training—for one of the main purposes of education is to impart an intimate sense of the value and power of ideas, of the structure of ideas, and of the beauty of ideas, thereby cultivating that most austere of all mental attributes, the sense of style.

Fig 4. Dining hall at Thwaite Hall

After careful consideration and discussion, the Senate and Council approved that there should be two kinds of degree—'special degrees' and 'joint degrees'. The special degrees are in one main subject, joint degrees in two main subjects. A 'general degree', with three subjects taken to final year, as in London and some other universities, was rejected, partly because experience has shown that few students reach a satisfactory standard in all three; but more particularly because the great majority of students fail to co-ordinate the knowledge so as to achieve some measure of synthesis. The special and joint degrees are based on the established principle that a student's general education is a matter for the schools. The radical solution of lengthening the course for a first degree to four years, with provision in the first of these courses designed to give a broad survey of existing knowledge and disciplines, was not adopted. While it is true that many students could with advantage spend a fourth year at a university, the extension of first-degree courses to four years is impracticable on financial grounds for the great majority.

The first-degree courses have therefore been planned to occupy three academic years. The whole of this time, however, will normally be devoted to post-intermediate work, since there is no 'intermediate' examination in the usual meaning of that term. The University needs, of course, to be satisfied that candidates have passed the General Certificate of Education in those subjects which will enable them to enter with profit on the degree courses of their choice. In most cases, though not in all, they will need to have a General Certificate of Education in the particular subjects which they propose to read for their degrees; but this does not necessarily mean that they must hold a certificate which will exempt them from the usual type of intermediate examination in three or four subjects. All students must, of course, be qualified to matriculate on terms similar to those accepted by most universities; but what is needed in addition has been determined solely in the interest of degree studies.

All candidates for the B.A. degree, except those offering mathematics or music for a special degree, must take one additional subject—either as a two-year 'subsidiary' or as a one-year 'ancillary'. Within this broad scheme there is a wide variety of choice, both in the combination of subjects for the joint degree, and in the subjects which may be taken at subsidiary and ancillary level. In the final examination, classified honours or a pass may be awarded in both degrees.

The regulations governing the degree of B.Sc. are similar, but with some important differences. Except in mathematics, all candidates for the special degree must take either a two-year subsidiary or two one-year ancillaries. The choice of these is in some instances closely defined, especially where the second subject becomes a tool for the fuller understanding of the main subject. Thus, all students wishing to specialize in physics are required to take mathematics as a subsidiary, and candidates offering philosophy as main subject must take a two-year course in psychology. Specialists in chemistry are required to take mathematics as one of the two ancillaries; but there is a free choice of the second. With the view of broadening the range of a student's reading, provision is made in each faculty for students to opt for any ancillary for which teaching is available in the other faculty. The stage at which examinations for the special degree are held varies with the subject. In some, the final examination will be held in two parts—Part 1 at the end of the second year and Part 2 at the end of the third year. In other subjects there will be one examination at the end of the third year.

Students for the degree of LL.B. take three examinations—a qualifying examination, and Parts 1 and 2. For the degree of B.Sc. (Econ.) the qualifying examination is at the end of six terms, and the final examination at the end of nine terms.

In addition there are many diploma and certificate courses, among them the course leading to the Graduate Certificate in Education taken by those graduates who choose teaching as a vocation.

The degrees of B.D. and B.Mus. rank as higher degrees, and courses leading to them may only be taken by candidates who have a first degree. The University has the power to grant the usual masters' degrees, and here special mention should, perhaps, be made of two such degrees—that of M.Sc. (Econ.) and M.Ed.—for which provision is not made in all universities. Provision has also been made for the degree of Ph.D. and the higher doctorates*.

The new University of Hull looks to the future with confidence. It aims to give to its students a broad and balanced approach to their studies, with provision for specialist training for those best fitted for it. While the larger universities can, in many cases, offer a wider range of study, with a greater variety of specialized courses, there are compensating advantages in a community of moderate size, where personal contacts both with students and with members of staff are more readily established. In the words of Prof. Bonamy Dobrée, the University aspires along with its sister universities to contribute to "the creation, generation by generation in a continuous flow, of a body of men and women who share a sense of civilized values, who feel responsible for developing them, who are united by their culture, and who by the simple pressure of their existence and outlook will form and be enlightened public opinion".

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* Full syllabuses and notes on requirements are given in the University's 'Prospectus and Regulations".

CENTRE FOR RESEARCH ON MACROMOLECULES, STRASBOURG

THE Centre for Research on Macromolecules (C.R.M.), Strasbourg, is a foundation of the French National Centre for Scientific Research (C.N.R.S.). It is one of a series of specialized institutes each of which is devoted to a particular branch of research, and several of these are planned to be established in the course of the next few years.

This new institute is sited in Strasbourg because there was already in the faculty of sciences a university department for the study of macromolecules, financially supported by the National Centre. It is this nucleus that has been expanded and installed in a new building to become the new national centre for macromolecular studies.

The idea of the foundation, due to Prof. C. Sadron, the present director, is that it would facilitate the collaboration of physicists, chemists and biologists interested in macromolecular science. The physicist's part is the creation and the development of the necessary techniques for the investigation of the constitution of macromolecules by purely physical methods. In order to provide the materials for this work, teams of chemists and biologists are also necessary. Similarly, the physicists provide the finished tools for the use of the chemists and the biologists. In this way the highly specialized and difficult techniques and methods may all be applied so that correct interpretation of the results may be obtained in a very broad and difficult field. To provide for the carrying out of this broad plan, the following facilities and organization have been created.

The building is housed on four floors with a total area of about 35,000 sq. ft. In the basement on the ground floor are special rooms for precise physical measurements, administrative offices and general services. The first floor is devoted mostly to biology, some of the space having accommodation for spectroscopic instruments. The lecture room is also on the first floor and extends to the second floor as well. The second floor is concerned with chemistry and also houses the private apartments of the director.

The present staff consists of about sixty research workers, technicians, mechanics, secretaries and typists.

The physics section consists of about eleven people. It is directed by Prof. H. Benoit and is concerned with light scattering, Brownian diffusion, streaming birefringence, viscosity, fluorescence and dielectric constant as well as supersonic work. Infra-red and ultra-violet spectroscopic work are also the concern of the physics section.

There is also a separate section of X-ray studies with seven people directed by Dr. V. Luzzati. The topics here comprise the determination of molecular structures by conventional diffraction methods, the crystallinity of fibres and low-angle scattering by high polymer solutions. A Spinco ultracentrifuge and an electron microscope complete the equipment.

The biological section, directed by Dr. Vendrely, consists of ten people, and the two main topics are the structure of globular proteins and also the study of nucleic acids.

The chemical division is directed by Prof. J. Parrod, assisted by Dr. P. Rempp. It comprises two sections, the first being concerned with the synthesis of macromolecules of low molecular weight with a well-defined constitution, and the second with the study of polymerization reactions. Facilities for fractionation are also available in this section, and the particular concern of the polymerization section is elastomers.

The laboratory was formally opened on October 6. The ceremony was presided over by the Secretary of State for Scientific Research and Technical Progress in the presence of M. G. Dupouy, member of the Institut de France and director of the National Centre for Scientific Research, representatives of the Ministry of Education, and numerous personalities, French and foreign, belonging to the world of science and industry. An international colloquium was arranged on this occasion and some fifteen papers were given by eminent specialists on various aspects of the science of macromolecules. The colloquium was concerned not only with physics, biology and chemistry, but also with considerations of the industrial uses of high polymers, which come under the general care of the new Centre.

The Centre for Research on Macromolecules will therefore have the goal of contributing to the fundamental science of macromolecules, of furthering the progress of knowledge about certain essential properties of living matter, and of helping the development of the industrial production of high polymers. In this latter domain relations already exist between the Centre and various industrial establishments, the technologists of which are specializing in the various techniques needed for work on high polymers. Representatives from industries outside France will frequently discuss with the staff at the Centre problems concerned with the production of high polymers. The industry of the region will also be interested directly in the development of the Centre.

NEW INTERNATIONAL BAROMETER CONVENTIONS

By P. H. BIGG

National Physical Laboratory

THE purpose of this article is to bring to the notice of barometer users generally a new rationalized system of barometer conventions which has received strong support both in Great Britain and internationally, and will come into operation on January 1, 1955.

The development of the mercury barometer has been unfortunate in the number of scales which have come into use and in the variety of temperature and gravity values which have been associated with these scales. The use of three standard temperatures (0° C., 12° C. and 62° F.) with three variants of standard gravity (980·665 cm./s.^{2}, 980·62 cm./s.^{2}, and gravity at mean sea-level in lat. 45°), combined with the possibility of five scales (millibar, millimetre, inch, altitude in metres and altitude in feet), has been the cause of much misconception and error. The situation has been further complicated by the differing temperature coefficients of barometers with fiducial adjustment (for example, Fortin) and those without it (for example, Kew).

That much confusion and error were associated with the correlation and correction of readings on the various scales of these two types of barometer became increasingly evident to the National Physical Laboratory in the course of its barometric work; and hence, soon after the War, it initiated discussions with the Meteorological Office and the Ministry of Supply. At these discussions there was general agreement that simplification is most desirable. After consulting standards laboratories and meteorological organizations in the British Commonwealth and in the United States, and later the Comité International des Poids et Mesures, agreed proposals for the new system of conventions were submitted to the International Organization for Standardization (ISO) and the World Meteorological Organization (WMO). Committee ISO/TC12 of the International Organization for Standardization, which is concerned with quantities, units, symbols, conversion factors and conversion tables, at its meeting in October 1952 approved in principle the units associated with the new conventions and raised no objection to the adoption of the conventions as a whole. In 1953, the Executive of the World Meteorological Organization approved the proposals. The conventions have more recently been adopted by the British Standards Institution, and a British Standard* on the subject is in the course of publication.

The New Conventions

In the form adopted by the British Standards Institution, the rationalized conventions are as follows:

(1) *Pressure units.* Apart from the basic unit of pressure, namely, the dyne per square centimetre (symbol dyn/cm^2), the following pressure units only shall be recognized for barometric purposes. They are given in order of preference, the millibar being strongly recommended.

(i) The millibar, equal to 1,000 dyn/cm^2 (symbol mb).

(ii) The millimetre of mercury at 0° C and standard gravity 980·665 cm/s^2 (symbol mmHg).

(iii) The inch of mercury at 0° C and standard gravity 980·665 cm/s^2 (symbol inHg).

By 'mercury at 0° C' is meant a hypothetical fluid having an invariable density exactly 13·5951 g/cm^3. By 'inch' is meant a length of 25·4 millimetres exactly.

(2) *Standard instrumental conditions.*

(*a*) *Pressure scales.* Mercury barometers bearing scales representing the above units shall measure pressures directly in these units when the whole barometer is at 0° C and is subject to standard gravity 980·665 cm/s^2.

(*b*) *Altitude scales.* Mercury barometers bearing altitude scales shall correctly translate the applied pressure into the corresponding altitude (on the pressure/altitude relationship adopted) when the whole barometer is at 0° C and is subject to standard gravity 980·665 cm/s^2. (The definition of the various relationships between pressure and altitude in the atmosphere, and of the underlying assumptions, is not within the scope of the new barometer conventions, which are concerned with the conditions of use of barometers bearing scales complying with these relationships.)

The reforms which have been introduced arise mainly from the exclusive use of a single conventional value for standard gravity, together with a single reference temperature, in the definition of the millimetre and inch pressure units and in the standard instrumental conditions associated with all scales, including those of altitude.

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* British Standard 2520. Barometer Conventions and Tables. (British Standards Institution, British Standards House, 2 Park Street, London, W.1.)

The need for relating barometric measurements to a definite gravity value has long been recognized. In the past, various values have been used. The recent general acceptance of the conventional value for standard gravity, 980·665 cm./s.^{2} (which is not now associated with lat. 45° and is therefore not liable to revision), and its adoption as the reference value for all barometric purposes, constitute notable steps forward. The similar use of a conventional value for the density of mercury at 0° C. is also a noteworthy advance, as it gives precision and permanence to the millimetre and inch pressure units, while not precluding allowance being made, in barometric measurements of extreme accuracy, for the actual density of the mercury at 0° C.

In the past, it has not been clear whether millimetre and inch scales on mercury barometers should be regarded as scales of pressure (as they are on aneroid barometers) or as scales of length set up to measure the length of the mercury column. The millibar scale has always been free from such doubt, the millibar being clearly a unit of pressure and not of length. It has now been decided to regard all three scales as pressure scales, giving readings in the standard pressure units when the barometer is under standard instrumental conditions.

Effect of the Changes

The adoption of the new conventions will greatly simplify the manufacture and standardization of mercury barometers, the correction of their readings to standard conditions, the final expression of pressures, and the conversion of either readings or pressures from one scale unit to another.

As aneroid barometers are also to be regarded as graduated in terms of the new pressure units, their readings will show the same inter-relationships as the scale readings on mercury barometers.

At a pressure of about 1,000 mb. the reading of a Fortin millibar barometer graduated on the new basis will be 2·0 mb. *greater* than one graduated on the old basis. This is almost entirely due to the change in the standard temperature of the mercury from 12° to 0° C., and the difference is proportional to pressure. Millimetre Fortin and Kew barometers will remain unaltered, because their scales have always been standardized at 0° C. At ordinary atmospheric pressures the reading of an inch Fortin barometer will be 0·01 *less* than before. This is due to the change in the length of the inch scale between 62° F. and 0° C. The difference is proportional to pressure. On account of the special temperature coefficients of Kew-type barometers, millibar and inch Kew barometers will not be affected in quite the same way as the corresponding Fortin barometers. Details will be found in B.S. 2520.

Implementation of the Changes

It is recommended that existing millibar and inch mercury barometers should be modified to comply with the new conventions as soon as is practicable, for example, when barometers are due for repair. As from January 1, 1955, the testing of barometers by the National Physical Laboratory will be based exclusively on the new conventions; new barometers will be required to satisfy the Laboratory tolerances. For the time being, barometers already in service will be admitted unaltered to the test provided that certain inscriptions required by the British Standard have been marked permanently upon them. To prevent misconception, a small label referring to the National Physical Laboratory test will be attached to any unaltered barometer which shows large index corrections as a result of the change in the basis of the pressure scale.

Save in exceptional circumstances, no accurate pressure measurements can be obtained with a mercury barometer unless due correction is made on account of temperature and gravity. The British tables hitherto used for this purpose have been derived for the most part from the International Meteorological Tables published in 1890 and not since revised. In relation to modern instruments and pressure units they have for many years been incomplete and, to some extent, inaccurate. The British Standard therefore incorporates comprehensive correction tables, applicable to all current types of mercury barometer, on the basis of the new units and conventions.

The advantages of the new system are permanent, and will far outweigh the inconveniences in first applying them. The conventions will be implemented in important government services and by the barometer manufacturers. It is hoped that scientific workers and others will henceforth express barometric pressures exclusively in terms of the international units and symbols, and, with the view of reducing to a minimum the period of change-over, that they will have their millibar and inch barometers brought into accord with the new conventions at the first opportunity.

I wish to acknowledge the responsibility of Mr. F. A. Gould, who was until lately in charge of the barometric work at the National Physical Laboratory, for the Laboratory's part in the development of the new conventions. This work was carried out as part of the research programme of the Laboratory, and the present paper is published by permission of the Director of the Laboratory.

OBITUARIES

Prof. R. E. D. Baker

Richard Eric Defoe Baker, professor of botany in the Imperial College of Tropical Agriculture, died in Trinidad on November 19, of heart failure after a short illness, in his forty-sixth year. His death is a great loss to botanical science in the tropics, and especially to the College which he served untiringly for more than twenty years.

Born in 1908, Baker was educated at Oundle and Trinity Hall, Cambridge, where he obtained a first class in Part II of the Natural Sciences Tripos; he also rowed for his College. After a year of postgraduate study at the Imperial College of Tropical Agriculture, of which he was awarded the associateship, in 1933 he was appointed lecturer in mycology in the College, and promoted to professor in 1945. Although his earlier interests were mainly in cryptogamic botany, in which he did outstanding work on witches' broom disease of cacao (*Marasmius perniciosus* Stahel), he was no narrow specialist, and in 1949 was appointed to the chair of the newly amalgamated Departments of Botany and Mycology. He was an enthusiastic student of the phanerogamic flora of Trinidad and since 1947 had been editor of the "Flora of Trinidad and Tobago", of which most of the parts dealing with the Dicotyledons have already been published or are in the press. He was in charge of the botanical sections of the banana and cocoa research schemes at the College, and in 1948 he went on an expedition to East Africa to collect wild and cultivated species of bananas for extension of the breeding stocks. In 1952 he led an expedition to Colombia for the purpose of collecting wild species of *Theobroma*. He was also largely responsible for the successful organization of River Estate, the College's field station for cacao research.

Baker (or 'Dick', as he was known to staff and students alike) had a charming personality, a great sense of humour, and an interest in many subjects apart from his profession. Although, perhaps, he sometimes found it difficult to suffer fools gladly, he freely offered his time and experience to those whom he did not consider to be fools, and in this his judgment was seldom, if ever, at fault. The news of his untimely death will be a great shock to the numerous past students of the Imperial College of Tropical Agriculture, now scattered over all parts of the British Commonwealth, who have been taught and inspired by him.

If he was not, in the ordinary sense, a religious man, he whole-heartedly put into practice that great precept, "Whatsoever thy hand findest to do, do it with all thy might". He has been buried in the College cemetery, next to the grave of his former professor, H. R. Briton-Jones, who died in 1936. He is survived by a widow and four daughters.

T. W. Kirkpatrick

Mr. H. G. Yates

By the very sudden and untimely death on September 15 of Mr. Henry George Yates, the marine turbine industry has suffered a serious loss. At the age of forty-six he had not reached the peak of his activities, and his abilities as a steam turbine designer in the marine industry were widely recognized and appreciated. He was widely read, interested in amateur dramatics, and had a happy family life, although his two children are only at the start of their scholastic careers.

The study of vibration was a great hobby of his. Anything from the vibration of a sewing machine at home to the most complex types of vibration occurring in geared turbine systems was strenuously investigated. He had outstanding patience in explaining the more abstruse points in designs. His eyesight had been defective from birth in one eye, but he developed amazing ability in dealing with complex mathematical formulæ in his head.

After a distinguished scholastic career, he graduated at Trinity College, Dublin, in 1930 with first-class moderatorships in mathematics and physics and was afterwards awarded the M.A. degree. He continued at the University as a lecturer in physics for two years before deciding that he would prefer to be an engineer. He served a student apprenticeship with the English Electric Co., Ltd., at its Willans Works, Rugby, and was employed after his apprenticeship in the Turbine Department of the Company. In 1940 a Research Department was set up, and Yates was put in charge of the work. He joined the Parsons and Marine Engineering Turbine Research and Development Association (Pametrada) very near the beginning, and was associated with the growth of the Association, particularly in the work of the Design Department, in which many designs were prepared for turbine machinery to be installed in important British and foreign ships, the total horse-power of the designs aggregating some seven million. During this time Pametrada acquired a number of foreign licences, which enabled Yates's work to influence building in countries such as Holland and Canada.

Yates was an associate member of the Institution of Mechanical Engineers, Fellow of the Institute of Physics, a member of the American Society of Mechanical Engineers, and at the time of his death was a member of council of the North-East Coast Institution of Engineers and Shipbuilders and chairman of the North-East Branch of the Institute of Physics. Apart from the technical committees of Pametrada on which he was a valued member, he was on the Admiralty Noise Reduction Panel NRP.2, AVGRA Sub-Committee *D*, the Admiralty Gearing Noise Advisory Panel, the Heat Transfer and Heat Exchange Committee of the Mechanical Engineering Research Organization and Committee *J* (Power Plant) of the British Electrical and Allied Industries Research Association.

The thing that struck most people meeting him for the first time was his great personal charm and very quiet way in explaining difficult points in design so that they became clear and easy to understand. He is greatly mourned by his colleagues at Pametrada, where he spent the last ten years of his life in charge of the Design Department.

Thomas W. F. Brown

Mr. E. Laurmann

The sudden death of Emil Laurmann on November 10 at the age of sixty-four came as a great shock to his friends and colleagues in the Royal Society Mond Laboratory, Cambridge. An Estonian by birth, he was trained as an engineer at Strelitz in Germany but was unable to complete the course owing to the outbreak of war in 1914; he worked for a time at Siemens in Leningrad, and then at the newly organized Polytechnic Institute, where he started his collaboration with Kapitza. In 1922 he followed Kapitza to Cambridge and for many years acted as his personal assistant, first in the magnetic department of the Cavendish Laboratory and later in the Mond Laboratory. His qualities of inventiveness, skill and patience in all sorts of techniques such as electrical engineering, fine mechanics, photography and the handling of delicate metal crystals, contributed largely to the successful outcome of Kapitza's investigations at very high magnetic fields. After Kapitza's return to the Soviet Union, Laurmann spent a year in Moscow helping to set up similar equipment at the Institute for Physical Problems and collaborated with Kapitza in studies of the Zeeman effect at very high fields.

During the years since the Second World War, Laurmann worked with me in various researches on superconductivity and the magnetic behaviour of metals at low temperatures, and I owe more than I can adequately express in words not only to his technical skill and ingenuity but also to his patience and good nature. Many others in the Mond Laboratory have also benefited from his advice and help, which he always gave willingly in a characteristically quiet and unassuming way; his presence in the Laboratory will be sadly missed. He is survived by his widow, a daughter and a son. D. Shoenberg

NEWS and VIEWS

Imperial College of Science and Technology: Appointment of Rector

Prof. R. P. Linstead, professor of organic chemistry in the Imperial College of Science and Technology, London, has been appointed rector of the College in succession to the late Sir Roderic Hill. Prof. Linstead had been director of the Chemical Research Laboratory (Department of Scientific and Industrial Research) before he went to his present post in the Imperial College in 1949 (see *Nature*, 163, 558; 1949).

Paris: New Scientific Attaché

Mr. A. C. Copisarow has been appointed scientific attaché to the British Embassy in Paris. Mr. Copisarow graduated in the honours school of geology of the University of Manchester in 1942, specializing in mineralogy and petrology. He served for four years in the Royal Navy, and was a member of the Ultra-Short-Wave Panel of the Scientific Advisory Council. Entering the Civil Service in 1947, Mr. Copisarow eventually became head of the Industrial Sub-Division in the Ministry of Defence. His published work includes a number of experimental papers on the colloidal chemistry of silica.

Sheep Biology Laboratory, Prospect, New South Wales: Dr. I. W. McDonald

Dr. I. W. McDonald has been appointed officer-in-charge of the Sheep Biology Laboratory, Prospect, New South Wales, of the Commonwealth Scientific and Industrial Research Organization, Australia, in succession to Prof. C. W. Emmens, professor of veterinary physiology in the University of Sydney, who has been acting as officer-in-charge since 1952 (see *Nature*, 170, 954 (1952), and also 171, 597 (1953)). Dr. McDonald is a former student of Hawkesbury Agricultural College and a graduate of the University of Sydney. After graduation he undertook research on the nutrition of sheep at the Animal Nutrition Laboratory of the Commonwealth Scientific and Industrial Research Organization and at the Institute of Medical and Veterinary Science, Adelaide, where he was appointed deputy director. In 1945 he went to the Universities of Cambridge and Sheffield, gaining a Ph.D. for studies in the metabolism of the sheep, with special reference to the digestion of protein, and since 1948 he has been a senior principal scientific officer at the Institute of Animal Physiology, Cambridge, where he has continued his researches on the processes of digestion in the sheep.

The Australian Museum, Sydney: Dr. J. W. Evans

Dr. J. W. Evans, deputy chief scientific officer of the Civil Service in Great Britain, has been appointed director of the Australian Museum, Sydney, in succession to Dr. A. B. Walkom. After graduating at Cambridge, Dr. Evans went to Australia in 1926 and joined the staff of the Council for Scientific and Industrial Research. He held various appointments in Australia and returned to London in 1944. He has had wide scientific and administrative experience. Though employed chiefly as an applied entomologist, his forty to fifty papers indicate wider interests in taxonomy, comparative morphology and ecology.

Scientific Work on Smokeless Fuels

In a Royal Institution Discourse on December 10, Sir Charles Ellis described the National Coal Board's research work into the production of high-class solid smokeless fuels. The problem, he said, is twofold: it is necessary to remove the volatile matter from coal in some way that pays for itself; and secondly, coal used must not be carbonization type, the long-term supply position of which is giving cause for considerable anxiety in Britain. The National Coal Board, he said, intends to develop a range of smokeless fuels that will be specialized to their individual purposes and will be premium fuels. In spite of the urgency of the situation, the Board believes that a long-term policy is necessary, and it is aiming at developing new processes that will represent a real technological advance.

One promising line of work starts with 'fines', or powdered coal. This is subjected to a fluidization process, in which a column of hot gas or steam is blown upwards through the fine coal in a heated vertical chamber; this results in chemical changes in the coal and the separation of the volatile substances and oils. The product of this process is difficult to make into briquettes, so a binder such as pitch is added; this involves a further process of carbonization. For this purpose the hot-sand carbonization process has proved to be of great importance. It gives rapid carbonization; also, it is a continuous process. A small plant working on a 50 lb. an hour scale has been completed and the possibility of the process established. A drawback of compressing the less suitable types of coal into briquettes is that a binder has to be used. Quite recently, Sir Charles said, it has been found at the National Coal Board's research establishment that these high volatile coals can be made to stick together without using any binder. This discovery may revolutionize our thinking on the whole subject of supplies to consumers.

Scientific Research and Industrial Productivity

In No. 7 (July 1954) of the "Occasional Bulletin" from Sondes Place Research Institute, Dorking, which resumes publication after two and a half years, the problem of research and productivity is discussed with reference to the more effective use by industry of applied science to improve its technological efficiency. It is recognized that labour productivity is not the only factor affecting the overall efficiency, nor necessarily the most important, and that productivity depends upon many factors other than economic, such as technical efficiency, the extent to which manual labour is lightened by the use of machines, enlightened and efficient management, good relations with trade unions, the existence of adequate incentives, taxation policy and the nature of the social system. Higher productive efficiency can never be achieved if any one of these factors is ignored; but, limiting itself to technological efficiency, the Bulletin argues that a more intensive application of scientific methods to industrial problems offers great potentialities for increased productive efficiency. Pointing out that 98 per cent of Britain's factories employ less than two hundred and fifty workers but that more than 50 per cent of the country's industrial workers are employed in such factories, the Bulletin comments that, if the survey recently conducted by the Manchester Joint Research Council is representative of conditions elsewhere, up to half of the population of Great Britain is employed in industries where the chances of greater productivity arising from technological advances are remote. For such small firms the independent research institute is particularly useful, and the

Sondes Research Institute has always endeavoured to supply the research tools and the trained staff which such firms lack. All rights in any discoveries made in a project are automatically assigned to the sponsor, so that the Institute may be regarded as the research department of the sponsor for the duration of the project. Experience at Sondes Place confirms the difficulty of liaison with industrialists who are unable to define their own problems in terms which the technical man can understand, and also the backwardness of small firms in appreciating the contribution science can make to improving productivity.

Technical Graduates in the British Armed Services

IN written answers to Parliamentary questions on November 22, the Minister of Defence, Mr. H. Macmillan, stated that about 940 uniformed personnel at present employed on instructional duties in the Fighting Services hold degrees in science, including mathematics and engineering, the average annual intake for this purpose into the Royal Navy and the Royal Air Force together during the past three years being about 165. In addition, some 120 civilian science or engineering graduates are employed on instructional duties with all three Services, with an average annual intake of about ten during the past three years. Some 2,860 civilian science and engineering graduates are employed on research and development by the Service and supply departments, the average annual intake during the past three years being about 185. Science graduates are not recruited into the Services specifically for research and development duties, but about 110 uniformed personnel holding degrees in science, including mathematics and engineering, are in addition employed on research and development for the Services.

J. A. Gilruth and his Influence on Commonwealth Livestock Industries

THIS year the Macrossan Memorial Lecture was given at the University of Queensland by Sir Ian Clunies-Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Australia, who chose as his subject "John Anderson Gilruth: the Influence of his Life and Work on the Development of the Livestock Industries of the Commonwealth". Gilruth combined a forceful personality with true administrative and scientific ability. After training as a veterinarian at Glasgow, he spent seventeen years in New Zealand, where he built up what was probably the best government veterinary service in the British Commonwealth. Sir Ian considers this service one of the chief reasons why New Zealand achieved such a high reputation for exports of lamb and dairy produce. In 1909 Gilruth was appointed the first professor of veterinary science in the University of Melbourne, where he established the first five-year veterinary course in the British Commonwealth, if not in the world. The last and equally fruitful phase of his career started in 1929, when he was appointed chief of the Division of Animal Health of the then newly formed Council for Scientific and Industrial Research, now the Commonwealth Scientific and Industrial Research Organization. His sound judgment and planning have been reflected in the output of important research by the Organization in nutrition and infectious diseases, much of it fundamental in nature. His strong personality and original mind were responsible for the initiation and successful pursuance of a number of investigations that have yielded far-reaching results. Sir Ian then reviewed the achievements of Australian scientific workers in these fields and closed by pointing to some major problems still confronting the further development of Australia's agricultural industry—problems that offer a fascinating challenge to the best scientists that the country can produce.

Indian Journal of Fisheries

THE first issue of a new journal, the *Indian Journal of Fisheries* (1, Nos. 1 and 2; May 1954; pp. 416+8 plates; Rs. 7.8 net), published by the Ministry of Food and Agriculture of the Government of India, New Delhi, has recently appeared, and the welcome that one would normally accord to a new periodical devoted to scientific research in India is all the warmer for one that deals with questions likely to increase food supplies. The journal deals with fisheries research in Indian and adjacent waters—freshwater, lacustrine and salt water—and there are papers on plankton, algae, molluscs, crustaceans and fish. In all cases attention is given to the practical aspect of ensuring a continuation and improvement of the fish supply, the spawning and growth of fish being carefully considered. A detailed description is given of the Central Marine Fisheries Station, Mandapam Camp, Southern India, and this account must arouse envy in the hearts of fishery research workers in Europe, for there are twenty-three scientific officers, twenty-two research assistants and fourteen fishery survey assistants, in addition to the normal administrative staff. There are also subsidiary research stations, notably in Calicut and Karwar, and an inland fisheries research station has been established in Calcutta. There are lists of the publications issued at Mandapam and Calcutta. The Government of India is to be heartily congratulated, since in this issue of the new journal practically no problem connected with the fisheries is overlooked or neglected.

Fisheries of Lake Chilka in Southern India

CHILKA LAKE, which is situated on the east coast of India near Puri in the State of Orissa, is really a lagoon, for it communicates with the open sea by a narrow channel fourteen miles long. In the rainy season the area is 450 square miles, shrinking to 350 square miles in dry weather. It is very shallow, varying in the dry season from 3 to 4 ft. in depth. The salinity varies from practically fresh water to a high salinity near the sea entrance. Consequently, there is a remarkable fauna, both of fish and invertebrates. The total number of species of fish known in the Lake is 138. Large quantities of carp fry drift down into the Lake during floods and are utilized for stocking freshwater tanks. The shallowness of the Lake makes fishing comparatively easy, and the bulk of the catches goes by rail to Calcutta. A full description of the methods of fishing is given in the paper by S. Jones and K. H. Sujansingani in the first volume of the new *Indian Journal of Fisheries* (see above). The chief food fish are mullets, clupeoids, catfishes, sciaenoids, perches and bekti, and the yield per acre (both fresh and dried fish) amounted in the years 1948, 1949 and 1950 to 34·48, 31·58 and 29·80 lb., respectively. Since the Lake is an uncultivated piece of water and more than a fourth of it is too shallow to support a good fishery, these totals must be considered satisfactory. The authors recommend the abolition of the present zemindari (landlord) system and the transfer of the fishing rights to the State.

Methods of preserving the future supply are carefully considered, and a minimum size limit for fishes of economic importance during certain seasons is recommended. The crab fishery of the Lake has also been dealt with by the same authors (*J. Bombay Nat. Hist. Soc.*, 1952), and great credit is due to them for these two valuable reports.

Scientific Observations on Heard Island in the Antarctic

The Southern Ocean—the ocean surrounding the Antarctic Continent—is divided into two main hydrological zones by the Antarctic Convergence, the line of demarcation at the surface of the ocean between the cold antarctic water and the warmer sub-antarctic water. The Ocean contains several isolated islands and groups of islands, including the following: South Georgia, South Sandwich Islands, Bouvetoya, Prince Edward Islands, Iles Crozet, Iles de Kerguelen, Heard Island, Macquarie Island, Campbell Island and Auckland Island. Differences in their altitudes, atmospheric circulation and ocean currents, combined with their positions relative to the Antarctic Convergence, have resulted in some of these islands being ice-covered and glaciated whereas others are clothed in grass and other non-arboreal vegetation. Heard Island (lat. 53° S., long. 73½° E.), which lies about nine hundred miles north of the western sector of Australian-Antarctic Territory, is a typical ice-capped antarctic island. The recent establishment of a research station by the Commonwealth of Australia on Heard Island makes it possible to provide the first comprehensive scientific information on the geography, geology, meteorology, flora and fauna of the Island. This report has been prepared by P. G. Law and T. Burstall and issued by the Antarctic Division, Department of External Affairs, 187 Collins Street, Melbourne (Interim Report No. 7; pp. 32+7 plates; 1953). It also contains accounts of recordings to extend studies in geomagnetism, seismology and knowledge of cosmic rays, as well as observations of the aurora australis.

University of Birmingham

The following have been appointed lecturers in the University of Birmingham: E. H. Wright (mechanical engineering), Dr. S. A. Barker (chemistry), Dr. K. F. Chackett (physics), C. B. Wright (physical metallurgy), Dr. J. D. Blainey (experimental pathology), J. B. W. Halley and K. R. Thornton (pathology), and Dr. N. S. Ross (Harry Payne lecturer in employer–employee relations). The following have been appointed to research fellowships: Dr. Jacques Vilain, Dr. P. D. Whitaker and E. A. Finlay (physics); Dr. O. Theander, Dr. A. Sykes, Dr. C. R. Patrick and M. Kapel (chemistry); Dr. E. L. Breese and Dr. F. W. Allard (genetics); J. R. Coope (geology); Dr. A. D. Hudson, Dr. Francine Gregoire and Dr. A. L. Woolf (pathology); Dr. P. B. Bradley (experimental psychiatry); and W. A. Coppel (pure mathematics). The following have resigned from the University: Dr. Hilde Behrend, research fellow in commerce, and J. S. Howell, research fellow in pathology. The National Coal Board has provided a sum of £1,600 for research in the Department of Mining of the University, and Unilever, Ltd., has made a grant to the Institute of Engineering Production of £200 a year for seven years towards expenses of the Institute. In the Department of Chemistry, 15,000 dollars has been provided by the Rockefeller Foundation for Prof. M. Stacey's research in biochemistry, the amount to be spent over three years, and the Geigy Company has sponsored a research fellowship in the field of organic chemistry for one year.

Announcements

Prof. R. E. Glover, professor of veterinary pathology in the University of Liverpool since 1949, and a past president of the Royal College of Veterinary Surgeons, has been appointed principal and dean of the Royal Veterinary College in succession to the late Prof. J. B. Buxton.

The Minister of Agriculture and Fisheries and the Secretary of State for Scotland have appointed Lord St. Aldwyn, joint parliamentary secretary to the Ministry of Agriculture and Fisheries, as chairman of the Myxomatosis Advisory Committee in succession to Lord Carrington. Dr. I. Thomas, deputy chief scientific officer to the Ministry of Agriculture and Fisheries, has been appointed a member of the Committee in succession to Dr. J. W. Evans (see p. 1130).

Lieut.-Colonel L. F. Urwick has been awarded the Wallace Clark International Management Award for 1955. This Award has been given annually since 1948 by the American Society of Mechanical Engineers, the American Management Association, the Society for the Advancement of Management and the Association of Consulting Management Engineers, and is presented by the Council for International Progress in Management (U.S.A.), which represents the American management movement internationally. Colonel Urwick is the first British national to receive the Award.

Under the will of the late Francis Amory, the American Academy of Arts and Sciences is offering a substantial prize for outstanding work on some aspect of the alleviation or cure of diseases affecting the human reproductive organs, in particular those of men. Nominations, supported by statements of qualifications with regard to work done since 1947, should be sent as soon as possible to the American Academy of Arts and Sciences, 28 Newbury Street, Boston 16, Massachusetts.

The Institution of Naval Architects is offering the following scholarships for training in a university institution: *I.N.A.–Elgar–Martell Scholarship*, for naval architecture, worth £275 a year, which is open to British subjects less than twenty-three years old who have been employed for at least two years upon shipbuilding (entries close January 14, 1955); *Denny Scholarships*, one in naval architecture and one in marine engineering, worth £175 a year for four years at the University of Glasgow, with apprenticeship of five years, which is open to British subjects less than nineteen years old (entries close May 31, 1955). Further information can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

A telegram has been received from Copenhagen announcing the discovery by Abell, at Palomar, of an asteroid on December 3. Its position was R.A. 7h. 08·1m., Dec. −21° 19′; daily motion: in R.A. −06m. 46s.; in Dec. −01·25°; mag. 17; appearance stellar.

Erratum. In the article on "Chemistry of some Natural Pigments" in *Nature* of November 27, p. 990, col. 2, eight lines from the bottom, for ". . . introduced into tetramethyl tetrazaporphin . . ." read ". . . introduced into octamethyl tetrazaporphin . . .".

ROCKEFELLER FOUNDATION GRANTS

GRANTS made by the Rockefeller Foundation during the third quarter of this year totalled 1,015,696 dollars. During the same period, the Foundation awarded thirty-nine fellowships to individuals from twenty countries. Among the grants to institutions are the following: £24,000 and 10,000 dollars (about 82,000 dollars in all) to the Royal Technical College, Glasgow, for post-graduate training and research in environmental control engineering, to be conducted with the several new towns in the Scottish Highlands in mind, which are now in varying stages of development; 50,000 dollars to the Department of Biochemistry of the Pasteur Institute, Paris, for the purchase of research equipment and other purposes; 45,000 dollars over five years to the Department of Chemistry, University of Edinburgh, for research on natural high polymers; 12,000,000 lire (about 22,000 dollars) over a period of three years to the Institute of Zoology, University of Pavia, for cytogenetic studies of mosquitoes; 30,000 dollars to the Marine Biological Association of the United Kingdom for use at its laboratory in Plymouth; 30,000 dollars to the Strangeways Research Laboratory, Cambridge, for the purchase of an electron microscope; 30,000 dollars over three years to the biophysical research unit at King's College, London; 30,000 dollars over three years to the Gordon Research Conferences of the American Association for the Advancement of Science, as a continuation of previous aid for financing the visits of selected foreign scientists to the United States to attend conferences on the chemistry of biologically significant molecules; 15,000 dollars over two years to the Royal Institution of Great Britain and its associated Davy Faraday Research Laboratory towards the expenses of research on the structure of proteins; 15,000 dollars over three years to the University of Birmingham for further support of the research in the chemistry of carbohydrates under the direction of Prof. M. Stacey.

Other grants made in the third quarter of this year include the following: 500 dollars to Dr. George Otto Gey, director of the Division for Cellular Pathology, Department of Surgery, Johns Hopkins University, Baltimore, to visit European laboratories conducting work in cell research and virology; 10,000 dollars to the Inter-American Society of Soils Scientists for meetings of the Society during the period ending March 31, 1956; 5,000 dollars to the University of Arizona, Tucson, for a conference on the problem of cloud physics research held in Tucson during August 1954; 3,500 dollars to McGill University, Montreal, for aid to the general organizing committee in preparation for the Tenth International Congress of Genetics to be held at McGill in 1958; 1,000 dollars to the University of Liège for research in carbohydrate chemistry, under the direction of Dr. Claude Liébecq, of the Institute of Higher Physical Education; 2,200 dollars to the University of Paris, for research in chemical genetics, under the direction of Prof. Boris Ephrussi; 6,000 dollars to the Institute of Anatomy, Karolinska Institute, Stockholm, as a further contribution towards the purchase of an electron microscope to be used for research under the direction of Dr. Fritiof S. Sjöstrand; 5,000 dollars to the Institute of Physiology, University of Geneva, for the purchase of equipment to be used by Prof. Jean Posternak; 7,500 dollars to the University of Glasgow for three small working conferences of European scientists interested in genetical problems, to be held during the five-year period beginning January 1, 1955; 7,200 dollars to the Department of Biological Chemistry, University of Aberdeen, for equipment to be used in general biochemical research; 2,000 dollars to the Department of Natural History, University of St. Andrews, for equipment for research in marine biology; 895 dollars to the Virus Research Institute, Lagos, for air-conditioning equipment; 5,500 dollars to the Department of Physiology, Medical College, Indore, for equipment to be used under the direction of Dr. J. C. Sachdev; 2,000 dollars to the Department of Microbiology, Institute of Public Health, Tokyo, for the application of tissue culture methods to the study of viruses; 2,000 dollars to Dr. Konoshin Onodera, of Kyoto University, to visit the United States for research in carbohydrate chemistry at Ohio State University, Columbus; 3,000 dollars to Prof. Juan Sanchez Salcedo, jun., professor of chemical hygiene and nutrition, Institute of Hygiene, and professor of biochemistry, School of Medicine, University of the Philippines, Quezon City, to observe new developments in biochemistry and nutrition in Europe and the United States; 5,000 dollars to the Department of Biochemistry, University of Minas Gerais, Belo Horizonte, for equipment to be used by Dr. James B. Sumner; 39,200 cruzeiros (about 1,000 dollars) to the University of Rio Grande do Sul, Pôrto Alegre, towards the establishment of Casimiro Tondo as director of the Institute of Biophysics Research; 525 dollars to the Instituto Agronómico do Sul, State of Rio Grande do Sul, for equipment for investigations in soil physics; 3,350 dollars to Raul Cortes, entomologist in the Department of Agricultural Investigations, Ministry of Agriculture, Santiago, for visits to agricultural research centres in entomology in Latin America and the United States; 1,200 dollars to Joaquin Loredo, head of the Federal Extension Service, Ministry of Agriculture and Animal Industry, Mexico, to visit the United States Department of Agriculture and various State extension service centres; 975 dollars to Raul Palacios, representative of the Ministry of Agriculture and Animal Industry, Agricultural Directive Committee, State of Jalisco, Guadalajara, to visit agricultural research centres in the United States; and 7,300 dollars to the Faculty of Veterinary Medicine, University of San Marcos, Lima, for a co-operative project with the Ministry of Agriculture on the study of diseases of the alpaca, under the direction of Dr. Manuel Moro.

The 39 fellowships awarded by the Foundation during the third quarter of 1954 were distributed among the divisions as follows: medicine and public health, 15; natural sciences and agriculture, 10; social sciences, 7; and humanities, 7.

NATIONAL TRUST

ANNUAL REPORT

THE fifty-ninth annual report of the National Trust, presented to the annual general meeting on November 12, records an increase of 8,550 in membership during 1953, and the membership rose further from 44,450 to 47,676 by July 1, 1954, in spite of the increase in minimum subscription for new members from 10s. to £1. For the year ending December 31, 1953, the deficit on ordinary maintenance and administration was about £1,500 compared with deficits of £33,000 and £29,000 for 1951 and 1952, respectively. The position, however, is less encouraging than these figures suggest. The Trust has both a general fund and numerous special funds which can be used only in connexion with particular properties. When such properties show surpluses of income over expenditure, these surpluses are not available to the general funds of the Trust but must be credited to the special trusts concerned, and surpluses of £14,000 were so credited in 1953. On the other hand, deficits on special trust properties have to be met by loans (totalling £15,000 in 1953) from general funds; and taking into account also a similar position which arises with certain properties managed by local committees, the general funds have been called upon to contribute not £1,500 but £22,500 to meet the deficit on ordinary maintenance and administration. It is thus obvious that the natural pull towards the special funds may seriously embarrass the smooth working of the Trust, and the report emphasizes the paramount importance of more 'free' money that can be spent on the general purposes of the Trust and is not tied to one particular property.

The fall in timber prices has also seriously affected the Trust's income, but the Council expresses the hope that the Trust's woodlands will be self-supporting, that in future the property income and membership subscriptions will more than cover the costs of maintenance and administration, that free gifts and bequests will be available to finance improvements, and that the funds for specific purposes will, whenever possible, be used for the purchase or endowment of new properties. Concern is expressed in the report at the inadequate protection afforded to scenery of natural beauty in certain areas by the Town and Country Planning Acts, and it is pointed out that Trust ownership, or covenants with the Trust, still offers valuable protection for unspoilt countryside and, in particular, for stretches of coastal scenery where the pressure for development is usually most vocal and powerful. The Council, while recognizing the necessity for a new orbital road south of London, has strongly opposed the Surrey County Council's choice of route, which is planned to traverse the North Downs, cutting across commons and stretches of country of exceptional beauty, either in the Metropolitan Green Belt or proposed as a conservation area in the National Parks report.

During the year, the General and Specific Purposes Funds have been supplemented by three grants under the Historic Buildings and Ancient Monuments Act, 1953, of £2,100 for repairs to the Treasurer's House, York; £9,000 for repairs to Dunsland House, Devon; and £3,000 for repairs and £1,000 a year for four years for the maintenance of Lyme Park, Cheshire. But at the annual meeting of the Trust, Sir Alan Lascelles, chairman of the Historic Buildings Council for England, said that, while the prospect for historic buildings other than houses is reasonably satisfactory, the outlook for houses generally is sombre. The threat is social rather than financial. Many historic houses owe their preservation solely to the devoted work of their occupants; as that older generation dies out, private maintenance inevitably becomes rarer and public maintenance more and more necessary if such buildings and their contents are to survive. Lord Crawford and Balcarres, presiding over the meeting, referred also to the unnecessary destruction which is taking place and to the damage caused, for example, by the careless siting of electricity generating stations.

CIVIL ENGINEERING TO-DAY

PRESIDENTIAL ADDRESS TO THE INSTITUTION OF CIVIL ENGINEERS

IN his presidential address to the Institution of Civil Engineers, given on November 2, Mr. David Watson directed attention to the wide sphere of interest of the Institution, at its inception in 1818 and during its early years. He quoted the remarks made by Sir John Rennie in 1845, on assuming office, who mentioned harbour construction, railway development, the manufacture of steam ships, drainage schemes, gas illumination, machinery manufacture and mining, as being among the interests of members of the Institution. Many of these pursuits are now the concern of other institutions, that of the civil engineers being concerned to-day almost exclusively with large-scale constructional work. This narrowing of scope is partly a natural process, though it may have been due to a philosophy which appears to have been based upon faith in past experience, rather than in the possibilities of scientific research; but as Mr. Watson pointed out, the Institution remains available to all practising engineers whatever their speciality.

Although Sir John Rennie spoke in 1845 of the "deservedly high place our profession holds in public estimation", Mr. Watson doubts if the public of to-day is given the opportunity of forming an estimate of the place held by the civil engineer, who is too often content to be just a 'back-room boy', of whom the public has never heard. His work is taken for granted; he is too modest and does not seek recognition of the essential part he plays in inspiring, planning and working out all the practical details which eventually give place to the actual direction of the great sources of power in Nature to the use and convenience of man. The public does not know the heavy responsibility that rests on the engineer in spending public money on capital works; it does not realize that his lengthy processes of comparing many ways of doing even a simple job, assessing the life as well as the annual costs, is by no means a mechanical process. It is his experience and judgment which prompt him to recommend only one of the many schemes he has considered. Thereby he assumes the real, if not the nominal, responsibility.

Mr. Watson's own engineering activities have been mainly in the field of public health and sanitary engineering: it was his firm that was responsible for the West Middlesex main drainage scheme with its magnificent sewage disposal works at Mogden. This scheme, since its completion in the mid-thirties, has been an outstanding success and has encouraged the development of biological methods of sewage purification. Such methods are eminently satisfactory for normal domestic wastes, but the biological action may be inhibited by large quantities of industrial waste or even by an excessive concentration of domestic detergents. Mr. Watson suggested that new legislation is long overdue to prevent the penalization of local authorities, owing to these novel and sometimes unpredictable hazards.

BACTERIOLOGY OF MILK AND MILK PRODUCTS

THE autumn meeting of the Society for Applied Bacteriology was held in London on October 26, when recent advances in the bacteriology of milk and milk products were discussed. Dr. J. G. Davis (London) was in the chair. The full papers of the symposium will appear in the *Journal of Applied Bacteriology* (18, No. 2).

W. A. Cuthbert (Leeds), introducing his paper on coli-aerogenes bacteria in dairy water supplies, explained that it was a continuation of an investigation, the earlier part of which had already been reported. Discussing sampling methods in farms and dairies, he directed attention to difficulties and dangers due to fire risks often encountered when carrying out the prescribed flaming of taps in farm buildings. A long series of tests has shown that there is no significant difference in coliform contents of samples taken with and without flaming.

Comparative tests made between brilliant green-bile broth and standard MacConkey broth for detecting *Bact. coli* showed that there is little to choose between the two methods, and hence there was no reason for changing from MacConkey's medium. It did not appear essential to limit the initial incubation period in MacConkey broth to twenty-four hours, as the percentage of positive responses obtained with longer incubation periods, either at 37° or 24° C., did not alter significantly. Incubation of the 44° confirmatory tests, however, could not be reduced to less than forty-eight hours, as there was a 7 per cent increase in positive responses during the second twenty-four hour period. Mr. Cuthbert said that the presence of true *Bact. coli* is generally accepted as an indication of recent fæcal pollution. He also showed that there is an association between the numbers of *Bact. coli* type I, total coli-aerogenes bacteria and fæcal streptococci found. Moreover, except for certain seasonal variations, the 44° and 37° counts vary together. On this basis he doubted whether the 44° confirmatory tests can be justified. There is a natural die-out of *Bact. coli* which varies with temperature and with *p*H of the water. For example, in water from limestone areas *Bact. coli* persists for forty-five days or more, whereas in acid peat soils it dies out in ten days or less.

A review was given by S. B. Thomas (Aberystwyth) of the incidence and classification of coli-aerogenes bacteria isolated at 37° and 30° from farm milk supplies during the past twenty years, in his paper on coli-aerogenes bacteria in milk. The five thousand strains isolated at 37° by fourteen investigators were about equally divided among *Bact. coli*, intermediate and aerogenes-cloacæ types. On the other hand, aerogenes-cloacæ types constituted about 50 per cent of the strains isolated at 30° at Aberystwyth. Only 15 per cent of the strains isolated at 30° from raw milk were 37° negative; the proportions were much higher with strains from soil, water, cereals and ungrazed herbage. It was shown that the coli-aerogenes content of farm milk supplies handled in sterilized equipment did not increase appreciably in 24 hr. at 10°–12°, whereas there was a very marked increase in milk produced under unsatisfactory conditions. Under clean conditions, these organisms were generally not detectable in 0·01 ml. even 24–28 hr. after milking. Mr. Thomas considered selective plating media superior to MacConkey's broth for the determination of the coli-aerogenes organisms content of milk, and said that there is an association between the *Bact. coli* and total coli-aerogenes organisms. On this basis, he maintained that the coli-aerogenes colony count at 30° provides valuable information for advisory work when applied to farm milk supplies within 6 hr. of production. The presence of coli-aerogenes bacteria in apparently normal udders was discussed in relation to the increasing use of penicillin in mastitis control.

The laboratory and field evaluation of chemical sterilizers for dairy farms was discussed by Dr. L. F. L. Clegg (Shinfield). He reviewed the different types of tests devised in past years, and divided them into two groups: 'suspension tests', in which the organisms in aqueous suspension are treated with the disinfectant dilutions; and 'surface tests', in which organisms on various surfaces are treated. From the aspect of practical application, particularly when the highly surface-active quaternary ammonium compounds are being considered, surface film tests are the most suitable, and at the National Institute for Research in Dairying three tests are being developed and undertaken: the laboratory Hoy can test and a surface film test, and finally farm trials. Details of the Hoy can test have been described elsewhere; in principle, the procedure consists of treating infected milk cans for a short period with test disinfectant dilutions, and then examining the effect of the rinse on the keeping quality of normal milk at 22°. This type of test is essentially a comparative one, and a hypochlorite–soda ash solution is used as the standard. In the surface film test, metal strips are inoculated with bacteria, treated for short periods with disinfectant solutions and the surviving bacteria enumerated. The effect of detergency can also be measured by agitating the test solutions gently during the disinfecting period. Experience has shown that dry films are disinfected more slowly than are moist ones, and the rate of disinfection is increased by agitation. Results generally are at a lower level than with suspension tests. For the final farm trials, it is essential to have a control disinfectant running at the same time as the test material, and the efficiency of disinfection is assessed by a combination of colony counts, methylene blue tests, and keeping-quality tests on the milks. In evaluating a new preparation it is important to examine not only its disinfectant properties, but also its effect on rubber and other equipment, and its influence on odour and taste of the milk.

J. D. Ridgway (Stockport) discussed some recent observations on the bacteriology of sterilized milk, and said that faults are generally due to sweet curdling and are more numerous on storage at 23° than 37°. There is an unexpectedly high proportion of failures in winter milks, and this is always due to sporing bacteria which had escaped destruction during the normal sterilization process of heating to 106·5° for 35 min. There is a linear relationship between the logarithm of spore content and the number of samples failing, but there is no relationship between total bacterial content, the thermoduric bacterial content and the spore content of raw milks. Therefore, it is not possible to assess the value of milk for sterilization purposes in terms of good and bad farm milk-production; a good raw milk, or one which pasteurizes satisfactorily, may not give a sterilized milk which will keep well. The source of the spore-forming organisms has not been ascertained with certainty, but they do not appear to be air-borne. Spores have been found in udder milk, presumably originating from straw bedding used. The hygiene of plant is of utmost importance, and steam sterilization is only effective if the plant has been thoroughly pre-cleaned.

The value of the antibiotic nisin in cheese manufacture was described by H. B. Hawley (Yeovil) in a paper on the development and uses of nisin. He described how certain strains of *Strep. lactis* have been found to inhibit lactobacilli under given conditions, and investigations at the National Institute for Research in Dairying led to the discovery of nisin, which is produced by certain strains of the streptococcus. Nisin has a polypeptide structure, and there are several different known types. They have different antibacterial properties, and the types and proportions of each produced depend on the cultural conditions. Because of the particular value of nisin in inhibiting growth of *Cl. welchii*, it has been used effectively in the controlling of cheese, and is particularly valuable with processed cheeses; experimental work is proceeding at present on sweet, low-acid cheeses. Nisin can also be used for control of flat-sour in canning and in the preservation of other foods, particularly meat products. There are numerous and unexpected problems associated with the use of nisin in cheeses because, for example, it upsets the general balance of the bacterial flora and so may produce a cheese of very different texture, odour and taste. Moreover, the presence of certain bacteria appears to nullify the effect of the nisin.

CHARACTERISTICS OF THE BOTTOM ZONE OF LAKES

A SYMPOSIUM on "The Biological, Physical and Chemical Characteristics of the Profundal Zone of Lakes", organized by Prof. V. Tonolli, was held at the Istituto Italiano di Idrobiologia at Pallanza, Lago Maggiore, during July 21–24, under the auspices of the International Union of Biological Sciences with the financial aid of Unesco.

Many advances have been made in recent years in our knowledge of the physical conditions and chemical exchanges at the interface between mud and the bottom water of lakes, thanks to the development of various new techniques, and H. J. Elster (Germany), while emphasizing the services rendered to limnology by A. Thienemann's oligotropic-eutropic classification of lake types, made it clear, using Black Forest lakes and Lake Constance as examples, that a rigid adherence to the classical type concept is not justified, particularly as the chemical turnover in the hypolimnion is to a considerable extent influenced by hydrographical factors. O. Steinböck (Austria) supported this view by his thesis that in the case of upland lakes hydrographical factors are predominant: there are here no lake types but the waters have geographical characteristics, and are best classified as mountain lakes, perennial pools and temporary pools. In those of the second category, daily meteorological changes affect the whole depth of water, so that there is no stable layering. The oxygen content of the bottom water of the upland lakes depends not so much on the productivity of the lake as on organic material washed into it, so that a pseudo-eutropic condition may arise.

K. Strøm (Norway) and B. Dussart (France) dealt with certain little-known phenomena in the hypolimnion. The temperature of the bottom water with maximal density depends on pressure and hence is below 4° C. in the depths of great lakes. The existence of supposed subaquatic springs is often doubtful, for direct observation, as in the Lac d'Annecy, can seldom be made, and their presence is usually deduced from temperature, bottom conditions and faunistic peculiarities; but it can be shown, for example in Lake Geneva, that the phenomena in question may be caused by special hydrographical conditions.

Exchanges at the mud surface were considered by F. Ruttner (Austria), who reported on a striking natural experiment in one of the lakes at Lunz which illustrates the provisional nature of lake types. This 8-metre deep spring-lake is characteristically oligotropic, with a sparse plankton and without thermal and chemical layering. In autumn, however, after dry weather, considerable quantities of lime become dissolved as a result of the decay of the macroflora. The resulting solution of a higher specific gravity flows down into the now inactive funnel of the spring, giving a eutropic zonation, with the disappearance of oxygen, formation of hydrogen sulphide and development of an oligoaerobic plankton. The great extent of mud surface relative to water volume is largely responsible for the very considerable chemical exchanges, with a paucity of oxygen. Such exchanges also take place between water and dissolved colloidal substances, particularly humus. This is an important phenomenon in peaty waters, where the colloids, acting as cation and anion exchangers, control the ionic composition. W. Ohle (Germany) gave a good example of such an action in the case of a magnesium–calcium ratio which was 1 : 2 in electrolyte-poor water and as much as 1 : 7 in water rich in electrolytes.

Sedimentation studies were described by Mrs. W. Tutin (Great Britain) and E. Thomas (Switzerland). The latter has made a quantitative investigation of organic and inorganic sediments in various Swiss lakes, comparing oligotropic with eutropic conditions, considering in particular the nitrogen and phosphorus balance between mud and water in relation to production.

On the faunistic side, H. Järnefelt (Finland) came to the conclusion, from extensive studies of Finnish lakes, that no single factor studied up to the present can account for the nature of populations: a complex of causes must be involved. F. Lenz (Germany) supported this thesis with reference to the bottom fauna of the Lago Maggiore, which varies with meteorological and consequent hydrographical conditions. Contributions to a knowledge of these conditions were made by N. Della Croce and O. Ravera (Italy). The former has investigated oligochaete populations, the density of which depends in part on the particle size of the sediments. Ravera made an experimental study of the quantity of excrement produced in unit time by members of the three oligochæte species of the lake bottom; characteristic differences were found, depending both on species and depth. G. P. Moretti (Italy) made, in the same connexion, a quantitative study of the cases of caddis larvæ, some found as deep as 300 m.

I. Findenegg (Austria) reported on the bottom faunas of lakes in the Kärntner region, which are known to limnologists for the frequent occurrence of the so-called meromictic lake type. It was found that the density of the bottom fauna was at least as great in oligotrophic as in eutrophic lakes. This is due to the low oxygen content of the eutrophic hypolimnion and to the greater vertical range of plankton in the transparent oligotropic waters and consequent greater fall of food material to the bottom.

A particularly interesting faunistic situation from the evolutionary point of view is provided by Lake Ochrida, on which S. Stanković (Jugoslavia) spoke. This pre-Glacial lake has a hypolimnion with a constant temperature throughout the year, and an endemic profundal fauna, with sub-species the nearest relatives of which inhabit the littoral zone, from which they are clearly derived.

Other valuable contributions were made by E. S. Deevey and D. G. Frey (United States) and by H. Züllig (Switzerland). A detailed report of the symposium will be obtainable from the Secretary of the International Union of Biological Sciences, Laboratoire de Physiologie Végétale, Sorbonne, Paris, or from the Istituto Italiano di Idrobiologia, Pallanza, Italy.

R. A. VOLLENWEIDER

THE IONOSPHERE DURING THE SOLAR ECLIPSE OF FEBRUARY 25, 1952

By C. M. MINNIS

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DURING the past twenty years, an intensive study has been made of the response of the ionized layers of the earth's upper atmosphere to changes in the intensity of the solar radiation incident on them. Most of the existing fund of knowledge on this subject has been built up from observations of the variations in ionospheric parameters which result from the diurnal and annual changes in radiation intensity caused by the rotation of the earth about its axis and around the sun. The slowness of these changes and the superposed perturbations arising from imperfectly understood large-scale tidal effects lead to difficulties in the analysis of such data.

An eclipse of the sun may be thought of as providing the conditions for a controlled experiment in the ionosphere during which a rapid change in the intensity of the incident radiation takes place but which is not, to a first approximation, further complicated by the normal diurnal changes. Ionospheric observations have, for this reason, been made during solar eclipses on many occasions since the first indirect measurements of Eccles[1] in 1919; but, since the end of the Second World War, few suitable opportunities have occurred of using modern ionospheric sounding techniques in this way. The totality belt for the 1952 eclipse extended from West Africa across the Anglo-Egyptian Sudan to Persia and was, in consequence, fairly accessible. The Department of Scientific and Industrial Research sent two expeditions to Central Africa: one to Ibadan, near Lagos, where the eclipse was partial, and another to Khartoum in the totality belt. At both stations measurements of the height and electron density of the ionospheric layers were made during the eclipse and during the control periods preceding and following it. In addition, observations were made at the Radio Research Station at Slough and at its outstations at Inverness and Singapore, all of which were near the edge of the eclipse area.

E- and *F*1-Layers

The sudden reversal in the rate of change of the radiation intensity during a total or near total eclipse ought, in principle, to make possible the calculation of the effective recombination coefficients which are measures of the rate of decay of ionization in the different layers. For the application of this technique in its simplest form, a necessary condition is that the ionizing radiation should be emitted uniformly from the whole of the sun's disk. Unfortunately, the character of the changes in electron density which are actually observed during eclipses casts considerable doubt on the validity of this assumption. For the 1940 eclipse, Higgs[2] found it to be untenable and attempted to explain his results by assuming that the radiation was emitted from four known areas of calcium flocculi in addition to a component assumed to come from a uniformly radiating disk. The best fit with the observed densities in the *E*-layer was obtained when the intensity of the disk component was put equal to zero; but, as Higgs himself points out, this is not a unique solution. It seems likely that the best fit was not the true one in this instance, particularly since the corresponding results for the *F*1-layer indicated a very large contribution from the disk.

Waldmeier suspected that the *E*-layer measurements made by Rydbeck during the 1945 eclipse might be consistent with the assumption that the ionizing radiation originated in those parts of the inner corona in which the emission line at 5303 A. was strong; a comparison of the ionospheric data with a contour map of the intensity of the 5303 A. line confirmed this[3]. A similar comparison between the ionospheric data obtained at Khartoum in 1952 and the coronal contours based on measurements made at the Pic du Midi tended to support Waldmeier's conclusion, although an unexplained discrepancy remained[4].

A later examination of the Khartoum data for the *E*-layer has shown that the distribution and relative intensities of the sources of radiation can, for this eclipse, be deduced with some precision from the ionospheric data alone, without the need for making any assumptions concerning the positions of the sources. The discrepancy mentioned earlier is then seen to be due to the existence of an intense narrow source on the west limb of the sun, the evidence for which on the coronal intensity map is not decisive. Confirmation of the positions and relative intensities of the sources, as deduced from the Khartoum results, has been obtained by applying a similar method of analysis to *E*-layer data obtained by Piggott[5] at Ibadan two hours earlier (Table 1).

Data on the sources of 5303 A. are given in Table 2. While there is an obvious similarity between

Table 1. Sources of E-Layer Ionizing Radiation, February 25, 1952

Source	Position angle (from N. pole)	Radial extent ($R_\odot$)	Intensity (per cent)
	Khartoum		
Kh 1	240°–320°	0·98–1·0	25
Kh 2	68°	0·64–1·0	8
Kh 3	330°	1·0	3
Disk	—	—	64
	Ibadan		
Ib 1	240°–295°	(*)	25
Ib 2	59°	0·8	8
Disk	—	—	67

(*) Assumed to be confined to the limb as inferred from Khartoum data.

the ionospheric and coronal sources, it would be unwise at present to conclude that they are identical, particularly since a consideration of the area and intensity of the west-limb source (Kh 1, Ib 1) leads to the conclusion that its intrinsic brightness is at least thirty times that of the uniform disk radiation.

The peak of the *F*1-layer at Khartoum was partly obscured by the *F*2-layer, and measurements of its electron density could not be made to the degree of accuracy required to allow the positions and intensities of the *F*1-layer sources to be derived. However, there is no doubt that the uniformly radiating disk model is not capable of accounting for the changes in density which actually occurred. On the other hand, a very good fit between the observed and calculated variations is obtained if it is assumed that the disk model derived from the Khartoum *E*-layer data is valid for the *F*1-layer also. There appears, therefore, to be evidence for believing that a close relation exists between the sources of ionizing radiation responsible for the *E*- and *F*1-layers.

The value of the electron density and its time derivative immediately before totality at Khartoum can be used to determine the effective recombination coefficient (α') for both *E*- and *F*1-layers if it is assumed that during totality the intensity of the ionizing radiation is zero; the values obtained, which are unlikely to be in error by more than 10 per cent on account of errors of measurement, are $\alpha' E = 1 \cdot 51 \times 10^{-8}$ cm.^{3} s.$^{-1}$ (125 km.) and $\alpha' F1 = 8 \cdot 2 \times 10^{-9}$ s.$^{-1}$ ($\sim$ 170 km.).

*F*2-Layer

It is not possible to account for the complex response of the *F*2-layer to an eclipse in terms of the modified Chapman-layer structure assumed for the *E*- and *F*1-layers, because tidal effects seem to play a predominant part at heights greater than 200 km. At Ibadan, the old *F*2-layer which began to form after sunrise but did not have time to attain its daytime density was occulted by a newly formed *F*2-layer which appeared soon after the maximum phase of the eclipse. At Khartoum also, soon after totality, a new layer formed between the *F*1- and *F*2-layers; but, although its density increased very rapidly, it quickly rose in height and merged into the normal *F*2-layer, the density of which had remained quite constant during the eclipse. The sequence of events in the *F*2-layer both at Khartoum and Ibadan, and also during the normal sunrise period, is suggestive of the generation of free electrons at a fairly low level and the vertical transport of this ionization to higher levels where the much lower recombination coefficient results in the very slow rate of decay normally associated with the *F*2-layer.

Table 2. Sources of Coronal Radiation 5303 A., February 25, 1952

Source	Position angle (from N. pole)	Corresponding *E*-layer sources
W. limb (Climax)	225°–330°	Kh 1, Kh 3, Ib 1
E. limb (Climax)	65°–100°	Kh 2, Ib 2
Disk (Pic du Midi)	78° (small area near limb) 103° (small area near limb) Otherwise no outstanding features	Disk radiation

Es-Layer; Corpuscular Eclipse

An unusual and very deep minimum in the critical frequency of the sporadic *E*-layer occurred with a time-lag of about 90 min. after totality at Khartoum. Although no similar change had been observed during the control period, it would be speculative to suggest that it had any connexion with the eclipse.

It is usual to look for possible evidence of a corpuscular eclipse in the ionosphere about two hours before the optical one, but none was observed on this occasion. During the night preceding the eclipse, an ionospheric storm resulted in low and fluctuating values for the electron density in the *F*2-layer, and it is possible that storm effects would have masked any corpuscular eclipse effects which might have been present.

Acknowledgments. This work, a fuller account of which will appear in the *Journal of Atmospheric and Terrestrial Physics*, was carried out as part of the programme of the Radio Research Board; and this account is published by permission of the Director of Radio Research of the Department of Scientific and Industrial Research.

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MEASUREMENTS OF AGE BY THE CARBON-14 TECHNIQUE

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THE technique we have used for age determination by means of carbon-14 has already been described elsewhere in detail[1,2]. The essential difference from Libby's technique is the use of a proportional counter filled with carbon dioxide prepared from the sample. Two improvements may be of interest. The first deals with the removal of radon from the carbon dioxide. It was found that the radon originated from the calcium oxide used, obviously by contamination with radium. With another supply of calcium oxide all difficulties were removed and it was checked that radon present in the sample had been removed by the chemical treatment. Further, we have examined various suggestions mentioned in our paper for reducing the background. It was found that an extra anti-coincidence ring did not give any appreciable improvement. The efficiency of one ring is nearly complete; the lower efficiency found by Raeth *et al.*[3] is probably due to coincidences produced by gamma-

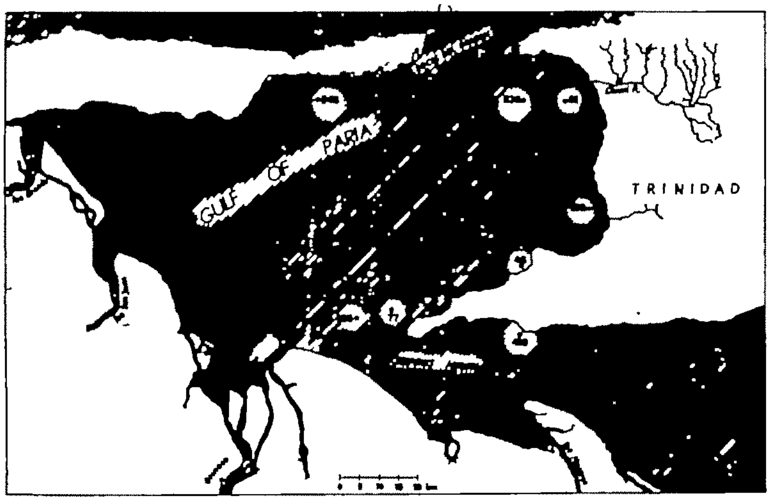

Fig. 1. Gulf of Paria. The numbers of the stations refer to Table 1

Table 1. SHELL SAMPLES FROM THE GULF OF PARIA

Samples from shell beds are marked with an asterisk. Stations 77 and 418 gave only a few scattered shells. 21 and 536 were close together

Station	Depth (cm.)	Age in years	Station	Depth (cm.)	Age in years
21*	0	720 ± 150	77	0	− 130 ± 130
536	70	1,645 ± 160	418	0	60 ± 130
48*	0	655 ± 150	86	63	2,605 ± 240
212*	0	720 ± 200	86	150	3,175 ± 160
548*	10	1,030 ± 140			

rays. An extra layer of mercury proved to be very effective, and we did not find any significant difference between lead and mercury. The background was reduced from 4/min. to 2·64/min. for a layer between the counter and the anti-coincidence ring, and to 3·04 if the extra layer, with the same thickness of 2 cm., was outside the anti-coincidence ring. For special reasons the second arrangement has been used during recent months.

A half-life for carbon-14 of 5,570 years was used for the calculations. The errors given are the statistical errors in the counts, since, according to our experience, no other sources of errors (impurities of the sample, etc.) play any part. Checks on the reliability of the method and remarks on the treatment of the samples are included in the text. Unless otherwise stated, the samples were treated at least with diluted hydrochloric acid. Generally the expected age was not known before the measurement. The following summarizes our results up to July 1954.

Geological Samples

The first group of samples consisted of shells from different parts of the Gulf of Paria (South America) (see Fig. 1). The greater part of the samples contained less than 1 gm. of carbon (which is required for our normal work). A complete discussion of the results in relation with an extensive geological survey is in the press[4], but the general conclusions were as follows. From geological evidence it was anticipated that in more or less recent times the arm of the Orinoco had broken into the gulf. By this 'catastrophe', shell-beds were 'killed' by the fresh water. Indeed, samples 21, 48, 212 and 548 all had the same age. Samples 77 and 418 were expected, for various reasons, to be of recent origin. The rates of sedimentation which can be calculated from the samples at various depths are reasonable.

For the calculations we assumed the specific activity of the shells to be the same as for organic carbon of the same age. Previously it was claimed by Anderson and Libby[5] and by Kulp *et al.*[6] that the activity of the shell carbon was higher, but unpublished measurements of ours give no evidence of any difference; these studies are being continued, but the results for samples 77 and 418 already indicate the activity of recent shells to be the same as for organic carbon. One Tertiary sample has been dated as a check. If no exchange of carbon dioxide had taken place, it would not have contained any carbon-14. Nevertheless, the activity was 3 ± 1·5 per cent of the activity of recent carbon. This, however, is not very significant; moreover, the history of this sample was not known (it came from a museum).

(2) Lowering of the Dutch coast relative to sea-level. This is a scientific problem as well as a practical one. An extensive programme is being carried out on behalf of the committee which studies the possibilities of the closure of the estuaries in south-west Holland. Up to now, about forty samples (peat and shells) have been dated. At the same time, pollen diagrams of the peat are being made. In Fig. 2 we give only a few results which pertain to samples from a large excavation at Velsen (North Holland). The curve demonstrates that the rate of sinking of the bottom was about 35 cm./century some 7,000 years ago, and about 10 cm./century at present. We cannot go into details of the geological problems which have to be solved, such as depth of sample relative to sea-level at time of formation, and disturbance of

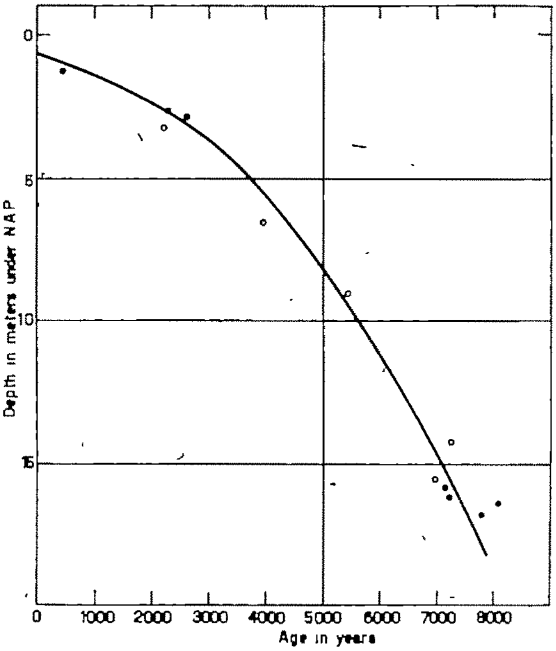

Fig. 2 Lowering of Dutch coast relative to sea-level ●, peat samples; ○, shells. N.A.P. = Ordnance Datum

original position; van Straaten[7] has prepared a preliminary report on these problems.

(3) Bones of domestic animals from underneath lava in south-west Syria, provided by Dr. W. J. van Liere (Food and Agriculture Organization, Damascus). These lava formations are found over a large area and they were expected to be fairly young (from a geological point of view). The present samples came from Kheurbet el Ambachi. Generally, bones are not very suitable for carbon-14 measurements; but part of the present material had obviously been charred in the absence of oxygen. It was nearly black and it contained as much as 25 per cent of carbon. The age was found to be 4,075 ± 160 years.

Archæological Samples

(1) Dried wheat from a Badarian cemetery in Egypt, submitted by Dr. H. Meyers. The grains were scarcely more than thin foils; they were boiled first with hydrochloric acid. The age was found to be 5,110 ± 160 years, which is somewhat younger than expected. We are trying to get a better sample.

(2) Charred wheat, submitted by Prof. Rotmahler. The sample was in a very good condition. It could be considered as presenting the oldest agriculture in Central Europe (*Bandkeramik*). It was found in Westeregeln (close to Magdeburg). The expected age was between 4,000 and 6,000 years, though the lower limit is better in accord with present views. We find 6,200 ± 200 years.

Other samples bearing on the same problem are being assembled, but according to personal information, recent evidence is in support of the present result.

(3) Charred wood from a ceramic band settlement (*frühe Bandkeramik*), submitted by Dr. H. Gross (Bamberg). It was found in Wittislingen, south-west Germany (for details see ref. 8). The sample was separated into two fractions: one fraction was extracted with hot sodium hydroxide and the other boiled with hydrochloric acid and the residue after extraction with hot sodium hydroxide solution examined. The results were 6,090 ± 180 years and 6,000 ± 140 years, respectively. There is no systematic difference; this indicates that no humic acids, etc., had infiltrated. Therefore, we give the average result: 6,030 ± 110 years. For the discussion see also sample (2).

(4) Charred wood from Donderen (Netherlands), submitted by the Biological–Archæological Institute, Groningen (director, Prof. A. E. van Giffen). Dated as Hamburgian. The sample contained few roots, which were selected so far as possible, and it had not been completely converted into coal.

The first measurement, after treatment with cold hydrochloric acid, gave 6,950 ± 160 years. Obviously this age is not compatible with a Hamburgian date, therefore, it was decided to sacrifice the rest of the sample and to separate it into various fractions, as will be described in more detail elsewhere. The results are:

(*a*) Material extracted by hot hydrochloric acid	2,190 ± 300 years
(*b*) Material extracted by hot sodium hydroxide	7,630 ± 140 „
(*c*) Carbon, remaining after (*a*) and (*b*) and after extraction of cellulose	7,365 ± 400 „

The large errors in (*a*) and (*c*) are due to the fact that these fractions contained only about 0·3 gm. of carbon. Obviously the sample did contain some fairly recent material, but nevertheless the age of the rest was still younger than expected. Our conclusion is that the discrepancy cannot be due to an error in measurement.

(5) Charred wood, well preserved, from Een (Drenthe, Netherlands), also submitted by the Biological–Archæological Institute, Groningen. Age found, 7,030 ± 140 years. The expected age was approximately the same as for the previous sample, so that these results suggest a new critical study of the chronology of the Late Palæolithic in the Netherlands.

(6) Four samples of charred wood and one of calcined bone, from a necropolis of thirty barrows at Toterfout-Halve Mijl (North Brabant, Netherlands), submitted by the Biological–Archæological Institute, Groningen (see thesis of Dr. W. Glasbergen[9]).

According to pollen analysis, tumulus 4 was the oldest barrow, dating from about 1500 B.C. We find 3,375 ± 200 years.

Tumulus 8 was important, since it gave information about the burial ritual. It was dated as Bronze Age, about 1100 B.C. We find 3,055 ± 90 years.

Tumulus 1*B* contained an early form of 'Deverel'-urn. According to pollen analysis, it should date from a period close to tumulus 4. We find 3,450 ± 85 years. It follows from this result that the Continental 'Deverel' culture is not related with the later urn-fields, but represents an invasion of British elements. Recent archæological evidence has confirmed this conclusion.

A sample of charred wood from an urn-field, also at Toterfout-Halve Mijl, gave an age of 7,865 ± 240 years. The expected age was some 2,500 years, and this difference is so large that it is beyond doubt that the sample did not come from that urn-field. Indeed, it did not form part of the contents of an urn, but it was found very close to it. It must be ascribed to a Mesolithic settlement; indeed, some flint artefacts were found which were probably Mesolithic.

The urn itself contained some calcined bone, which contained less than 1 per cent of carbon. Moreover, some roots had grown into it which were difficult to remove. Nevertheless, we have made an age-measurement, and find 905 ± 300 years. As might be expected, this is much too young.

(7) Charcoal sample from the primary grave of a Dutch disk barrow, tumulus II, near Postel (Belgium), not far from the Dutch frontier, submitted by Prof. S. J. de Laet (Ghent). We find 3,185 ± 120 years.

It was expected to date from a period between tumulus 1*B* and tumulus 8 described under (6). This is confirmed by our result.

(8) Wood from a Swiss lake dwelling at Thayngen Weier, submitted by Dr. W. U. Guyan (Schaffhausen). The wood was very well preserved. We find 4,735 ± 130 years.

(9) Charred wood from a megalithic tomb (passage grave) at Diever (Netherlands). In agreement with the views of Prof. van Giffen, the age turned out to be 3,850 ± 150 years.

(10) Charred wood, well preserved, from Haule (Netherlands), also submitted by the Biological–Archæological Institute, Groningen. Mesolithic. We find 7,525 ± 200 years.

It had been dated by Libby as 7,900 ± 300, which agrees with our result. Pollen analysis suggested an age of somewhat more than 7,000 years.

(11) Wood from a site at Jemgum (Ost Friesland, Germany). It came from a so-called *Flachlandsiedlung* preceding the first artificial dwelling mounds (*terpen*). In accordance with the age expected by Dr. W. Haarnagel, we find 2,335 ± 70 years.

(12) Charred wood from a Late Neolithic barrow near Hijken (Drenthe, Netherlands). Age expected

by Prof. van Giffen about 1400 or 1500 B.C. We find 3,300 ± 150 years.

(13) Charred wood from a Bronze Age barrow near Grootebroek (North Holland, Netherlands). Age, in accordance with the age expected by Prof. van Giffen (see ref. 10), 3,000 ± 140 years.

(14) Three samples from a three-period barrow in Oudemolen (Drenthe, Netherlands) submitted by Prof. A. E. van Giffen. The original barrow was Late Neolithic, the second period was a barrow with timber circle and, finally, this barrow was covered by another barrow in the Late Bronze Age. In the first and in the last grave charcoal was found, whereas the second period only gave huminiferous sand derived from the original posts. In historical order the results we obtained are: 3,505 ± 125 years, 3,180 ± 120 years, and 3,620 ± 120 years.

Obviously the age for the huminiferous sand is too young. This may be partly due to infiltration of recent huminiferous material from above. Unfortunately, no samples of sand from close to the post holes had been taken as a check. Moreover, the two samples of charred wood from the first and the last period may not give the real age of these two barrows. The dead were probably cremated in a hollow tree; if our samples originated from the central part of this tree—and no special care was taken to avoid that—then an error will be made which is equal to the age of the tree.

(15) Three samples of charred wood from a group of barrows near Wijster (Drenthe, Netherlands). For details see ref. 11. Pollen analysis dated these as "Iron Age". Fragments of bronze artefacts were dated as La Tène (Late Iron Age).

Our results, which are in accordance with this archæological evidence, are: 1,985 ± 150, 2,025 ± 175, and 2,350 ± 300 years. The last sample was re-measured as 2,130 ± 140 years.

(16) Wood from underneath the previous Walburg church at Groningen (Netherlands), submitted by Prof. A. E. van Giffen. For a historical study of the Walburg church see ref. 12. For various reasons this wood sample, consisting of two large blocks, with a cross-section of 50 cm. × 50 cm., was measured several times, in the course of nearly two years. Unless otherwise indicated, new carbon dioxide was prepared each time.

(a) First measurement (May 1952)	850 ± 200	years
(b) Sample from heart of beam	1,200 ± 150	,,
(c) Same carbon dioxide preparation as (b)	1,140 ± 100	,,
(d) Top of block, which might have been infiltrated with recent material	1,060 ± 120	,,
(e) This sample, and the following samples, were taken from a block, sent back by Libby	880 ± 90	,,
(f) Same preparation as (e)	1,010 ± 80	,,
(g) New carbon dioxide preparation	905 ± 65	,,
(h) Material extracted by hot sodium hydroxide	990 ± 140	,,
(i) Material extracted by hot hydrochloric acid	1,035 ± 150	,,
(j) Carbon dioxide prepared from carbon which had been measured by Libby	1,100 ± 200	,,

The average value is about 1,000 years. The deviations from the average are not significant enough to draw conclusions from them. (Denoting the deviation of an individual result by Δ, and the statistical error given in the last column by σ, we find 1·25 for the average of Δ^2/σ^2 (which has to be close to 1). The probability that a value of 1·22 or a larger one happens by chance in a series of ten measurements is about 0·4.) Among others, the result of (h) and (i) indicates that no appreciable amount of young organic material has infiltrated into the sample. We have also prepared pure cellulose from it, but this will be measured with high accuracy in a larger counter.

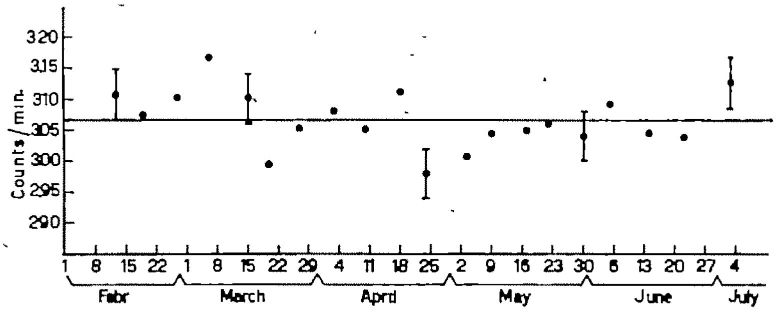

Fig. 3. The background in counts/min. during six months

The main reason why this sample was measured so often was that it was dated by Libby as 2,220 years (± 200). After samples (a), (b) and (c) had been measured, Libby re-measured his first preparation of carbon, but with essentially the same result (3,133 ± 300 and 2,500 ± 270 years). More recently he has measured a new preparation of carbon (from the same block of wood); result, 2,053 ± 345 years.

Finally, the same sample has been used as a cross-check by two other carbon-14 stations. According to private communications, the results were 1,065 ± 130 (Heidelberg, Germany) and 950 ± 80 years (Royal Institution, London). In Heidelberg a carbon dioxide counter is used; in London the counter is filled with acetylene. The origin of the discrepancy between Libby's results and the European results is not yet clear. We mention this, because for sample 8 of this list the agreement was good. Since the wood did not belong to the church itself, we do not know its age exactly. According to ref. 12, however, an age of about 1,000 years does not seem to be unreasonable.

To conclude, we give in Fig. 3 a survey of the backgrounds measured in the past six months. As a rule, the background was measured every week from Saturday to Monday. Fig. 3 does not give significant indications for variations of the background. The average of Δ^2/σ^2 (see earlier comment) is 1·4, whereas the *a priori* probability for this value (or a larger one) is 0·15. Perhaps there is a gradual decrease of the background, but it is too small to be significant. Our normal procedure is to take the average background during the past four weeks, giving double weight to the last two measurements.

We are indebted to the Netherlands Organization for Pure Research (Z.W.O.) for financial support.

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LETTERS TO THE EDITORS

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Structural Units in Collagen Fibrils

The structure of fibrous proteins has long been a subject of controversy. X-ray and electron microscope evidence has accumulated which suggests that single chains may not run the whole length of the fibril, but that the latter is made up of an aggregation of smaller parts of quite definite size. In collagen the sub-unit has been considered[1] to be a protofibril of size about 640 × 12 A., although recently Schmitt[2] has proposed a unit of about 2000 × 50 A., which he has named 'tropocollagen'. Striations of axial lengths about 210 A. (particularly in developing material[3]) and 70 A.[4] are also observed in electron micrographs of collagen. It is of interest to note that evidence for structure of size approximately 200 A. is found in α-keratin[5] and 230 A. in fibrin[6], although the recurrence of this figure may be no more than coincidental.

We have obtained X-ray diffraction evidence from dry collagen fibres which also suggests that the predominant 640 A. period is divided into sub-units of length about 210 A., although these are not necessarily discrete particles. In native tendon, new X-ray photographs show that the protofibrils are associated laterally into bundles.

In Fig. 1 are plotted the square roots of the observed intensities for the first twelve orders of diffraction of the macro-period (691 A. in this case) against sin θ/λ for dry rat-tail tendon under slight tension. From this plot we have endeavoured to trace out the structure factor of the diffracting unit, and we find that the probable zero positions fit in remarkably well with those for a uniform sphere or ellipsoid of length ∼ 230 A.

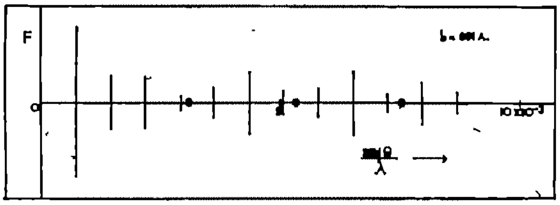


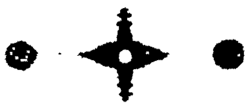
Fig. 1. Square roots of the observed intensities of diffraction orders of the macro-period of dry rat-tail tendon. The circles represent the zero positions for diffraction from a uniform sphere of diameter 230 A.

Fig. 2 shows the central region of a photograph of very dry rat-tail tendon taken in an evacuated camera of high resolving power with nickel-filtered copper-$K\alpha$ radiation. Around the central beam can be seen a roughly ellipsoidal halo of diffuse scattering. Applying Guinier's method[7], we have determined the size of the particle which would produce this scattering, assuming it to be an ellipsoid of revolution; we find its axes to be about 200 A. in the fibre direction and about 40–90 A. at right angles. These dimensions correspond very closely with those of the apatite crystallites associated with collagen in bone, which are, moreover, oriented in the same way[8].

On the other hand, when native collagen fibres are sealed in thin-walled glass capillary tubes before they have dried out, they produce an X-ray fibre diagram, Fig. 3, showing a number of equatorial reflexions of spacings (Table 1) larger than that usually ascribed to the interplanar spacing of single protofibrils. Further, the usual single strong interchain reflexion is now seen to be split up into two components, one on the equator at 12·6 A. and the other just off it on a layer line of spacing of ∼200 A. Attempts to index these reflexions suggest a packing arrangement with dimensions perpendicular to the fibre of:

$$a = 62\text{ A.};\quad c = 76\text{ A.};\quad \beta = 125°.$$

The layer line at 200 A. may correspond to the repeat of a helix or super-helix. There is also some indication of fine structure on the 10 A. layer line.



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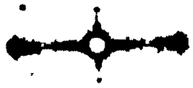

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Fig. 2. Central region of X-ray photograph of vacuum-dried rat-tail tendon, fibre axis vertical

Fig. 3. Central region of X-ray photograph of moist native tendon, fibre axis vertical

Table 1. Equatorial or Row-line Spacings of Reflexions in Fig. 3, with Rough Intensities

12·6	13·5	14·9	17·0	18·3	20·5	24·5	31	37	49 (A.)
VS	VS	M	M	M	W	M	W	S	S

The intensity variation along the equator suggests an arrangement of bundles of about 40–50 A. diameter, each bundle consisting of about seven protofibrils hexagonally packed. The above unit cell would contain two such bundles. On drying, shrinkage is accompanied by loss of order, the bundles eventually scattering independently. Once this stage has been reached the ordered arrangement is not reproduced on wetting, although the individual bundles swell. Irreversible drying phenomena are commonly found in other more truly crystalline proteins.

The overwhelming intensity of the first order of diffraction of the 640 A. period and the asymmetry of the banding as seen on electron micrographs show that this unit is the true repeating entity along the axis of the collagen fibre in its native state.

Evidence has accumulated from a study of low-angle line shapes[9] and from swelling[10] which suggests that within the macro-period there exist alternating regions of greater and less order—interbands and bands respectively—the latter being the sites occupied by stains, such as phosphotungstic acid. We have recently shown[11] that the effects of tension on air-dried fibres are consistent with this picture.

From the improved high-angle X-ray diagram obtainable from fibres held under tension, we have shown that the polypeptide chains within the well-ordered interbands almost certainly have a helical configuration[12].

The diffuseness of the high-angle pattern, however, indicates that these crystalline regions are of small extent, perhaps only 50 A. long. It is not yet clear how the various regions are arranged to give the 640 A. macroperiod with its apparent 200 A. substructure. Nevertheless, the whole system is a highly ordered one, as shown by the sharpness and extent of the low-angle diffraction pattern.

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Phosphorylation coupled with the Oxidation of Ferrocytochrome *c* by Heart Sarcosomes

Nielsen and Lehninger[1] have recently demonstrated the incorporation of phosphorus-32 into organic phosphate during the aerobic oxidation of ferrocytochrome *c* by rat-liver mitochondria in the presence of adenosine diphosphate, magnesium, versene, antimycin A and inorganic phosphate labelled with phosphorus-32. In the present communication, a net phosphorylation is shown to accompany the same reaction catalysed by rat-heart sarcosomes (mitochondria).

The sarcosomes were isolated in 0·21 *M* sucrose, 0·01 *M* versene, *p*H 7·4, as described previously[2]. The washed sedimented sarcosomes were suspended in 0·021 *M* sucrose, 0·001 *M* versene, *p*H 7·4, to give a concentration of 8·5 mgm. protein/ml., and the suspension was kept at 0° C. for 30 min. to allow oxidation of residual substrates. Four volumes of recently boiled and cooled glass-distilled water were then added, so that the sarcosomes were now suspended in a medium 1/50th the tonicity of rat blood. This hypotonic pretreatment of the sarcosomes was suggested by the work of Lehninger[3] on the phosphorylation coupled with the oxidation of reduced diphosphopyridine nucleotide by liver mitochondria. The concentration of the final suspension medium giving maximum phosphorylation was found in experiments which will be published elsewhere.

Table 1. PHOSPHORYLATION COUPLED WITH THE OXIDATION OF FERROCYTOCHROME *c* BY RAT-HEART SARCOSOMES.

See text for reaction mixture and procedure. *p*H of reaction mixture, 7·4; 14·4 min. at 22° C.

	Cell 1	Cell 2		Cell 3	
Cytochrome *c* (μmoles)		Ferri	Ferro	Ferri	Ferro
Initial	0	0·18	1·42	1·40	0·17
Final	0	1·28	0·32	1·54	0·03
Δ	0	1·10		0·14	
Hexose monophosphate (μmoles)					
Initial	0·022	0·022		0·022	
Final	0·058	0·244		0·057	
Δ	0·036	0·222		0·035	
Δ (corr.)	—	0·186		0	
$\Delta P/\frac{1}{2}\Delta$ cytochrome *c*	—	0·34		0	

A 1-cm. spectrophotometric cell (cell 2 in Table 1) contained 90 μmoles phosphate, 60 μmoles glucose, 3 μmoles versene, 120 μmoles fluoride, 0·6 μmole adenosine monophosphate, 0·6 μmole adenosine diphosphate, 127 units hexokinase[4] and 1·6 μmoles cytochrome *c* (89 per cent reduced, 11 per cent oxidized) in a total volume of 2·8 ml. A reference cell (No. 1) contained all these ingredients except the cytochrome *c*. Magnesium chloride (0·1 ml. of 0·15 *M*) was added to each cell and the optical density at 600 mμ of cell 2 read against that of cell 1 until a steady reading was obtained (this is necessary because of the formation of a slight turbidity when the magnesium is added). At zero time, 0·1 ml. of the diluted sarcosomal suspension (containing 0·19 mgm. protein) was added to each cell, and the oxidation of the ferrocytochrome *c* followed by measuring the increase of optical density at 600 mμ. After 14·4 min., when 1·10 μmoles of ferrocytochrome *c* had been oxidized (the cytochrome *c* was now 20 per cent reduced, 80 per cent oxidized), trichloroacetic acid was added to each cell and the hexose monophosphate formed determined according to the method previously described[5].

The small amount of hexose monophosphate found in the reference cell is mainly due to the non-oxidative phosphorylation of glucose by adenosine diphosphate catalysed by myokinase and hexokinase[4]. Phosphorylation derived from the oxidation of traces of substrates in the sarcosomal preparation will also be included in the hexose monophosphate found in this cell. The hexose monophosphate found in cell 2 minus that found in cell 1 represents the phosphorylation coupled with the oxidation of ferrocytochrome *c*. The corrected value (0·186 μmole) is many times greater than the sensitivity of the analytical method (about 0·01 μmole) and corresponds to a ratio of phosphorus to ½ (ferrocytochrome *c*) of 0·34. This ratio is about the same as the ratio of phosphorus – oxygen atoms (0·32) obtained when ascorbic acid was oxidized by the same preparation in the presence of catalytic amounts of cytochrome *c*. It is likely, then, that the phosphorylation obtained with ascorbate[6] occurs in the reaction between cytochrome *c* and oxygen.

The preparation of ferrocytochrome *c* used was made by reduction of a stock solution of cytochrome *c* by hydrogen in the presence of platinum black, the hydrogen then being removed by a stream of nitrogen and the platinum by centrifugation. Cell 3 in Table 1 was an additional control in which the stock solution of cytochrome c (11 per cent reduced) was used. No phosphorylation beyond that found in the control cell 1 was found in cell 3, showing that the prior reduction of the cytochrome c was entirely responsible for the corrected phosphorylation measured in cell 2.

The demonstration that phosphorylation can be coupled with the oxidation of ferrocytochrome c is in complete agreement with the findings of Nielsen and Lehninger[1]. From the point of view of the mechanism of the phosphorylation, it is important to establish whether the ratio of phosphorus to ½ (ferrocytochrome c) is equal to or exceeds 0·5 (corresponding to a ratio of phosphorus to oxygen molecules of 1). Our results to date suggest that the ratio in heart sarcosomes might not exceed 0·5, but it is quite possible that improvements in technique will result in ratios approaching 1. With liver mitochondria, Nielsen and Lehninger[1] have obtained ratios between 0·44 and 0·86 for this reaction. Liver mitochondria oxidizing ascorbic acid in the presence of catalytic amounts of cytochrome c also yield ratios of phosphorus to oxygen atoms approaching one[7].

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Infra-red and Ultra-violet Absorption Spectra of Proteins in the Solid State

The potassium bromide pressed-disk technique for the determination of infra-red spectra in the solid state was first developed in our laboratories during the period 1947–49 under contract with the U.S. Air Materiel Command, but, as restricted information, was not formally published at that time[1]. The method has since been used by Stimson[2] and independently by Schiedt[3,4]. The technique has been successfully applied by us to a number of proteins, and the purpose of this communication is to direct attention to this application. A major advantage of the technique lies in the ability to determine both infra-red and ultra-violet absorption of the same protein sample under identical conditions.

The technique was briefly as follows: 'A.R.' grade potassium bromide, ground to 200-mesh in a mullite mortar, was dried at 110° C. Samples of purified proteins, also ground to 200 mesh, were mixed to give the desired concentration (usually 1 per cent) and the mixture was passed several times through a 200-mesh sieve. 200 mgm. of mixture was placed in a cylindrical 0·5-in. (1·27-cm.) steel die which was enclosed in a larger cylinder connected to a vacuum pump and McLeod gauge. The system was evacuated for approximately five minutes at 40 microns pressure; lower pressures were not more advantageous, but evacuation was necessary or the disks clouded and fractured from occluded gases after pressing. With the system still being evacuated, pressure, usually 150,000 lb. per sq. in., was applied for a few seconds to one minute; longer pressing offered no advantage. Air was then admitted. The clear disk was removed from the die and weighed. A companion disk of pure potassium bromide was also made. Our apparatus could be electrically heated, but heat was not useful in the pressing of potassium bromide. It was helpful in pressing materials of lower melting point such as thallium halides or silver chloride. The maximum variation in weight between disks was 30 mgm. in 200 mgm., but it was possible to hold the variation to not more than 5 mgm. in a given series. Maximum variation in thickness in such a series was about 0·0025 cm. in disks with an average thickness of 0·0635 cm. As also shown by Stimson[2], these differences are compensated, and uniform distribution is demonstrated by the fact that the quotient, optical density/per cent times weight, is reasonably constant.

Preliminary measurements were made on several mechanical properties of the pressed disks of potassium bromide as compared with the crystalline halide. For this purpose a 1-in. die was used. Young's modulus of the pressed potassium bromide was $1·17 \times 10^{11}$ dynes/cm.^{2}, as compared with $0·76 \times 10^{11}$ dynes/cm.^{2} for a grown crystal. Pressed potassium bromide had a coefficient of linear expansion of $38·8 \times 10^{-6}$ cm./cm./deg. C., as compared with $35·0 \times 10^{-6}$ cm./cm./deg. C. for a grown crystal (Baxter[5] reports $37·0 \times 10^{-6}$ cm./cm./deg. C.). Tensile strength of the pressed halide averaged 1,000 lb./sq. in. compared with 400 lb./sq. in. for grown crystals.

The proteins used in these studies were crystalline bovine serum albumin and chymotrypsinogen (gifts of the Armour Laboratories); and egg albumin, cytochrome c, and lyophilized whole rabbit serum prepared in our laboratory. The infra-red spectra were obtained with a Perkin-Elmer *IR* Spectrophotometer, Model 21, through the courtesy of Dr. Seymour Levine and Mr. H. J. R. Stevenson, of the Sanitary Engineering Center, U.S. Public Health Service, Cincinnati. The ultra-violet spectra were obtained with a Beckman Model *DU* quartz spectrophotometer.

Typical infra-red spectra are shown in Fig. 1. All proteins, of course, display the expected bands in the 3 μ, 6 μ and 6·5 μ regions. Bovine serum albumin, egg albumin and cytochrome c have a shoulder at about 3·25 μ; this shoulder is slightly evident in whole rabbit serum but is absent in chymotrypsinogen. All show bands of varying intensity at about 3·42 μ. All except chymotrypsinogen (which shows at most a slight shoulder) have a band at 6·9 μ. All have a band at 7·2 μ; this is particularly pronounced for chymotrypsinogen and is shifted slightly to 7·15 μ. Egg albumin and rabbit serum show separate bands at 7·7 μ and 8·1 μ, but the first of these is barely discernible in cytochrome c and in chymotrypsinogen; the absorption is broad over this region for bovine serum albumin, with only slight suggestions of two peaks. Slight bands are present in the 8·55 μ–8·65 μ region for all proteins except chymotrypsinogen. Slight bands are also present for all proteins in the

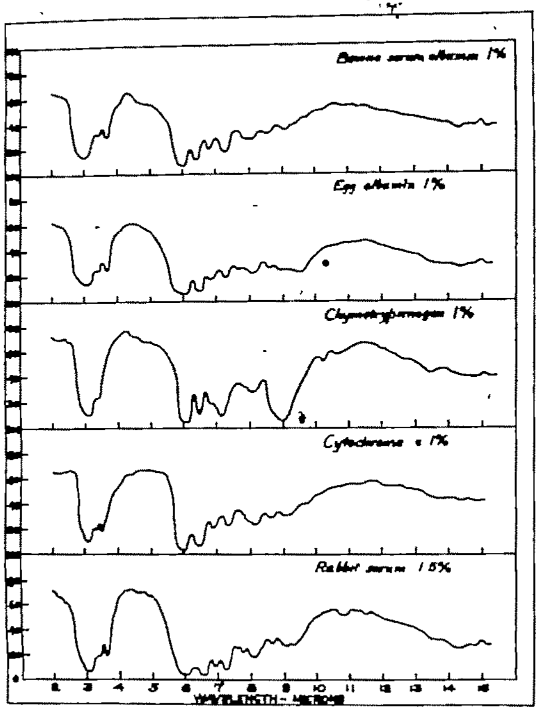

Fig. 1. Infra-red absorption of proteins in potassium bromide disks

9·0 μ region, but this absorption is very pronounced for chymotrypsinogen. With slight differences in detail, these spectra compare favourably with the corresponding ones reported by Klotz[6] for cytochrome *c* and bovine serum albumin in films on silver chloride, and they appear to resemble closely those reported by Fong *et al.*[7] for crystalline human serum albumin.

The ultra-violet spectra of the solid proteins were compared with the spectra of solutions in 0·1 *N* hydrochloric acid and in 0·1 *N* sodium hydroxide. The spectra of egg albumin in the solid state and in acid exhibited a peak at 278 mμ, whereas in base the peak was shifted to 290 mμ. Bovine serum albumin in the acid solution had a peak at about 278 mμ and in basic solution at 290 mμ; in the disk, although there was a shoulder at 280 mμ, peak absorption occurred at 265 mμ. Chymotrypsinogen appeared to be relatively unaffected by *p*H; solutions in acid and base both showed absorption peaks at 280 mμ. The disk had a shoulder at 280 mμ but a more pronounced peak at 272 mμ. Cytochrome *c* in solution displayed an acid peak at 275 mμ and a basic peak at 290 mμ. The disk had a selective absorption, but not pronounced peaks, at 262 mμ and 280 mμ. All the ultra-violet absorptions thus far described can be attributed, of course, to aromatic amino-acids. None of the proteins absorbed appreciably at wavelengths longer than 300–320 mμ, with the exception of cytochrome *c*, which absorbs at longer wavelengths because of its prosthetic group.

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Origin of Glycine and Serine in Bakers' Yeast

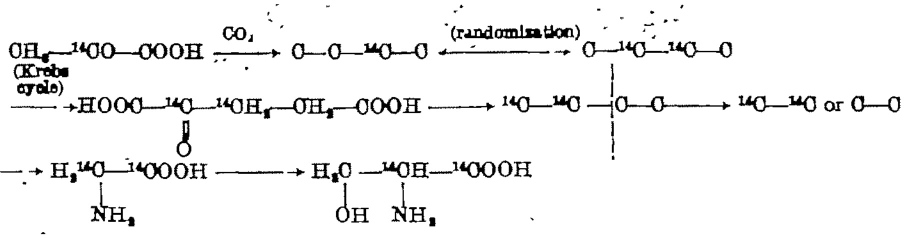
THE ready interconversion of glycine and serine in biological systems has been well recognized for several years. Somewhat less attention has been paid to the origin of this pair of compounds from other metabolites, although evidence has been presented[1] to indicate that serine may arise prior to glycine, through transformations involving pyruvate or other C_3 compounds.

Work in this laboratory has been focused upon the conversion of pyruvate-2-^{14}C to amino-acids in bakers' yeast. Using this substrate and the yeast samples described previously[2–4] for examination of other amino-acids, the distribution of isotope was observed for the serine and glycine isolated from the yeast hydrolysate. Both compounds were obtained in pure form by adsorption of the hydrolysate on a 'Dowex-50' column and fractional elution according to the method of Stein and Moore[7]. Threonine and alanine were removed by separation on cellulose powder columns. Purity of the samples was checked by paper chromatography.

It will be noted from Table 1 that the isotope patterns in carbons 1 and 2 of serine and glycine are very similar, with carbon 2 only slightly higher in activity than carbon 1. This confirms the ease of interconversion of these two compounds. However, when alanine from these yeast samples was degraded, it was found to be labelled primarily in carbon 2 (67 per cent in the aerobic culture, 90 cent per in the anaerobic). The alanine side-chains of phenylalanine[3] and tyrosine[4] also showed preferential labelling in carbon 2, as might be expected if these units arose from the pyruvate administered. It is therefore evident that the pathway from pyruvate to serine is less direct, and must involve one or more steps which permit isotope equilibration in positions 1 and 2 of serine.

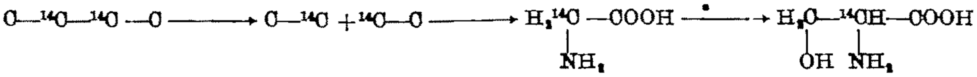
This condition could be satisfied if serine were formed through glycine, by forward operation of the Krebs cycle, followed by α,β-cleavage of a C_4-acid. The glycine carbon atoms would thus correspond to carbons 2 and 3 of α-ketoglutarate or glutamic acid, which were, as shown previously[5], equally labelled in this yeast sample. Sequence *A* illustrates the suggested formation of glycine from pyruvate and its conversion to serine:

(A)

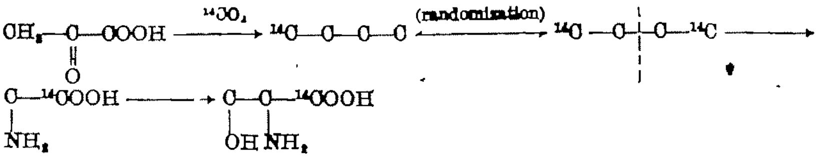


(B) via fumarate or succinate:

(B)



(C)



Reverse operation of the cycle (scheme *B*) would, on the other hand, provide preferential labelling in carbon 2 of glycine.

The slightly higher isotope concentration in this position of both glycine and serine (Table 1) may suggest a partial contribution from this pathway.

Fixation of carbon-14 dioxide with non-isotopic pyruvate is also being examined in this yeast. Under these conditions, glycine and serine become labelled within one hour, shortly after aspartic acid becomes radioactive, whereas alanine remains unlabelled during periods up to five hours. This again supports the conclusion that serine probably does not arise directly from pyruvate. Degradation of serine reveals the isotope mainly in the carboxyl group. This could be expected from equilibration of the C_4-acids formed, followed by their conversion to glycine (scheme *C*), since simultaneous operation of the cycle (scheme *A*) would in this experiment provide only unlabelled glycine and serine.

Table 1. DISTRIBUTION OF CARBON-14 IN GLYCINE AND SERINE UTILIZING $CH_3{}^{14}COCOOH$

Amino-acid	Carbon atom	Radioactivity			
		Aerobic		Anaerobic	
		c.p.m. × 10^{-4}*	per cent of total	c.p.m. × 10^{-4}*	per cent of total
Glycine	Total	1 81	100	1·75	100
	1. COOH	0 85	47	0·70	40
	2. CH_2NH_2	0 96	53	1·05	60
Serine	Total	2 84	100	1·18	100
	1. COOH	1·16	41	0·49	42
	2 $CHNH_2$	1·60	57	0 55	48
	3. CH_2OH	0 06	2	0·11	10

* Specific activity (total) is expressed as counts per min. per m.mol amino-acid; the activities of individual carbon atoms are counts per min per m.mol. carbon. All values are given in terms of the undiluted amino-acids.

It is concluded that the serine ⟷ glycine interconversion in bakers' yeast is fed primarily from C_4-acids through glycine, in contrast to the situation in animal metabolism, where serine is thought to arise directly from pyruvate.

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Electrophoresis of Human Red-Cell Stroma

IN an attempt to provide a chemical basis for an understanding of the morphological appearance of human red cells and of the changes in red-cell morphology in various hæmatological disorders, we have fractionated red-cell stroma preparations by electrophoresis. Three lipid-containing protein fractions have been separated, two of which migrate readily in veronal buffer at *p*H 8·6 ($\mu = 0{\cdot}1$). Red-cell stroma was prepared initially in the manner described by us[1], but in addition was washed twice with 0·1 *M* potassium dihydrogen phosphate and three times with distilled water. A stromal extract obtained with 0·2 *M* ammonium hydroxide and containing 18 μgm. of tyrosine equivalents of protein[2] was then subjected to paper electrophoresis[3].

Fig. 1 shows the electrophoretic mobilities of the fractions as determined on the basis of azocarmine *B* and sudan black binding resulting from staining after electrophoresis. The dye concentrations were estimated colorimetrically and are expressed as optical densities.

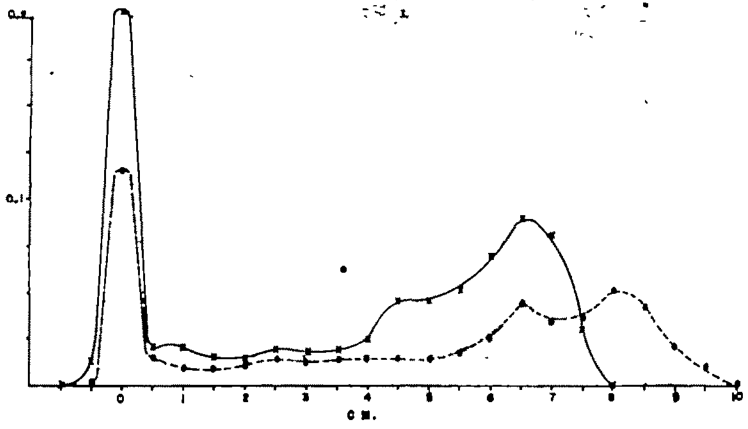

Fig. 1. Electrophoretic mobility pattern of red-cell stroma. Solid line: azocarmine binding; broken line: sudan black binding

Similar studies were carried out on a preparative scale by zone electrophoresis on cellulose slabs using Whatman No. 1 standard grade cellulose powder. These fractions were examined serologically and it was found that the blood group substances *A* and/or *B* were located in the slowly moving fraction in high concentration. *Rh* substance is present in the crude stroma extract but, on electrophoresis, neither fraction was sufficiently strongly inhibitory to the *Rh* antibody to indicate the fate of this substance. Details of these studies will be published elsewhere.

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Renal Excretion of 17-Ketosteroids by Members of some Ethnic Groups living in Malaya

We have recently studied the 24-hr. renal outputs of 17-ketosteroids by normal adult males belonging to some of the well-defined, civilized ethnic groups living on Singapore Island and in the Federation of Malaya. The groups for which complete data have been obtained (a sample of twenty subjects was taken from each ethnic group) are Chinese, European and Malay. The Chinese were all of recent Southern Chinese origin, most of the Europeans were of recent English origin and most of the Malays were of recent 'Peninsular' origin. Work on other subjects belonging to both civilized and uncivilized groups has yet to be completed and evaluated. Meanwhile, the existing complete data are discussed briefly (Table 1).

The ages of the subjects were all within a range (17–46 yr.) over which the 17-ketosteroid excretion of normal male Europeans has been found to be relatively independent of age[1,2], and we are of the opinion that only a small fraction, if any, of the differences revealed in Table 1 can be attributed to disparities in the ages of the subjects.

The observations afford three pair-comparisons of the 17-ketosteroid excretions. Employing the arithmetic values and (in view of the non-homogeneous variances) having recourse to the Cochran and Cox[3] *t* statistic to test the significance of differences between the arithmetic means, it is found that the differences between the Chinese and European means and between the European and Malay means are probably of high statistical significance. However, the intra-sample distributions of 17-ketosteroid values approximate to 'log-normal'[4] rather than 'normal' form, and the validity of the test is therefore impaired. As the variances of the $\log_{10}$ (values) are fairly similar, 'Student's' *t* test has been applied to test the significance of differences between the means (namely, the $\log_{10}$ (geometric means), these latter being: Chinese 8·7, European 15·3, Malay 7·3), using for the purpose a pooled estimate of variance (0·02068). The comparisons yield: Chinese and European, $t = 5{\cdot}40$, $P < 0{\cdot}001$; Chinese and Malay, $t = 1{\cdot}66$, $P > 0{\cdot}05$; European and Malay, $t = 7{\cdot}05$, $P < 0{\cdot}001$, the probability (P) levels being taken from tables[5] of *t*. Differences as large as those observed in the first and the third pair-comparisons would be extremely unlikely to arise in random sampling from homogeneous populations, a finding which confirms that indicated by the less satisfactory examination mentioned earlier.

Little work of this type has yet been performed. It has been observed[6], however, that mature African and English males appeared to have very dissimilar excretions of 17-ketosteroids; and our results, rather similar to those of Barnicot and Wolffson[6] so far as the European subjects are concerned, likewise suggest

Table 1. Renal Excretion of 17-Ketosteroids by Samples of Twenty Adult Males

Each sample was drawn from a separate ethnic group. 17-Ketosteroids in urine estimated by the procedure (ref. 8) recommended by Warren (ref. 9), and creatinine by the method of Folin (ref. 10). Means and standard deviations of $\log_{10}$ (values) are shown in parentheses in columns 2 and 4, respectively

Ethnic group	24-hr. 17-ketosteroid excretion			24-hr. mean creatinine excretion (gm.)	Mean wt. (kgm.)	Mean age (yr.)
	Mean (mgm.)	Range (mgm.)	Standard deviation (mgm.)			
Chinese	9·2 (0·940)	3·9–17·5	3·26 (0·154)	1·45	53·3	23·2
European	16·0 (1·185)	10·5–27·9	4·82 (0·125)	1·87	73·5	31·8
Malay	7·8 (0·864)	4·4–14·9	2·89 (0·154)	1·42	57·1	32·4

that the excretions of other ethnic groups are lower. However, the two samples studied by Barnicot and Wolffson exhibited distinctly similar creatinine excretions, whereas our European subjects excreted appreciably more creatinine (on the average) than did our Chinese or our Malay subjects. Again, our European subjects were (on the average) appreciably heavier than those of the other ethnic groups—Barnicot and Wolffson have given no comparison of weights.

Our work suggests that there may be a correlation between 17-ketosteroid output on one hand and creatinine output and/or weight on the other. In this connexion it is pertinent to recall that evidence has earlier been found[7] of a correlation between the 17-ketosteroid and creatinine outputs of children of European origin.

A more rigorous statistical examination of our results (complicated by the fact that the distributions of some variates, but not all, are more nearly 'log-normal' than 'normal') is in progress. It is hoped that the investigations may (among other things) suggest a clinically more useful estimate of '17-ketosteroid status' than is afforded by the absolute 24-hr. excretion values themselves or is suggested by the correlation observed by Nathanson, Miller, Towne and Aub[7].

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Neurohypophysial Control of Follicular Maturation in the Domestic Fowl

EVIDENCE from several sources[1–4] supports the view that the discharge of ovulation-inducing hormone from the hypophysis of the domestic fowl is mediated by a nervous mechanism, as in the rat[5]. The interval from 'excitation' for the release of the hormone to ovulation has been estimated to be of the order of 8–14 hr.[4,6,7]. In the present communication we wish to direct attention to results indicating that ovulations in the hen may be suppressed by the interruption, long before the estimated hour of release of the ovulation-inducing hormone, of processes presumably associated with maturation of the ovarian follicle.

The birds used, conditions of their maintenance, and experimental procedures have been described recently[4]. Hens selected for test were ovulating in 3-day 'closed' cycles[4]. The first or C_1 ovulation in such cycles occurs at about 6.00 a.m., the second or C_2 ovulation at about 10.30 a.m. on the next day. Ovulation does not take place on the third day of the cycle, but does so at 6.00 a.m. of the day thereafter to initiate a new cycle. The interval between C_1 and C_2 ovulations is thus about 28·5 hr., that between C_2 and C_1 ovulations about 43·5 hr. In the main body of experiments, the suppressing or 'blocking' agents were injected 38 hr. before expected C_1 ovulation, or 5–6 hr. following the preceding C_2 ovulation. The hens were palpated at appropriate hours to determine the occurrence or non-occurrence of ovulation on the day of expected ovulation or on the day thereafter. When the injected agent interfered with normal feed or water intake, the birds were forcibly fed and watered.

The suppressing agents included phenobarbital sodium, diallylbarbituric acid ('Dial'), pentobarbital sodium ('Nembutal'), the adrenergic blocking agent *SKF*-501, and the anticholinergic drug, atropine sulphate. Solutions of the barbiturates were prepared according to Fraps and Case[4], of *SKF*-501 and atropine sulphate as described by Zarrow and Bastian[8]. No attempt was made to determine the conditions of maximal suppressing action of the several agents.

Table 1. SUPPRESSION OF C_1 OVULATION BY BARBITURATES AND 'BLOCKING' AGENTS ADMINISTERED 38 HR. BEFORE EXPECTED OVULATION

Treatment			No. of hens injected	Ovulations suppressed	
Agent	Route*	Quantity		No.	Per cent
Phenobarbital sodium	Sc.	100 mgm./kgm.	10	9	90
'Dial'	Im.	80 ,,	10	8	80
'Nembutal'	Sc.	60 ,,	11	6	55
SKF-501	Im	10 ,,	9	7	77
Atropine sulphate	Ip.	150 mgm./hen	9	6	67

* Sc., subcutaneous; Im., intramuscular, Ip, intraperitoneal.

Results of injections 38 hr. before expected C_1 ovulation are recorded in Table 1. The significance of these results becomes apparent on comparing the effects of the same agents following administration at about 14 hr. before expected C_1 ovulation, that is, when injected for effect on the neural component of the mechanism causing release of the ovulation-inducing hormone specifically. Phenobarbital at 14 hr. suppresses few or no ovulations[1], in contrast with 90 per cent at 38 hr. 'Dial' and 'Nembutal' actually induce ovulation prematurely in some hens injected at 14 hr. before expected ovulation[1], whereas at 38 hr. the same barbiturates act only as suppressing agents.

A single injection of *SKF*-501 at 14 hr. suppresses 30–40 per cent of expected ovulations (unpublished observations), as against 77 per cent at 38 hr. The incidence of ovulations suppressed by the single 38-hr. injection of *SKF*-501 compares favourably with the results of two injections used by Zarrow and Bastian[8] for direct blockade of ovulation-inducing hormone release. These authors also reported that atropine sulphate suppressed C_1 ovulation following administration of the drug at hourly intervals for 12 hr., beginning some 8–10 hr. before expected ovulation. A single injection of the same agent at 38 hr. yields results of the same order.

The suppression of C_1 ovulation by barbiturates and 'blocking' agents injected 38 hr. before expected ovulation indicates almost certainly the blockade of a nervous mechanism controlling some essential pre-ovulatory process. The direct suppression of the release of ovulation-inducing hormone is obviously improbable. It is suggested that the nervous activity in question controls the secretion of hypophysial hormone (or hormones) required for maintenance and function of the maturing ovarian follicle.

A fairly extensive body of circumstantial evidence might be marshalled in support of the view that the hen's maturing follicle secretes progesterone (or a physiologically equivalent steroid) and that this hormone, rather than œstrogen, 'excites' the mechanism for release of the ovulation-inducing hormone. On this view, the hen's maturing follicle may be said to undergo luteinization prior to release of gonadotrophin for its ovulation. Pre-ovulatory progesterone has been demonstrated in mammals[8], but apparently only following release of the luteinizing hormone for ovulation. The postulated pre-ovulatory luteinization of the hen's follicle may imply the existence of nervous and hypophysial functions usually associated with ovulation and post-ovulatory luteinization in the rat[6]. Further observations bearing upon this hypothesis will be presented elsewhere.

Note added in proof. The adrenergic blocking agent, 'Dibenamine', administered 38 hr. before expected C_1 ovulation but otherwise in accordance with procedures of van Tienhoven *et al.*[5], suppresses ovulation in more than 90 per cent of injected hens. This drug should therefore be included with effective agents listed in Table 1.

Thanks are due to Dr. A. E. Heming, of the Smith, Kline and French Laboratories, Philadelphia, for 'Dibenamine' and *SKF*-501, and to the Research Department of Ciba Pharmaceutical Products, Inc., Summit, New Jersey, for 'Dial'.

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Research on the Mammals of South Africa

A RECENT paper by Dr. L. Harrison Matthews[1] has raised several interesting points regarding the biological study of mammals in Africa. Most stress was laid on big game studies, and the fact that they must be done before the game has disappeared owing to the advance of civilization. In South Africa two big game animals, *Equus quagga* Gmelin, the true quagga, and *Ozanna leucophaea* (Pallas), the blue antelope, are already extinct as a result of indiscriminate hunting, while many other groups like the bontebok (*Damaliscus pygargus* (Pallas)) are approaching extinction.

While the activities of hunters have to some extent been curbed by severe legislation, large numbers of game animals have been destroyed in the Union of South Africa and still are being decimated in the Rhodesias and Bechuanaland in combating the tsetse fly. Furthermore, here as elsewhere, wherever game stands in the way of agricultural development, the game inevitably goes. Hence it truly becomes necessary to learn all that is possible of the animals concerned before it is too late. At the same time, as pointed out by Harrison Matthews[1], where game is being destroyed, splendid opportunities exist for the collection of skeletal material for study purposes, and scientific institutions should be given the chance to avail themselves of these opportunities.

The biological study of small mammals is equally important, but from a different point of view. Here the stress is not on the danger of extinction, which for the smaller forms is not very real, but on the various scientific and economic problems that small mammals, and particularly rodents, bring in their train. Possibly the most important of these is the danger of plague, which is transmitted by small mammals. Another is the economic importance of rodent epizootics, for example, the destruction of trees in forestry plantations in the Sabie area (Transvaal) in 1951 and the recent (1953) invasion of *Mastomys* (multimammate mouse) in the Springbok Flats area of the Transvaal.

The problem is further complicated by our incomplete taxonomic knowledge of our mammal fauna. Two recent books on this subject, by Roberts[2] and Ellerman, Morrison-Scott and Hayman[3], both fail to present a true picture of this, the first as a result of intensive splitting, the second by extreme lumping together of groups of doubtful affinities. As pointed out by Handley[4], "some portions of the world are still in the 'exploration and cataloguing' stage as far as mammalogy is concerned". This is very true of South Africa, and while this remains the case, biological knowledge of our fauna is bound to progress little. On the other hand, of course, to complete the circle, taxonomy cannot produce "a sifted, sorted, and simplified nomenclature" (Handley[4]) without a more detailed biological background than at present exists.

A certain amount of work on mammal biology has been done. The splendid work of the late Dr. C. J. van der Horst has already been mentioned[1]. Furthermore, the Plague Research Laboratory of the South African Institute for Medical Research has for a number of years been carrying out researches on the taxonomy and biology of plague-carrying rodents. Examples of this are to be found in the work of Davis[5,6], Oliff[7] and others.

A Zoological Survey was brought into being in 1936 by the Division of Veterinary Services and did valuable work on the carriers of animal-borne disease (see Thomas and Kolbe[8]). Unfortunately, this project died an untimely death, and nothing similar has since been attempted.

At the present moment efforts are being made to form a Division of Biological Survey, and various groups and individuals (see Meester[9]) have stressed the need for a body of this nature. However, these efforts are handicapped first by the lack of official support and secondly by the shortage of trained workers. It seems, therefore, that some time will elapse before concrete results can be expected. Delay, however, is inadvisable and may be fatal. As Harrison Matthews has pointed out[1], the advance of civilization in Africa will inevitably result, in a relatively short period, in the destruction of the larger elements at least of the mammal fauna outside the game reserves. It is essential to learn what can be learnt while there is the time and the material.

At the same time, without belittling the isolated work done by the various groups and individuals mentioned by Harrison Matthews and here, there can be little doubt that the interests of science would be better served by a broader, more realistic approach. Even the Biological Survey mentioned above would have a restricted, national scope.

It seems, therefore, that the problem should be approached on an international basis, similar to that of the International Red Locust Control Board. The only organization with a more or less international scope in Africa at the moment is the Scientific Council for Africa South of the Sahara, which has already shown its willingness to co-operate in conducting studies on African mammals. In view of this it would seem highly desirable for the Council to interest itself in organizing a body for the purpose of conducting and correlating biological research on African mammals.

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Fine Structure of Exocrine Cells of the Pancreas

A cytological study has been carried out on exocrine cells of the pancreas of the mouse with the aid of the electron microscope. The tissue was taken from animals aged two to three months and fixed in osmic acid buffered[1] to a pH of 7·4. It was then embedded in *n*-butyl methacrylate and sections about 400–800 A. thick were cut. Similar tissue, also fixed in buffered osmic acid, was embedded in gelatine for sectioning and examination by light microscopy in order to compare the effects of osmium fixation with those obtained by other fixatives employed in previous studies[2,3].

One of the most conspicuous objects identified in pancreas cells by means of the electron microscope was the Golgi apparatus (Fig. 1). In each cell this usually consisted of several groups of three or four vacuoles in close association with the zymogen granules. The vacuoles were apparently closely pressed together, but were separated from each other by a dense transverse membrane about 450 A. thick (Fig. 1, *tm*). This membrane joined with a limiting membrane (Fig. 1, *lm*) which was often similar in appearance to the transverse membrane but which separated the vacuoles from the surrounding cytoplasm. In some instances the limiting membrane was thicker (about 900 A. in diameter) on one side of the vacuoles than on the other side. In other cases it was a tubular or bilamellar structure about 1500 A. wide containing cristæ and granules dispersed along its length. In the region of the Golgi vacuoles numerous granules about 650 A. in diameter, sometimes containing a minute single dense particle, were seen scattered in the adjacent cytoplasm. These observations are consistent with the view[3] that the Golgi apparatus, as seen in sections 4–5 μ thick, is a three-dimensional canal-like organelle with transverse striæ passing across its lumen.

The mitochondria were not of uniform appearance but tended to fall into three categories: (1) tubular bodies about 3 μ long and about 0·3 μ in diameter containing many fine cristæ close together; some of these possessed lateral or terminal 'buds'; (2) tubular objects about 2·5 μ long and about 0·3 μ in diameter with a thickening at one end and bearing distinct cristæ; (3) tubular inclusions about 3 μ long and about 0·3 μ in diameter showing evidence of vacuolation and poorly developed cristæ; the surface of these bodies was indented in the midline in such a way that they bore a superficial resemblance to *Paramecium*. These three types of mitochondria may actually represent different functional conditions of a single type or be indicative of age changes[4].

Objects identified as prozymogen bodies appeared to originate from mitochondria by a process akin to budding and contained cristæ. In the Golgi zone it was observed that such bodies contained some of the 650 A. granules mentioned above and that few cristæ were present. Other prozymogen bodies contained a dense inner core which was regarded as the first sign of a developing zymogen granule. Finally, a micrograph was obtained which left little doubt that the fully developed zymogen granules are sometimes dehisced from the prozymogen bodies. These observations support the view[3] that prozymogen bodies originate from mitochondria and receive some contribution from the Golgi zone before completing the synthesis of zymogen.

The zymogen granules were seen as dense oval or spherical bodies (Fig. 1, *z*) sometimes with an irregular spiky outline. Some of them contained very small granules (about 200 A. in diameter) which may be related to the granules found within the prozymogen bodies. The density of the zymogen granules was not attributed to their osmophilia, since in the gelatine sections, which were examined by the light microscope, it was seen that they were relatively non-impregnated.

The appearance of the endoplasmic reticulum[1] varied considerably from cell to cell. It is believed

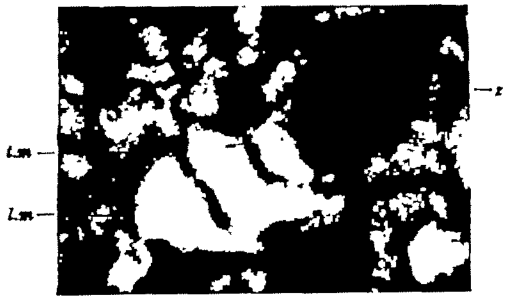

Fig. 1. Golgi apparatus, with transverse membranes (*t.m*) and limiting membrane (*l m*), close to zymogen granules (*z*). Electron micrograph. × *c* 25,000

that this was not due to vagaries in fixation but probably reflected the condition of cells in different phases of the secretion cycle[3]. In some cells the reticulum was represented by many parallel lamellæ or canaliculi, whereas in other cases only a vestige of this structure was retained and the cytoplasm resembled an open network.

Examination of the nucleus showed that along the nuclear membrane were many granules of the kind described by Ludford[5]. At first sight the nucleolus appeared to consist of an anastomizing opaque reticulum, but careful examination revealed that the strands of the reticulum actually consisted of granular material.

When osmium-fixed, gelatine-embedded sections were examined with the ordinary light microscope and the results compared with those obtained in previous studies[2,3] it was found that: (1) buffered osmic acid renders the tissue so brittle that thin (3–4 μ) sections can rarely be obtained; (2) it preserves lipids; (3) there is no specific impregnation of mitochondria, Golgi apparatus or prozymogen bodies by the osmium. It may be emphasized here that the fact that lipids are preserved in osmium-fixed gelatine-embedded preparations does not signify that they are retained in *n*-butyl methacrylate-embedded material. It is quite probable that some lipids are lost in preparing material for the electron microscope, and that vacuoles in such material actually represent the site of this substance.

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Chemical Composition of Uredospores of Wheat Stem Rust (*Puccinia graminis tritici*)

ONE approach to the problem of controlling wheat stem rust is the study of the chemistry of the parasite. As part of an investigation into the chemical nature of wheat stem rust, a preliminary examination has been made of uredospores of *Puccinia graminis tritici*. When uredospores of mixed races are subjected to the action of 72 per cent sulphuric acid for 24 hr. at room temperature (23° C.) and then heated with 2 *N* sulphuric acid in a sealed tube immersed in boiling water for 16 hr., D-glucose, D-mannose and D-arabitol are liberated. These three substances were identified by paper chromatography using ethyl acetate – acetic acid – water (3 : 1 : 3)[1]. By means of a cellulose column and the same irrigating solvent, enough of each of these three components was separated in order to provide crystalline derivatives thus:

D-Arabitol pentaacetate, m.p. 75° C., $[\alpha]_D^{25}$ + 37·4° (chloroform)
D-Mannose *p*-nitroanilide, m.p. 221° C., $[\alpha]_D^{25}$ – 404° (pyridine)
1,2,3,4,6α-D-Glucose pentaacetate, m.p. 108° C., $[\alpha]_D^{23}$ + 105° (chloroform)

The literature shows that glucose and mannose have been identified in uredospores of wheat stem rust by paper chromatography, but no crystalline derivatives were prepared and it was not possible to state whether they were the D- or the L-sugars[2]. So far as we are aware the work reported herein constitutes the first proof of the identity of D-glucose, D-mannose and D-arabitol in uredospores. The five-carbon sugar alcohol, D-arabitol, is seldom encountered in natural products, although it has been reported in lichens[3].

Quantitative analyses, using the method of Dubois *et al.*[4] for the sugars and of Lambert *et al.*[5] for D-arabitol, indicated that the uredospores contained 2 per cent D-glucose, 19 per cent D-mannose and 3 per cent D-arabitol on a dry-weight basis.

Work is in progress to ascertain the nature of the carbohydrate compound(s) from which the above three substances are derived.

We thank Prof. Fred Smith (University of Minnesota) and Prof. J. G. Dickson (University of Wisconsin, Madison) for their interest in this work.

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Seed Dressings for the Control of Wheat Bulb Fly

GOUGH[1] has referred to the serious damage caused by wheat bulb fly (*Leptohylemyia coarctata* Fall.) in Great Britain in 1953 and discussed various means of preventing or reducing attacks. Of the possible methods of chemical control, seed dressings seemed worthy of investigation; previous experiments had given conflicting but usually negative results. One of the possible reasons for this was the length of time between the date of sowing and the egg-hatching period, and we therefore laid down two field-experiments to study this time-factor. The seed dressings were: (1) a standard proprietary one containing 1 per cent of an organo-mercurial fungicide applied at 2 oz./bush.; (2) 40 per cent gamma-BHC containing 0·8 per cent of an organo-mercurial applied at 3 oz./bush.; (3) 40 per cent dieldrin containing 0·6 per cent of an organo-mercurial also applied at 3 oz./bush.

There were two sowing dates, an early one in October or November, and a late one in December or January. The six treatments, that is, three seed dressings × two sowing dates, were randomized among four blocks in exp. *A* (peat soil) and three blocks in exp. *B* (acid peat). Both fields had previously been cropped with potatoes and were known to have a very high population of wheat bulb fly eggs of the order of 3–5 million per acre.

Table 1

	Exp.	Early sowing A–13.XI.53. B–20.X.53			Late sowing A–6.I.54. B–17.XII.53			S.E. 5 per cent
		Control	Dieldrin	BHC	Control	Dieldrin	BHC	
No. attacked shoots in millions/ac. (approx. equivalent to larval count)	*A* *B*	1·90 2·20	1·60 2·30	1·53 2·35	1·01 1·17	0·73 0·77	0·50 0·95	— —
Per cent attacked shoots	*A* *B*	43·1 53·7	34·3 53·8	34·1 55·7	79·6 96·4	65·0 74·9	37·3 73·9	— —
Per cent attacked shoots (angular transformation)	*A* *B*	41 47	36 47	36 48	64 79	54 62	38 61	4·7 13·0

In both fields by April the early-sown wheat had tillered well, masking the heavy larval attack. In exp. *A* in the late-sown (January 6) plots the gamma-BHC plots were uniformly good, the control plots uniformly poor and the dieldrin plots intermediate. In exp. *B*, where the late sowing was on December 17, the BHC plots were moderate, the controls a complete failure and two of the three dieldrin plots intermediate.

In May the same visual differences were still apparent on exp. *A*, except that the dieldrin plots were much improved relative to the controls, which were a complete failure; the early-sown plots continued to grow away from the attack. On exp. *B*, all the late-sown plots were failures and the attack had caused considerable thinning of the early-sown plots.

Plant samples were removed from five (exp. *A*) or seven (exp. *B*) unit areas on each plot at the end of March. The unit areas were two adjacent and parallel 1-ft. lengths of row. These samples were stored in a refrigerator until they could be examined and the numbers of attacked shoots and larvæ counted.

As only one larva survives in any one shoot[2] the absolute number of larvæ on the late-sown plots (where no tillering had taken place) was much smaller than on the early-sown plots. The results (Table 1) are therefore best compared on a percentage basis, and the analysis of variance has been made on an angular transformation.

Thus it is clear that the treatments have had little or no effect on the early-sown wheat, but have had a marked and significant effect on the late-sown treatments on field *A*. The differences on field *B* are not significant. Whether the lack of effect (or reduced effect) on field *B* is due to the different conditions or to the somewhat earlier date of sowing is not certain, but the latter is a reasonable assumption.

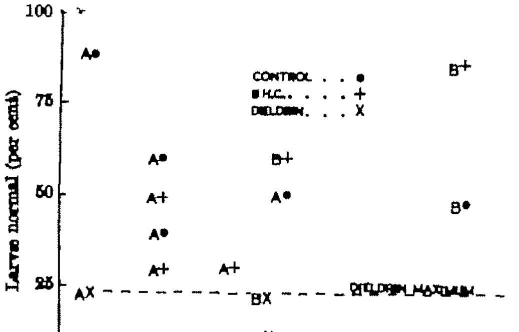

Fig. 1. Condition of wheat bulb fly larvæ from late-sown plants treated with BHC or dieldrin seed-dressing. The numbers of larvæ examined for exp. *A* are much greater than for exp. *B*

During a previous trial it had been noted that there was a slightly higher proportion of dead larvæ inside plants grown from aldrin- and dieldrin-treated seed than from BHC-treated and untreated seed, and the condition of the larvæ was therefore recorded in the present trials. Unfortunately, the length of time taken in dissecting and examining many thousands of plants rendered a direct comparison of the relative proportions of dead larvæ unreliable, and the effect is most clearly seen in a graph (Fig. 1), when the percentage of apparently normal larvæ for each of the later-sown treatments is plotted against the number of days elapsing between collection and examination. The remaining larvæ were either dead or classified as moribund or abnormal.

It is clear that dieldrin is having a marked effect on the larvæ in the plants, though the effect of BHC is less certain. It was, however, noted during the examination of the plants that many of those in the late-sown BHC treatments had a minute hole or tear in the first leaf consistent with the attempt of a larva to enter, though there were no signs of larvæ having been in these plants. It would appear, therefore, that the main effect of the BHC had been to prevent entry of the larva, and that of dieldrin had been to kill the larva after entry. This would explain the poor appearance of the dieldrin plots in the early stages and their subsequent improvement. As the larvæ were not killed until some time after entry, it seems likely that the dieldrin was taken up by the plant. This apparent systemic effect of dieldrin has been independently confirmed by workers in the Department of Insecticides and Fungicides at Rothamsted.

Insecticidal seed dressings are widely applied to cereals, and their use is being rapidly extended to other crops; but knowledge on their mode of action is meagre. Lange *et al.*[3] showed that wireworms died when confined in soil with lima beans dressed with BHC. Dogger and Lilly[4] suggested a repellent action, and this appears to be the general assumption. Seed treatment with insecticides can be regarded as a special method of soil application, and Starnes[5], Howe[6], Shapiro[7] and Kozlova and Dvortzova[8] have recorded mortality of insects feeding on or in various parts of plants growing in soil treated with BHC and other chlorinated hydrocarbons. In view of all these observations, it would seem desirable to study the mechanism of the protection afforded by seed treatments.

The seed dressings were prepared by the Department of Insecticides and Fungicides, Rothamsted Experimental Station, and we are indebted to Dr. C. Potter of that Department for this facility and for reading this communication in draft. We also acknowledge the help of several colleagues and of Mr. W. R. Green and Mr. T. A. Saul, who provided

the sites and carried out all the cultivations. This work is supported by a grant from the Agricultural Research Council.

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Polarization of Radio Echoes from Aurorae

NOTABLE variations in the polarization of radio echoes from aurorae have been observed at Saskatoon (52·1° N., 106·6° W.), using frequencies of 56 and 106·5 Mc./s. Theories of very high-frequency radio propagation predict the maintenance of the transmitted state of polarization under normal ionospheric conditions. An examination by Moore[1] of amateur radio transmissions by 'auroral propagation' indicated that this was also the case when aurora was present. Observations by Bowles[2] confirmed this conclusion, although exceptions occurred when aurora was overhead. More recently, Harang and Landmark[3], in reporting on back-scatter echoes during aurora, mentioned that 35 Mc./s. echoes were sometimes completely depolarized and sometimes nearly plane polarized, and that 74 Mc./s. echoes were plane polarized in the same sense as the transmitted signals. The Saskatoon observations are apparently the only ones that have been made so far where it has been possible to verify the auroral origin of the echoes[4].

The apparatus consisted essentially of two radar units transmitting horizontally polarized signals toward magnetic north on frequencies of 56 and 106·5 Mc./s., and a multiple antenna system designed to detect the angle of arrival and various types of polarization of the resulting echoes from aurorae. The 56 Mc./s. receiving antennae consisted of a high, horizontally polarized Yagi; a low, horizontally polarized Yagi; a low, vertically polarized Yagi; and a low, circularly polarized antenna which could be alternated rapidly between right-handed and left-handed circular reception. A common receiver was used for these antennae, a radio-frequency switch alternately connecting the two antennae of a selected combination to the receiver. The first two antennae were designed primarily to determine the angle of arrival of the echoes[4]. Only a horizontally and a vertically polarized Yagi were used for reception of 106·5 Mc./s. echoes. The received signals were presented on a cathode-ray tube as a range-amplitude display. The traces for each antenna combination were shifted vertically in synchronism with the radio-frequency switching. The displays were photographed using short time exposures. To obtain the polarization ratios plotted in Figs. 1 and 2, the amplitude ratios obtained from the photographs were normalized using a factor calculated from the horizontally and vertically polarized propagation patterns of the antennae. This normalization factor is a function of angle of arrival and hence of range.

Observations on 56 Mc./s. during the period from December 1953 to August 1954 showed a large variation in the polarization ratios of the echoes. A strong degree of de-polarization was exhibited by a large proportion of the echoes. Fig. 1, based on the measurement of 489 56 Mc./s. echoes, is a histogram of the occurrence of echoes with various polarization ratios. For the 'finite ratio' group (66 per cent) of the 56 Mc./s. echoes, the most probable polarization ratio (horizontal to vertical component of field-strength) was 1·1 and the mean power ratio was 3 decibels. The 'infinite ratio' group (34 per cent of the echoes)

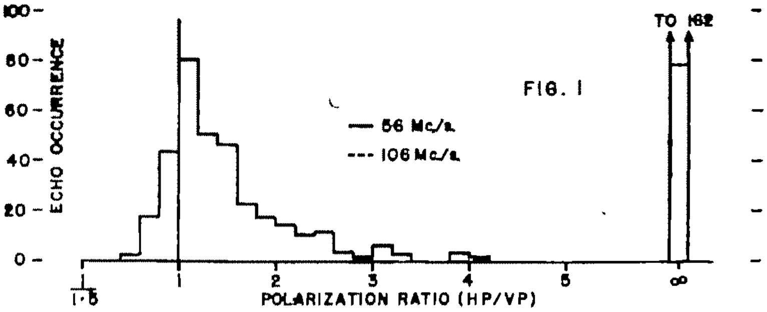


FIG. 1

FIG. 2

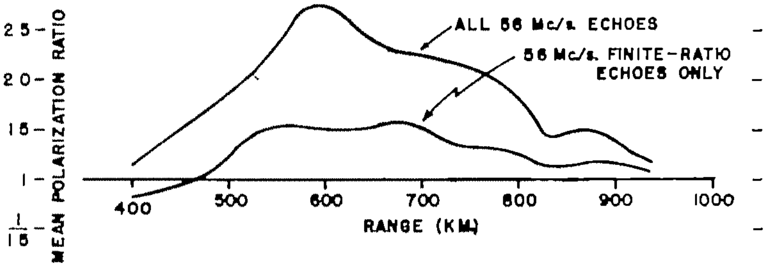
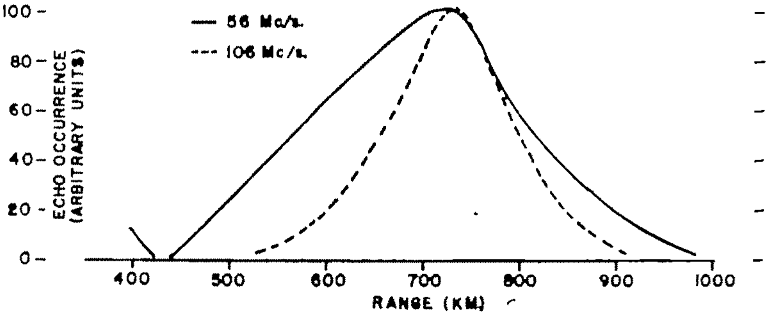


FIG. 3



were substantially plane polarized in the sense of the transmitted signals. The mean power ratio, including both types of echoes, was 5 decibels. An exact division of the echoes into the two types was not possible because the relatively small signal-to-noise ratios (0–26 db.) made precise measurement of amplitude difficult, and the transition from one classification to the other was not sharply defined. The presence of polarization ratios of less than unity is believed to be due to experimental error. Observations with the circularly polarized antenna showed approximately equal amplitudes for left- and right-handed senses of rotation. The ratio of the circularly polarized antenna signal to the horizontally polarized antenna signal was practically constant. The polarization ratios (horizontal to vertical) sometimes differed widely for echoes occurring simultaneously but at different ranges. Also, the polarization of the echoes was observed at times to change from the plane to the de-polarized state, or vice versa, within a period of minutes.

Fig. 2 shows the variation of the mean normalized polarization ratio as a function of range. There appears to be a significant increase in the polarization ratio in the range 500–900 km. The region indicated by these ranges approximates to the meridian section of the Chapman echo surface[5], where the radar line of sight is perpendicular to the earth's magnetic field at E-region heights.

All observations of the polarization of 106·5 Mc./s. echoes (June–August 1954) have shown only plane polarization in the same sense as the transmitted signals. The seventy-eight echoes recorded in this period are shown in Fig. 1 by the dotted line. Instantaneous polarization relationships and relative occurrence of 56 and 106 Mc./s. echoes could not be inferred from the observations, since simultaneous display of polarization effects on the two frequencies was not possible with the apparatus employed. However, the change-over from one frequency to the other was accomplished within a few seconds, and general relationships could be determined.

Fig. 3 is a plot of echo occurrence against radar range. The shape of the 106 Mc./s. distribution is only approximate because of the much smaller number of echoes available. Apparently the 106 Mc./s. occurrence is largely restricted to the range interval in which high polarization ratios are obtained on 56 Mc./s. The occurrence of echoes is controlled by a number of factors: the propagation pattern of the antenna, the latitudinal variation of auroral occurrence, the earth's curvature, and the attenuation effect which limits occurrence of echoes to low angles of elevation. Correlations of polarization ratios with types of echoes (diffuse and discrete), or with types of visible aurora (homogeneous and rayed structures), have not yet been attempted. Two processes which could cause de-polarization of the signals are the magneto-ionic effect and multiple scatter within the reflecting region. Of the two, the latter seems the more likely. If the primary reflexion is by coherent scatter from long trails of ionization lying along the lines of the earth's magnetic field, aspect attenuation will limit the back-scattered signal to regions satisfying the criterion of perpendicularity. Multiple scatter will cause a broadening of the scattering polar diagram and thus permit echoes to be obtained from somewhat beyond the Chapman echo surface. In addition, over-dense volumes in the ionized region[4] will themselves possess omnidirectional polar diagrams and thus further extend the echoing region. This condition should occur oftener at the lower frequency.

This work has been made possible by financial assistance from the Defence Research Board of Canada and by loan of equipment from the U.S.A. Air Force Cambridge Research Center.

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Titanium Nitride and Titanium Carbide as Semiconductors

It is well known that titanium nitride shows the electric properties of a typical metal[1]. In fact, the specific resistivity ρ is lower than that of titanium metal itself. We have re-examined these experiments, using van Arkels's technique[2] of deposition from the vapour phase for the preparation. Our results, given in Table 1, agree fairly well with those of the earlier investigators.

By the same method we have prepared layers of titanium nitride (TiN) on sintered aluminium oxide and quartz glass. The thickness of these layers varied between 1 and 25 μ. The layers on aluminium oxide have essentially the same properties as the titanium nitride deposited on tungsten wire. The small differences may be due to the uncertain thickness of the layer or perhaps to small impurities. The layers on quartz glass, on the other hand, show completely different electric behaviour, which resembles that considered typical for semiconductors. The specific resistivity at room temperature is $10–10^3$ times as high as for the samples on tungsten and aluminium oxide. In a certain temperature-range the temperature coefficient of the resistivity is negative. The position and height of the maximum depends on the particular kind of sample. The resistivity at 800° C. is almost the same for all layers on quartz glass. It is still higher than that of titanium nitride on tungsten or aluminium oxide. The Hall coefficient R has a negative sign and is essentially the same for both kinds of samples.

The structure of layers from both sides after removing the base materials has been examined by X-ray diffraction. We found no difference between the metallic and semiconducting titanium nitride. No impurities could be detected, and the lattice constant

Table 1. Electric Properties of Different Samples of Titanium Nitride

Sample No.	Base material	ρ 20° C. (Ω cm.)	ρ 800° C. (Ω cm.)	Temp. coeff. of ρ between 700° and 800° C	Hall coeff (R) (cm.³/coulomb)
1	Tungsten wire	$1·65 \times 10^{-5}$	$5·82 \times 10^{-5}$	$+3·2 \times 10^{-4}$	
I_{Al}	Aluminium oxide	$4·6 \times 10^{-5}$	$1·2 \times 10^{-4}$	$+2 \times 10^{-3}$	$-1·2 \times 10^{-4}$
IV	Silica	$1·4 \times 10^{-3}$	$1·8 \times 10^{-4}$	-2×10^{-3}	
I*	Silica	$3·9 \times 10^{-4}$	$1·6 \times 10^{-4}$	-4×10^{-4}	$-1·3 \times 10^{-4}$

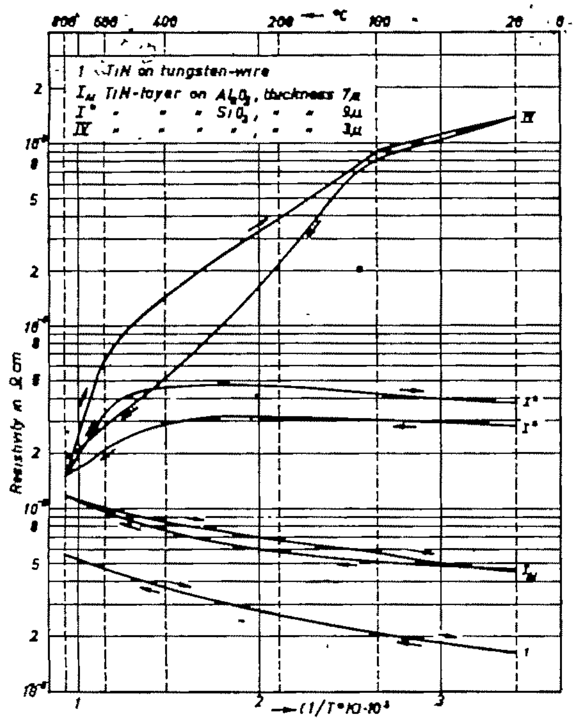

Fig. 1

has exactly the same value in both cases (4·2346 ± 0·0002 A.). Fig. 1 shows the relation of the specific resistivity to temperature for typical samples. Some numerical results are given in Table 1. Essentially the same behaviour has been observed for titanium carbide and mixed crystals of titanium nitride and carbide.

A full description of the experiments and the theoretical discussion will be published elsewhere.

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Point Source and Sink in a Parallelepiped

THE potential distribution in a parallelepiped arising from a point source and sink is of practical importance in the measurement of the thickness of plates and tubes[1,2], and the electrical conductivity of semiconductors[3]. A common practical arrangement employs four collinear equi-spaced contacts: current I is passed between the outer pair, and the potential difference V between the inner pair is measured. If the contacts are aligned centrally parallel to the longest side 2α of a rectangular block of material, its width being 2β and its thickness γ in units of the electrode spacing, the conductivity is given by the triple series :

$$\sigma = \frac{I}{\pi V} \sum_{-\infty}^{\infty} \sum_{-\infty}^{\infty} \sum_{-\infty}^{\infty} (-1)^{n} \Big\{ [(2n\alpha + 1)^2 + 4m^2\beta^2 + 4r^2\gamma^2]^{-1/2} - [(2n\alpha + 2)^2 + 4m^2\beta^2 + 4r^2\gamma^2]^{-1/2} \Big\}$$

The difficulty in computing this series lies in the slow convergence of the single series :

$$s = \sum_{-\infty}^{\infty} [(n^2 + x^2)^{-1/2} - (n^2 + y^2)^{-1/2}],$$

when x and y are large. Warren[2] applied the Euler–Maclaurin summation formula to obtain approximations, and other workers have offered no alternative formula.

Although it is not difficult to show that

$$s = \int_{-\infty}^{\infty} \left[\frac{H_0^{(1)}(xt) - H_0^{(1)}(yt)}{e^t - 1}\right] dt,$$

and thence to obtain the alternative expansion

$$s = \left\{2 \log(y/x) + 4 \sum_{n=1}^{\infty} [K_0(2\pi nx) - K_0(2\pi ny)]\right\},$$

this result does not appear to have been published hitherto.

It is a simple matter to reduce triple summations to a calculable form by means of this transformation, and the result may be readily extended to series involving higher inverse powers of $(n^2 + x^2)$ and $(n^2 + y^2)$. Such series are important in solid-state crystal theories, where they have usually led to tedious approximations, although recently a more powerful approach has been described[4].

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Dielectric Increment of Sodium Alginate as a Function of Polyion and Counter-ion Concentration

A NUMBER of linear polyelectrolytes—acid as well as basic—give high dielectric increments in aqueous solution, when compared with less asymmetric proteins and simple dipolar ions.

The sodium salt of alginic acid (poly-β-*d*-mannuronic acid) has been shown recently to have dielectric properties in aqueous solution similar to the other polyelectrolytes studied, namely, high dielectric increments which show anomalous dependence upon concentration (see Fig. 1), dielectric dispersions at radio-frequencies which are strongly dependent upon concentration, decrease of increments and change of dispersions with addition of small amounts of simple electrolytes, and decrease of increments and change of dispersion with decrease of dielectric constant of solvent (water changed to ethanol–water)[1]. It was thought of interest to investigate in more detail the effect of excess counter ions.

The ellipsoid method[2], which permits measurements with solutions with comparatively high electric conductivity, was used for the determination of dielectric constants, which were made at various frequencies in the range 30 Mc./sec. to 30 kc./sec., so that the dispersion curve due to the solute(s) was obtained in each case. From this the dielectric con-

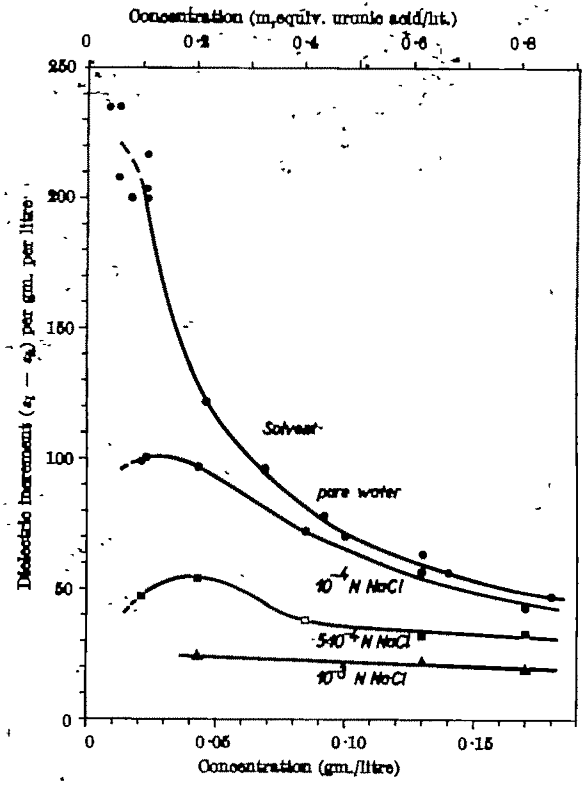

Fig. 1. Dielectric increment per gm. per litre of sodium alginate in water and at various sodium chloride concentrations. pH about 6

stant at high frequencies (ϵ_h) and low frequencies (ϵ_l) relative to the dispersion region was obtained graphically. The difference between ϵ_l and ϵ_h is the increment used for further calculation.

Fresh solutions of sodium alginate (purified by high-speed centrifuging and dialysis, freeze-dried, number average molecular weight approximately 50,000)[1] in pure water were investigated during the time interval 2–8 hr. after dissolution. Solutions in 10^{-4}, 5×10^{-4} and 10^{-3} *N* sodium chloride were prepared by dilution from 0·04 per cent alginate stock solutions in the respective solvents. Stock solutions were stored at approximately + 4° C. and the dilutions were examined during the time interval 1–3 days after preparation of stock solution. Sodium alginate was used in the concentration-range 0·01–0·2 gm./litre.

The results obtained are shown in Fig. 1. The dielectric increment has been given as the reduced quantity, increment per gm. per litre, I_{ϵ}. With most proteins and simple dipolar ions studied[2] the increment in pure aqueous solution is a linear function of concentration and thus I_{ϵ} is a constant. With polyelectrolytes this is not the case, and the considerable increase of I_{ϵ} for alginate in pure water with decreasing concentration is a typical finding. If the increment is assumed here simply to be a reflexion of the net (negative) charge of the polyion, then the qualitative interpretation of the shape of the curve in pure water is a decreased polyion – counter ion association with decreasing concentration of polyions. At very low concentrations, namely, less than 0·02 gm./litre, I_{ϵ} tends towards a constant value (although the errors of measurement are high at the lowest concentrations: approximately ± 20 per cent at 0·01 gm./litre as compared with approximately ± 3 per cent at 0·1 gm./litre). This implies that at concentrations lower than 0·01 gm./litre, the (negative) charge of the polyion approaches its maximum value and thus the interaction between polyions and counter ions approaches complete disassociation. The increment will then be a linear function of concentration.

When the solvent contains small amounts of sodium chloride, the higher the sodium chloride content the lower will be the dielectric increment. In accordance with the above argument, this is due to the electrostatic screening of the excess of counter ions, that is, a decrease of the net charge of the polyions with increasing counter-ion concentration. With 10^{-4} and 5×10^{-4} *N* sodium chloride, the curve shows a maximum, which is displaced towards higher polyion concentration with increasing counter-ion concentration. This effect may be interpreted as being due to the competing actions of increased screening with increased counter-ion concentration, leading to a decrease of the increment, and the tendency towards a higher I_{ϵ} value with decreasing polyion concentration, as stated above. The former effect will prevail at polyion concentrations lower than those of the maximum of the curve. At the maxima the concentration of polyions and counter ions is of about the same order on the basis of equivalents per unit volume.

With the highest sodium chloride concentration studied, 10^{-3} *N*, I_{ϵ} approaches a constant value. Thus polyion – counter ion association occurs at all concentrations and the net charge of the polyion approaches zero. At this concentration of counter ions there is still a residual increment. Unfortunately, it does not seem possible with present methods to make dielectric measurements at higher simple electrolyte concentrations than approximately 10^{-3} *N*.

Towards higher polyion concentrations all the curves show a tendency to extrapolate to a common and constant value of I_{ϵ}. This corresponds to the state just mentioned, due to the prevalence of polyion – counter ion association.

In the region of low concentration studied here, the results are in general agreement with those obtained in other studies of polyelectrolytes[4]. My curves show striking resemblance to curves obtained when plotting reduced viscosity vs. concentration for a number of polyelectrolytes under similar experimental conditions[5]. A similar interpretation to that given here for the dielectric increment has been given for the electroviscous effect.

Thanks are due to Alginate Industries, Ltd., England, for the gift of a sodium alginate sample ("Manucol SS/LH 30591") and to the Karolinska Institutet and the Thérèse and Johan Andersson Foundation for financial support.

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July 17.

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FORTHCOMING EVENT

Monday, December 20

Operational Research Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Meeting on "The Accuracy and Function of Time Study".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant, Grade B (with an honours degree in mathematics or engineering, and with suitable teaching experience), in the Department of Mathematics—The Registrar, College of Technology and Commerce, The Newarke, Leicester (December 28).

Principal Scientific Officer (with a first- or second-class honours degree in mechanical or chemical engineering or equivalent qualification, and some postgraduate research experience), at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a research team investigating heat transfer in heat exchange plant—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4401/54 (December 29).

Principal Scientific Officer (with a first- or second-class honours degree in engineering or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to initiate research into fundamental factors underlying the wear and lubrication of internal combustion engines, using modern techniques (e.g., radioactive tracers)—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4405/54 (December 30).

Analytical Chemist (with a degree in chemistry or equivalent qualification, and preferably with experience in analysis of compounded materials) in the Plant Protective Chemistry Section, for work which will consist mainly of analysis of spray materials and residues—The Secretary, East Malling Research Station, near Maidstone, Kent (December 31).

Assistant Experimental Officer (with a pass degree (chemistry or botany), or at least the general certificate of education at advanced level), in the Chemistry Section, to work mainly on the effects of crop residues on the soil—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (December 31).

Chemical Engineer, Senior Scientific Officer grade (with a first- or second-class honours degree in chemical engineering or equivalent, and postgraduate experience in development work, including design of pilot units), at a Ministry of Supply Establishment located in S.W. England, to be concerned with the development of chemical processes involving semi-technical research and design and operation of pilot units—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.806/54A (December 31).

Chemist (with a first- or second-class honours degree or equivalent qualification in chemistry, and preferably with postgraduate experience in physical analytical methods, micro-analysis, chromatography, corrosion of metals or biochemistry) at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to take charge of a chemical laboratory, and work on chemical and biochemical problems associated with the study of deterioration under tropical conditions of materials and stores of all types—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.816/54A (December 31).

Laboratory Technician in the Department of Chemistry, Potchefstroom University for Christian Higher Education, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, December 31).

Physical Chemist (with at least a good honours degree) for investigation on macromolecular substances of biological origin by physical methods—The Chester Beatty Research Institute, Fulham Road, London, S.W.3, quoting "Physical Chemistry" (December 31).

Physicists and Chemists, to carry out research into glass-making problems—The Secretary, British Glass Industry Research Association, "Elmfield", Northumberland Road, Sheffield 10 (December 31).

Physicist or Electrical Engineer (with a knowledge of electronics, and preferably familiar with electrical instrumentation and measurement techniques), for recording work on rocket motors; and Physicists or Mechanical Engineers for (*a*) experimental and theoretical work on the development of components for liquid and solid propellant rocket motors, and (*b*) for work on heat transfer problems in rocket motor nozzles, at the Royal Aircraft Establishment, Rocket Propulsion Department, Westcott, Bucks—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.346/54A (December 31).

Assistant Experimental Officer (science graduate) to do chemical analysis associated with grassland and other research—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (January 1).

Engineer (with a good honours degree in mechanical engineering or equivalent professional qualifications, proved research ability and preferably experience in the field of the strength of materials), at the Central Research Establishment, National Coal Board, to lead a group carrying out research on coal cutting—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/891 (January 1).

Research Fellow in Radiation Biology, and a Research Fellow in Biochemistry—The Clerk to the Governors, St. Bartholomew's Hospital, London, E.C.1 (January 1).

Research Worker (with a university degree, preferably in forestry, and with some practical forestry and research experience), to undertake a special study of the problem of planting mining refuse heaps in Scotland—The Secretary, The University, Edinburgh (January 1).

Lecturer (with a good honours degree) in Physics, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (January 3).

Mathematicians (with a first- or second-class honours degree in mathematics) at Ministry of Supply Research and Development Establishments in Southern England, for work on a wide range of problems chiefly concerned with aircraft, radio and radar equipment and armaments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.355/54A (January 7).

Physicist (with a good honours degree in physics, and at least two years experience in radiological physics), at the Combined Military Hospital, Rawalpindi, Pakistan—The Recruitment Officer, Education Division, Office of the High Commissioner for Pakistan, 39 Lowndes Square, London, S.W.1 (January 7).

Chair of Physical Metallurgy—The Registrar, The University, Sheffield (January 8).

Scientific Officer (with a first- or second-class honours degree in an approved scientific subject or other approved equivalent qualification, and preferably with previous industrial experience) in the Department of Industrial and Forensic Science of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast, N. Ireland (January 10).

Principal Scientific Officer (with a first- or second-class honours degree in mathematics, physics or engineering, or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to lead a team preparing tables of thermodynamic properties—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4402/55 (January 18).

Principal or Senior Scientific Officer (with a first- or second-class honours degree in physics or physical chemistry or equivalent qualification) at the Radio Research Station, Department of Scientific and Industrial Research, Ditton Park, Slough, Bucks, to lead a small, but expanding group investigating the fundamental electrical properties at high frequencies of materials of interest in radio applications and the relation of these properties to their physical and chemical structure—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4399/55 (January 20).

Research Assistant (with a first- or good second-class degree in botany or geography, and with ecological or physiographical interests) in Zoology, for work on *Spartina* colonization of coastal areas—The Secretary and Registrar, The University, Southampton (January 31).

Lecturer (graduate in science or agricultural science) in Botany at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 1).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary, The University, Edinburgh (February 14).

Lecturer in Inorganic and Physical Chemistry—The Secretary, The University, Edinburgh (February 28).

Assistant Conservators (with either a degree in forestry or an honours degree in natural science, with botany as a special subject) of Forests, in the Gold Coast Local Civil Service—Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.61/12/02.

Assistant Lecturers, Grade B, in the Department of Chemistry and Applied Chemistry—The Principal, Royal Technical College, Salford, 5.

Cytologist, for chromosome studies—The Sherardian Professor of Botany, The University, Oxford.

Entomologists (with an honours degree in zoology, and training in entomology) in the Department of Tsetse Control, Gold Coast Local Civil Service, to investigate various aspects of the bionomics and ecology of tsetse flies in relation to man and animals, and to supervise control measures under the direction of the Director of Tsetse Control—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.77/12/01.

Laboratory Assistant (with a general degree in science or agriculture, with main interest in chemistry, or an honours degree in chemistry) in the Department of Agriculture, Kenya, to carry out investigational work on problems of agricultural chemistry related to coffee culture—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.63/7/09.

Laboratory Technician (with experience in the use of routine apparatus, and preferably with biochemical or chemical training) in the Physiology Department—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

Lecturer (graduate in chemistry or biochemistry and experience in the food industry, preferably in the technology of edible oils and fats or of cereals)—The Registrar, National College of Food Technology, Cranwood Street, City Road, London, E.C.1.

Master to teach Biology to Scholarship level—Headmaster, Downside School, Stratton-on-the-Fosse, Bath, Somerset.

Mathematical Physicists (with a first- or second-class honours degree in mathematics or physics, together with some years appropriate postgraduate research experience), for work in one of the following fields: astrophysics, fluid dynamics, nuclear physics or statistics—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 283/WGE/2.

Physicist (with an honours degree, and an interest in classical physics, fluid mechanics and statistical analysis) to work with a small team engaged on a long-term study of the principles of operation of paper-making machines, and, in particular, of fluid flow of pulp suspensions—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

Research Assistant (female) (preferably B.Sc. (bacteriology)), for duties concerned with research on serology of viruses—The Secretary, Foot-and-Mouth Disease Research Institute, Pirbright, Surrey.

Research Assistant (Ph.D. standard), for work on reaction kinetics at gas-solid interfaces—Dr. Tomkins, Imperial College, London, S.W.7.

RESEARCH ASSISTANTS (with a higher or ordinary national certificate in science, technology or engineering, Inter.B.Sc., or equivalent qualification) IN THE FUEL TECHNOLOGY SECTION of the Physics Department—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Fuel Technology".

TECHNICIAN (with G.C.E. advanced level in mathematics or physics), for work in the isotope laboratory—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

REPORTS and other PUBLICATIONS

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THE NATURE CONSERVANCY

WHEN attention was directed to the work of the Nature Conservancy in an adjournment debate in the House of Commons on October 22, the two principal points stressed were the importance for the work of the Conservancy of both adequate finance and of public understanding. Those are likewise the two major points emphasized in the report of the Conservancy for the year ended September 30, 1954*, apart from the summary of the revised scientific programme of the Conservancy. During the past year, most of the remaining major gaps in the first stage of building up its organization and working arrangements have been filled; and for England and Wales the initial reconnaissance and listing of sites of special scientific interest have been finished, though the greater part of Scotland remains to be tackled, with the exception of the Central Lowland countries, where most threats to sites of this character arise. The Conservancy's two research stations and its two field stations were manned, fitted out and in almost full operation in time for the spring and summer field-work programme of 1954, while with the removal to the new London headquarters in Belgrave Square the important supporting services, notably the library and those for documentation, maps and photographs, came into fuller operation.

Owing to the long-term nature of the Conservancy's research work, the full results of these developments will not be felt for some years; but meanwhile administrative reorganization has permitted extensive decentralization, considerable progress has been made in identifying recurrent problems and in formulating appropriate procedures and policies to facilitate quick decisions, and the rate of declaration of national nature reserves, though still too slow, has improved. During the year, the number rose from 11 to 12, the acreage increasing from 22,497 to 71,152, chiefly through the 39,689 acres of the Cairngorm Reserve declared in July 1954. The entire programme of proposed nature reserves and the arrangements for dealing with them are at present under critical and detailed review by the Nature Conservancy.

Already in last year's annual report the Conservancy suggested that finance had become the main limiting factor in its activities. We are now told that, owing to financial stringency, works for the safeguarding and maintenance of existing nature reserves in Britain have had to be cut far below a reasonable minimum, and that in the current financial year severe economy will have to be exercised in respect of all the Conservancy's activities to keep within a financial provision which, in the debate on October 22, Mr. J. R. Bevins put at about £200,000. In the year ended March 31, 1954, actual expenditure, according to the present report, was £181,602 against a grant-in-aid of £125,000, and capital expenditure £34,038 against a grant-in-aid of £15,000, the difference being covered by a balance of £24,686 carried over from the previous capital account. For the six months ended September 30, 1954, expenditure was running close to estimate, and the Conservancy emphasizes that this situation affects the transport and supply of equipment and stores for its research stations and restricts well below the desirable level the award of postgraduate studentships and of grants for scientific work. It also embarrasses land management by compelling the Conservancy to postpone the fencing of reserves and long overdue woodland operations.

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* Report of the Nature Conservancy for the year ended 30th September, 1954. Pp. iv+55+4 plates. (London: H.M. Stationery Office, 1954.) 3s. net.

The Nature Conservancy is emphatic on the seriousness and urgency of the financial situation. The consequences are fairly and clearly stated, and the argument is the more impressive for the moderation and restraint with which it is advanced. There is no attempt to ignore the stringency of the national economic position or the possibility that conditions at present may not allow the present budget of the Conservancy to be increased; equally, the nation is left in no doubt as to the seriousness of the consequences that may then ensue.

Those consequences in two respects are parallel with those which followed the present Government's, and its predecessor's, parsimony towards the National Parks Commission. First, the acquisition of reserves will be so retarded that a number of irreplaceable sites of the greatest national scientific importance will be irretrievably lost. Moreover, the maintenance and bringing into good order of existing reserves will also be crippled, so that deterioration, both scientific and economic, cannot be avoided. Secondly, the advisory and educational work of the Conservancy, which could be of great value to farmers and foresters, sporting interests, schools and universities, will have to be curtailed or postponed indefinitely.

The importance of both the acquisition of reserves and their educational function, which like the financial situation in general was emphasized in the debate in the House of Commons on October 22, can only be fully appreciated against the context of the general situation in Britain in regard to the use of land. With the increase in population and of production, of mobility and of the claims of defence, the pressure on hitherto untouched land, which was already acute during the War, is becoming even greater. Probably few appreciate the extraordinary number of conflicting claims on individual sites, the amount of man-power used by both central and local authorities in examining and deciding on such claims, and the consequences of the Government's sustained refusal to ensure that Departments are not allowed to be the sole judges of their own causes. The Conservancy testifies to the immense amount of helpfulness and fairmindedness encountered among those concerned with the reconciliation of conflicts of interest over the use of land; but the very admission that there is no simple way of reconciling such conflicts enhances the need for clear and widespread public understanding of the purposes and functions both of the National Parks Commission and of the Nature Conservancy.

But there is a further reason why such educational work should be vigorously carried out by the Nature Conservancy, and one of particular interest to the scientific worker. The function of the Nature Conservancy is not primarily that of conservation or preservation. It is a research or experimental organization of the first importance, and its expenditure should be reviewed as part of, and alongside, the national expenditure on scientific research as a whole. Even its educational work has also an important scientific bearing. One consequence of inability of the Conservancy to employ a sufficient proportion of young scientists who have been trained and to provide them with the necessary technical assistance, equipment and transport to the isolated field sites where much of their work has to be done is, as the report notes, loss of the full fruits of the long-term postgraduate training policy already initiated, and under which ten studentships were awarded during the year and thirty-four were currently in force.

Here again the lower number of awards is attributed to financial stringency and to the rising cost per student. It is the more appropriate, accordingly, that the Conservancy should report direct to the Lord President of the Council irrespective of his membership, *ex-officio*, of the Committee of the Privy Council for Agricultural Research and Nature Conservation. The Conservancy has done well also to include in the present report a summary of the revised scientific programme which has resulted from a thorough review of all existing and proposed research projects, with the object of concentrating effort where it promises the best results, having in mind the scarcity of resources. As a direct outcome of this, the report presents a concise picture of the Conservancy's actual and potential contribution to ecological research which is admirably designed to enlist the understanding and support of scientists generally, whether they are themselves engaged in such work or in related fields or not.

The survey work of the Conservancy aims at acquiring knowledge about every site of scientific interest in Great Britain, a good deal more about sites selected as of major importance (including national nature reserves) and a vast amount on a limited number of sites specially adapted for research. For every nature reserve a reserve record is kept, containing large-scale maps, air and ground photographs at different dates, species lists and censuses, ecological surveys, climatic observations, soil and geological data, historical records, accounts of management operations, and, for all woodland reserves, a vegetation survey and a sylvicultural plan. The work of the Conservancy's scientists is concentrated on reserves or other specially selected sites on which survey is complementary to a programme of research. A more extensive survey programme in Scotland, which is mapping the distribution of the remaining native woodland, will provide a clearer picture of the woodland cover of Scotland, most of which was destroyed by felling and burning; and the Conservancy's research on Scottish mountain vegetation seeks to analyse and describe important areas in greater detail than hitherto attempted and to investigate the effects of such factors as sheep-grazing and snow cover on the distribution and composition of the plant communities. In the south of England a survey across Kingley Vale and Old Winchester Hill Nature Reserves and the proposed nature reserve at Lullington Heath is designed to afford valuable information both on the relations of the vegetation to soil, slope and exposure and on the changes, already noticeable at Lullington Heath, which may ensue when rabbit populations have been greatly reduced by myxomatosis.

To facilitate the availability of results so collected, the Conservancy is also studying appropriate systems of documentation, and has assisted the Botanical Society of the British Isles in compiling an atlas of plant distribution. Close touch is maintained with other ecological research proceeding at the universities, in independent institutions or under official organizations, and the possibility of overlapping is kept constantly in mind. Reference was made in the House of Commons debate to the investigations on myxomatosis and the effect of using chemical spraying for the control of weeds in roadside verges and hedgerows, and to the work on the technique of stabilizing shifting coastlines by means of appropriate vegetation which the Conservancy has resumed at Bridgwater Bay. Like the study of the vole plague in the Forestry Commission's plantations in the Carron Valley, Stirlingshire, or that on the ecology of high-level grasslands with special reference to the grazing factor now being initiated on the Moor House Reserve, these investigations represent as yet a comparatively slight proportion of the Conservancy's scientific effort compared with that expended on the study of woodlands.

That study was the earliest line of research to be developed by the Conservancy. Carried on with the co-operation of the Forestry Commission and largely on Forestry Commission land, it has involved detailed study of soil conditions in relation to a wide variety of species of trees. It has provided a sound basis for assessing the biological productivity of different types of woodland, and has opened up, for example, possibilities of comparing reliably the sustained yield capacity of a given site under different types of afforestation and under different types of cultivation or livestock rearing. The scientific investigations have now been extended to the district around Merlewood, as well as Gisburn Forest, Ennerdale, Roudsea Wood and Witherslack Wood, and Thetford Chase. Studies of soil conservation and afforestation have been extended to peat soils in North Wales and to a Cotswold locality on the Great Oolite, while on the Beinn Eighe Reserve experimental research on the restocking and extension of the wood by natural vegetation includes also the collection of data on the possible structure and dynamics of natural pine forest under Scottish conditions and fundamental studies on the autoecology of the pine.

The bearing of this extensive programme on Britain's economy is obvious; but the Conservancy also points out that in dealing with woodlands no hard-and-fast line can be drawn between survey, research and scientific management. Conservation may involve anything between leaving an untouched wilderness alone and carrying out a comprehensive programme of cautious and flexible modifications of the conditions produced by human interference. In all the Conservancy's woodlands, the first step is reconnaissance and primary survey, followed by the drawing up of a scientific basis of management and by more intensive survey and experimental work. Moreover, at Merlewood a distinct but related line of attack aims at describing the soil fauna associations in different types of local woodlands and studying the role of this fauna in the breakdown of litter and in its incorporation into the forest soils.

Perhaps the most impressive feature of the whole report is not so much the economic and scientific importance of the varied work which is already being carried out by the Conservancy, but the extent of the effort that has been possible within the slender resources available to the Conservancy. Even in the present financial stringency, it seems clear that the nation cannot afford to curtail the activities of the Conservancy, or to incur the risks which are involved if the Conservancy is unable to accelerate its acquisition of reserves and to extend its scientific work. But the question as to the proper financial appropriation for the work of the Conservancy should be considered not in isolation but in the context of the national expenditure on scientific and industrial research as a whole. In relation to an expenditure on civil research, estimated by Mr. J. R. Bevins as of the order of £20 million, an expenditure of £200,000 seems small enough, apart from the important returns in forestry and in agriculture alone which it is already yielding.

The point is one to which the attention of the Advisory Council for Scientific Policy might well be directed, and it should not escape that of the Parliamentary and Scientific Committee. There is a further reason for hoping that the debate on October 22 will stimulate that Committee to take up some of the points raised by the present report of the Nature Conservancy. The potential value of its scientific, educational and other activities is as yet understood and accepted only by an informed minority; yet the effectiveness of some of those activities depends largely on co-operation by local authorities and other bodies as well as by private individuals. There is need, as the Conservancy recognizes, not only to demonstrate this value by tangible results, but also to bring it home to wider circles by effective publicity.

Some of this educational work and publicity is being undertaken by the Conservancy itself, but it is limited by the slender financial resources. It needs to be supplemented by much voluntary work, and the present report supplies material which the scientist could easily use to extend the general understanding of the work of the Conservancy and its national importance. Here in particular the Parliamentary and Scientific Committee could render powerful support, and especially by promoting the fuller and clearer understanding by Parliament of the economic and scientific importance of the work of the Conservancy.

RATIONALISM AS A CREED

Human Society in Ethics and Politics

By Bertrand Russell. Pp. 240. (London: George Allen and Unwin, Ltd., 1954.) 15*s.* net.

WE are told on the dust jacket of this book that, as Bertrand Russell fully subscribes to Hume's view that "Reason is and ought only to be the slave of the passions", it is unfair to criticize him, as many have done, on the ground that he over-estimates the part which reason is capable of playing in human affairs. The present book certainly affords evidence on which the first part of this statement can be based; but we are left in doubt after we have read it whether Russell has worked out for himself a new view of the relation between reason and emotion, or whether he is merely a somewhat repentant rationalist undergoing an attack of second thoughts.

The starting-point of his ethical argument is the assumption that it "differs from scientific argument in being addressed to the emotions" and that the basis of ethics is "emotion and feeling". But this is the last concession that Russell makes to his critics, for he seems to be unable to explain how it is that man is guided by his feelings to distinguish the good from the bad, and assume an obligation to do right rather than wrong. One might suppose from what he says in his more cynical or depressed moments that man's instincts lead him to a course of action in the opposite direction. "There is no limit", he says, "to the horrors that can be inflicted by a combination of scientific intelligence with the malevolence of Satan. . . . Human imagination long ago pictured Hell, but it is only through recent skill that men have been able to give reality to what they imagined. . . ."

It is true that Bertrand Russell concludes that "the bright vault of Heaven" and the "dark pit of Hell" are equally "natural" to the human mind. But he has little to say on the question why it may be hoped that man will seek one and avoid the other. Religious instruction is rejected by him as it fosters "dogmatic beliefs", in the decay of which he can see "nothing but good". "What the world needs", he says, "is not dogma, but an attitude of scientific enquiry, combined with a belief that the torture of millions is not desirable, whether inflicted by Stalin or by a Deity imagined in the likeness of the believer".

To find a source for true belief of this kind, Russell is thrown back on reason once more, despite all his protestations that it is "not a cause of action, but a regulator". The only thing he can find to "redeem mankind" is "co-operation", the first step towards which "lies in the hearts of individuals". It is usual to wish oneself well, but "wishing well to oneself", he argues, "is sure to be futile unless it is combined with wishing well to others", and it is therefore evident to him that this should be made the basis of practical politics. The unhappy truth is, however, that arguments of this kind have not appealed to many of the more destructive politicians of our times, and it is this central problem which Russell has left unsolved.

However, he goes on to claim, it will pay us to be good, in the long run. "It is obvious to every person capable of free scientific enquiry that the doctrines of Lysenko are less likely to increase the wheat supply of Russia than those of orthodox geneticists are to increase the supply of the West. I think it is also very doubtful whether nuclear research can long continue to flourish in such an atmosphere as Stalin produced in Russia." Or, as Gibbon put it, the "gradual advance (of barbarians) in the science of war would always be accompanied, as we may learn from the example of Russia, with a proportionate improvement in the arts of peace and civil policy, and they themselves must deserve a place among the polished nations whom they subdue". Thus do the minds of great rationalists think alike.

It is not, however, on grounds of logical inconsistency that Bertrand Russell's work is most open to criticism. The plain fact is that the rationalism on which it rests does not attract the minds of more than a handful of the young men and women in our universities to-day, who are faced with the responsibility of deciding the critical issues of their lives in the years that lie immediately ahead. Rationalism is a dead creed for them, despite current attempts to accept emotion as well as reason as a significant influence in our lives. It has not yet been replaced in the Western world by anything that stands the tests of criticism and experience, and the younger generation of thinkers must be regarded as facing the intimidating task of discovering a new philosophy and a new faith, or rediscovering an old one.

T. S. SIMEY

NUCLEAR SCIENCE IN PHYSICS, CHEMISTRY AND BIOLOGY

Annual Review of Nuclear Science

Edited by James G. Beckerley. Vol. 3, 1953. Pp. x+412. (Stanford, Calif.: Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences, 1953.) 7 dollars.

THIS third volume of "Annual Reviews of Nuclear Science" is the first one for which the editors and the editorial committee of the Annual Reviews, Inc., Stanford, California, are fully responsible. Its policy is evident by the wide field of subjects covered, ranging from reactions of π-mesons with nucleons to vertebrate radiobiology, histopathology and carcinogenesis. Of 392 pages, about 190 are devoted to physics, 80 to chemistry and 120 to biological subjects. The laudable aim as expressed by the editors is to give the 'nuclear scientist' a chance to keep up with the whole field provided he knows the 'fundamentals'. But how does the harassed physicist find time and energy to read it all when the flood of information in his own specialized field is getting larger and less manageable every day? In addition, there are more reviews being published by the American Physical Society, the Physical Society (of Great Britain), "Progress in Nuclear Physics", etc.; these are summaries which the physicist can scarcely neglect and which he may even purchase. He falls into the serious danger of having no time to think for the reading. Does he choose the "Annual Reviews of Nuclear Science" series as an additional source of information if he has to pay 7 dollars? It all depends on the quality: one well-balanced, crystal-clear survey written with didactical virtuosity will go far to convince the hesitant buyer to part with the cash. If, however, he comes across a contribution consisting only of a formidable string of succeeding abstracts of papers, he will put his money back into his pocket. It follows that the author has to have plenty of leisure to read the original publications, to digest it all—a notoriously slow process—and then to set down in good English the rectified distillate of his mental exertions, arranged in a manner logical in its sequence and revealing in its sub-sections. An author who does all that and gets it out by the appointed date is an exception.

The present volume does not do badly in some sections. I liked the summary on reactions of π-mesons with nucleons, by E. M. Henley, M. A. Ruderman and J. Steinberger, because the theoretical formalism is lucidly exposed and the experiments chosen for discussion are relevant to our endeavour to understand nuclear forces. Mesons and heavy unstable particles in cosmic rays, by Louis Leprince-Ringuet, is clear and helpful in the maze of 'new events'. A timely and, I feel, important article on extra-nuclear interactions of electrons and gamma-rays comes from D. R. Corson and A. O. Hanson; it is satisfactory to know that all is happy in the interaction of electrons with electromagnetic fields, at least as long as one is satisfied with the degree of accuracy of experiment and theory, admittedly undesirably low in some cases. Neutron optics, by D. J. Hughes, and a good survey by A. Wattenberg on standardization of neutron measurements follow. Photographic emulsions, by Y. Goldschmidt-Clermont, and radiation dosimetry and protection, by L. D. Marinelli, complete the articles on physics, the latter containing a rather good survey and useful graphs for practical purposes. The chemical field is covered by J. L. Magee on radiation chemistry (very clear exposition), chemical effects of nuclear transformations (J. E. Willard), separation techniques used in radiochemistry (P. C. Stevenson and H. G. Hicks) and isotope effects in chemical reactions (P. E. Yankwich). The volume concludes with vertebrate radiobiology—embryology (R. Rugh) and histopathology and carcinogenesis (J. Furth and A. C. Upton); cellular radiobiology (A. H. Sparrow and J. Forro, jun.); and practical aspects of radiation injury (L. H. Hempelmann and J. G. Hoffman).

The production of the volume seems satisfactorily fast: most of the surveys of the literature were concluded during March–July 1953.

E. Bretscher

THE UBIQUITOUS ALDEHYDE

Formaldehyde

By J. Frederic Walker. Second edition. (American Chemical Society Monograph Series.) Pp. xvi+575. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 96s. net.

THE prodigious expansion of chemical knowledge and technology is well illustrated by the fact that it takes more than five hundred pages to present "the salient facts and theories" of the chemistry of one organic compound. Ten years only have elapsed since the first edition of "Formaldehyde" appeared, but there is every justification for bringing it up to date. During that decade, the production of formaldehyde in the United States has nearly doubled, improved methods of manufacture have been introduced, its uses have multiplied, and its chemical frontiers have been considerably extended. War-time developments fostered a marked expansion in the uses of formaldehyde, particularly noticeable being the increased volume used for chemical syntheses outside the synthetic resin industry, which is still the major consumer.

In the new edition two chapters out of twenty-one are devoted to the uses of formaldehyde, its polymers and hexamethylene tetramine; the rest deal with production, properties and chemical reactions. This allocation will please some, but disappoint others. It is very doubtful whether workers in the plastics field would agree that less than twenty pages are adequate to discuss the important role of formaldehyde in their industry. However, in defence of the author it must be pointed out that the fundamental chemical reactions on which the industry is based are very ably dealt with under the reactions of formaldehyde, and, furthermore, numerous recent reference books covering the industrial and technological aspects are available. The treatment of formaldehyde production in the opening chapter represents a very marked improvement over the somewhat paltry discussion in the original volume. The five chapters dealing with the physico-chemical properties of the monomeric aldehyde, its vapour and solutions, contain a wealth of data which will prove invaluable to chemists and chemical engineers.

A welcome addition is a section on toxic hazards and safe handling. Polymer formation, one of the most characteristic properties of formaldehyde, receives full and authoritative treatment, but it is surprising to find the term trioxymethylene, which the author admits to be an erroneous designation for paraformaldehyde, still being used synonymously on several occasions. The two chapters on the qualitative and quantitative analysis of formaldehyde, its polymers and solutions are extremely good. Although a distinct chemical entity, hexamethylenetetramine may be regarded as a special form of formaldehyde, since it behaves as formaldehyde in many of its reactions and therefore rightly deserves special mention. Its general reactions, including nitration, are reviewed, but unfortunately the reader is referred elsewhere for details of the complex and interesting chemistry associated with the war-time development of the high explosive *RDX*. A valuable addition to the new volume is a chapter on the reactions of formaldehyde with heterocyclic compounds.

The monograph is not claimed to be exhaustive, and it is not surprising, therefore, to find a few minor omissions; for example, there is no reference to the reaction of formaldehyde with chloral. What is surprising, however, is to find a major industrial use of formaldehyde for the synthesis of glycollic acid, ethylene glycol and methoxymethoxyethanol dismissed at the mere mention and with no more than a brief reference to the patent literature for details of the basic reaction with carbon monoxide. Admittedly, this is a fairly recent industrial development, but the omission is all the more remarkable because the author's own company was responsible for it and since an earlier monograph in this series (No. 114, "Glycols", 1952) gives prominence to it.

A critical selection of references is appended to each chapter, and a comprehensive index at the end. The latter is not without minor blemishes—qualitative analysis is listed for quantitative, and there are some minor lapses of nomenclature. The selection of photographs adds little to the value of the book.

Let these remarks not be construed to mean that this book has not fully maintained the very high standard we have come to expect from the American Chemical Society Monograph Series. This new edition, despite its high price, will be generally welcomed and will inspire chemists to probe still further into the almost endless ramifications of the chemistry of this ubiquitous and versatile aldehyde.

J. Idris Jones

The University of Utopia

By Robert M. Hutchins. (Charles R. Walgreen Foundation Lectures.) Pp. ix+103. (Chicago: University of Chicago Press; London: Cambridge University Press, 1953.) 19s. net.

In this brilliant sketch of the imaginary University of Utopia, Dr. Robert M. Hutchins's avowed purpose is not so much to describe the educationa system of Utopia, of which that university forms the apex, as to depict the hazards to education in the United States and the means by which these hazards may be reduced or eliminated. Chief among them are those arising out of industrialization, specialization, philosophical diversity in relation to the formation of a community, and social and political conformity. These are discussed with wit and shrewdness in four successive chapters representing lectures delivered at the University of Chicago in the spring of 1953. He has returned to some of his criticism of the American universities in lectures on the idea of an American university delivered in Great Britain last autumn, but those lectures are likely to encourage his hearers to read this book.

Although the American university is the main target of his criticism and his fourth chapter in particular is as courageous and forthright a defence of academic freedom and responsibility as is to be found in Prof. Commager's recent book, with which it may be fittingly compared, the book abounds in common sense, in aphorisms, in hard thrusts and asides which will delight the British as much as the American reader. His characterization of the custodial system resulting from the infringement of academic independence as 'adolescent-sitting' may no more commend itself in some quarters than did a certain bishop's proposal to a Lambeth Conference to entitle a conference report on education "Childhood by Second-Childhood". The value of the book, however, does not lie in its occasional astringencies but in the clarity with which it lays bare the fundamental issues involved in deciding what are the functions of a university in the world to-day. The important questions are asked, the essential principles are stated and all concerned with the application of these principles in the expansion of university and technological education in Great Britain, or with the wider question of adult education and the defence of freedom, can read these pages with profit as well as pleasure. R. Brightman

Physical Constants of Hydrocarbons

Vol. 5: Paraffins, Olefins, Acetylenes and other Aliphatic Hydrocarbons. (Revised Values.) By Gustav Egloff. (Monograph Series No. 78.) Pp. ix+524. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1953.) 160s. net.

This volume supplements the values for the melting points, boiling points, densities and refractive indices of paraffins, olefines, acetylenes and other aliphatic hydrocarbons which were collected in Vol. 1. Best values for the normal boiling points, densities and refractive indices of many compounds are also given. Corrections to Vol. 1 are listed with cross-references.

The general arrangement of the matter in the present volume is rather wasteful of space and is frequently not clear. For example, under melting points the symbol *a* is used approximately two hundred times and is followed by the sentence "(*a*) This constant was given as a freezing point in the literature"; if it were necessary to make this distinction, it would have been simpler to put the symbol F.p. in the table. Moreover, confusion may arise because the symbol *a* is used in the same section for other purposes; for example, on p. 10 it means "This is a calculated value", while it has other meanings on pp. 228, 262 and 270. Further, since *a* may have different meanings on the same page, it will be appreciated that there is room for improvement in the arrangement.

Some idiosyncrasies have been noted. Thus, while the formula for methane is given as CH_4, that of monodeuteromethane is given as CD. Under the heading of the boiling point of methane at 760 mm. of mercury pressure are to be found 170 entries for boiling points covering the pressure range 43,168–4·24 mm. and fourteen entries for sublimation temperatures. The majority of these boiling points are arranged in descending order of pressure, but there are just enough entries out of order to break the sequence. The data on acetylene are misleading because, although this compound does not exist as a stable liquid at 760 mm. pressure, since the triple point is at 962 mm., yet four values for the boiling point at 760 mm. are listed.

Vol. 1 was published in 1939, and it is a pity that the opportunity was not taken in the present volume to include information on properties which have since been recognized as useful in establishing the identity and purity of hydrocarbon samples, for example, infra-red spectra, Raman spectra and cryoscopic constants. However, the cost of this volume is already so high that perhaps it is as well that the book was not expanded. Nevertheless, it contains much collected data, and there is no doubt that many librarians will be pleased to have this book to add to their set in this series.

E. F. G. Herington

Paper Chromatography

By Dr. Friedrich Cramer. Second revised and enlarged edition. (Translated by Leighton Richards.) Pp. xii+124+4 plates. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1954.) 25s. net.

It is to be regretted that, in presenting this second, revised and enlarged edition of his book, the author has included so much subject-matter within such a limited space. The book, which is divided into two sections, is intended to provide a laboratory manual of paper chromatography. The first section deals sketchily and somewhat inaccurately with the history and theory of paper chromatography and then goes on to give a comprehensive and well-illustrated description of the various practical techniques. The newcomer to chromatography will find this portion of the book very useful.

The second section describes the application of paper chromatography to the separation of various groups of materials. The presentation of this portion of the book is unbalanced in that some applications are described in excessive detail whereas others receive only the briefest mention. A large number of useful tables and four hundred references, however, are included. That part of the book dealing with inorganic separations is so condensed and contains so many errors that it is better ignored. The book contains an annoyingly large number of mistranslations and spelling mistakes. R. A. Wells

MOLECULAR SPECTROSCOPY

THE ramifications of molecular spectroscopy in pure and applied physics and chemistry are now so numerous and technical progress is so rapid that frequent conferences about them are not superfluous. By any standard, the two-day meeting arranged during October 28–29 by the Hydrocarbon Research Group of the Institute of Petroleum was a success. By bringing together academic and industrial workers in Britain, and others from several European countries and the United States, a critical review of current problems was possible, and future trends in technique and theory were considered. The topics discussed ranged from the vacuum ultra-violet to the far infra-red, and although many papers were directed towards hydrocarbon chemistry, there was a balanced inclusion of results on a wider scale. So far as analytical work and structural diagnosis are concerned, it is becoming increasingly important to choose the most appropriate of the various physico-chemical methods. A similar choice may now be made between the various spectroscopic methods themselves, which are so often not alternative but supplementary to each other.

Opening the first session, E. J. Bowen (Oxford) made a critical evaluation of fluorescence measurements for industrial analysis and examination. Promising as this phenomenon might appear for the study of aromatic or heterocyclic compounds, great care is needed in its interpretation. Older data are often misleading, for few compounds fluoresce, and the fluorescence is destroyed or affected by trace compounds or other factors. Purity of a solvent, and the method of excitation and of spectral recording are important, and re-absorption of the fluorescence must be considered. There may be a gain in the analysis of oils by prior chromatography, or by low-temperature measurements in a solvent which congeals to a clear glass. Yet more information is required about such processes as 'resonance transfer' whereby one molecule transfers its energy of excitation to another trace compound and induces a fluorescence which may be entirely misleading.

G. Porter and M. W. Windsor (Cambridge) described results of another kind on the fluorescence and phosphorescence of aromatic hydrocarbons. It is known that, when suitably irradiated, as solids in glassy solvents, these substances show, in addition to the normal fluorescence which appears during illumination, a slower re-emission of radiation; the latter is composite, one part having a wave-length identical to the main fluorescence and a temperature-dependent decay, the other being a slower phosphorescence of longer wave-lengths. This phosphorescence has been interpreted in terms of a metastable triplet electronic state into which the molecules pass after initial excitation. By means of their elegant method of flash photolysis, Porter and Windsor have now obtained absorption spectra due to the transitions between the triplet levels for solutions of the hydrocarbons. Some microseconds after the flash, while enough molecules are still in the lowest triplet state, an absorption spectrum is measured, and by adjustment of the time interval the decay of the triplet level has been studied from the absorption-band intensities. From the remarkable effect of the solvent viscosity on the kinetics of the decay process, the nature of the triplet state has been examined. The results obtained by this novel technique may have an important bearing upon the photochemistry of aromatic hydrocarbons and of dyestuffs.

B. F. Dudenbostel (Standard Oil Development Co.) reviewed the present state of Raman spectroscopy. As a result of the Toronto mercury arc, the magnesium oxide reflector and more sensitive uncooled electron multiplier tubes, photoelectric recording appears to have replaced photography. Samples as small as 1 ml. can be used, but suspended dust or traces of fluorescent materials must be avoided. The main advantage of direct recording lies, of course, in the direct determination of line intensities or of integrated areas under the recorded peaks. No generalization can be made about which analytical problems will be more suited to Raman or infra-red work, but the former may find much use with aromatics, especially, perhaps, in the higher-boiling petroleum fractions and also with certain mixtures of olefins. The development of an intense monochromatic source of somewhat longer wave-length, with an appropriately sensitive detector, might extend this work considerably.

A vacuum grating spectrometer with photoelectric recording to 1700 A. was described by R. A. Burdett, L. W. Taylor and L. C. Jones (Shell Oil Co.). An E.M.I. photomultiplier with a thin (1-mm.) quartz window was used. A number of substituted benzenes, polynuclear aromatic hydrocarbons and sulphur compounds dissolved in heptane have characteristically different spectra which can be used for analysis more effectively than those in the normal ultra-violet, especially if some preliminary chromatography is carried out. It would seem that a grating is preferable to a prism in the far ultra-violet and that a better source may be obtained for the region 2100–1500 A. by excitation of xenon with a microwave discharge.

The second session dealt with infra-red technique. V. Z. Williams (Perkin-Elmer Corporation) discussed critically the instruments now available for research and for industrial analytical control. The choice between different spectrometers is now mainly governed by the nature of the problem under investigation. Single-beam instruments, with interchangeable prisms covering a wide spectral range, and a double-pass system to increase resolving power and also to eliminate false energy, have high photometric accuracy and elasticity as regards use with accessories such as the reflecting microscope or long-path absorption cells. Double-beam spectrometers, on the other hand, produce a direct spectral record and eliminate atmospheric absorption, and for routine qualitative work in organic chemistry these factors are important. Also, differential analysis using the double-beam arrangement shows much promise for analytical work. However, the flexibility of double-beam instruments is more limited and their photometric accuracy may be less. For pilot-plant or process control, continuously operating infra-red analysers are now in use for determining common gases in fairly complex mixtures. Some incorporate a small monochromator, whereas others work by non-dispersive principles. Much attention has been given to their long-term stability under rugged conditions. Their sensitivity can be as high as 0·25 p.p.m. In Dr. Williams's view, "to some extent to-day and more certainly in three years, these instruments will have a potential for the field which will be greater than the ability of the field to utilize".

These spectrometric developments do not necessarily imply an increase in instrumental complexity. In fact, there is a trend towards simplification for much of the work. One leading factor is the replacement of prisms by cheap echelette diffraction gratings, and L. A. Sayce and A. Jackson (National Physical Laboratory) described their recent work on replication from a helical matrix cut to high accuracy using the method of the Merton nut. The chief experimental inconvenience of gratings hitherto has been the need for some fore-prism arrangement to eliminate unwanted spectral orders. This difficulty may be removed by use of filters which cut off radiation at the shorter wave-length end. Important advances have occurred here by the discovery that thin layers of silicon, germanium, lead sulphide, coated silver chloride, and other substances have fairly sharp cut-off wave-lengths. More exciting possibilities are suggested by the *F*-centre filters developed by J. Gaunt and W. G. Burns (Harwell). Pohl first showed that when crystals of alkali halides acquire a stoichiometric excess of alkali metal they become coloured as a result of trapping of electrons at vacant lattice sites. Such colour centres can be formed by photochemical, radiochemical or electrolytic methods, but more satisfactory results appear to be obtained by heating the crystals with alkali metals. The conditions of preparation and subsequent cutting and polishing still need further study, but good filters appropriate to all the usual spectral regions have been produced. Their additional value for eliminating false radiation in prism spectrometers at longer wave-lengths is also important. The use of cæsium iodide as a prism material (extending to 52 μ) was described by E. K. Plyler (U.S. National Bureau of Standards), and it can be used as a thin window (2 mm.) out to 65 μ. Its dispersive characteristics from 25 μ to 35 μ are not quite so good as those of cæsium bromide. In fact, all spectral needs for a prism spectrometer in the range 2–40 μ can perhaps now be met by lithium fluoride, rock salt and cæsium bromide.

The pressed disk technique used by Stimson and by Schiedt, in which solids are suspended in sintered plates of alkali halide crystal, is improving rapidly. It reduces scatter of radiation, gives sharper absorption bands, eliminates the Christiansen effect and avoids absorption by any mulling agent. M. A. Ford, G. R. Wilkinson and W. C. Price (King's College, London) described their work on this subject and indicated factors such as particle size or sintering pressure which lead to satisfactory disk formation. Care is needed because of spurious impurity bands or possible slow chemical reactions of the solids, and, before quantitative intensity work can be regarded as reliable, further tests are required. T. S. Robinson and W. C. Price (King's College, London) also described a method for calculating the absorption spectrum of a solid from its reflexion spectrum. The computation is rather elaborate, but may be useful in those cases where the absorption of thin films is still too high, as with polytetrafluoroethylene. If polarized radiation is employed the reflectance data may also be used to determine the directions of certain bonds in a molecule with respect to the crystal axes.

Several papers dealt with the interpretation of vibrational spectra for analysis, vibrational assignment and structural diagnosis. Hitherto, infra-red analysis has usually been made on the assumption of additivity of optical densities at band peaks, using extinction coefficients defined by Beer's law. This method is in reality semi-empirical, since it assumes the use of infinitely narrow slit-widths which pass monochromatic radiation. The extinction coefficients depend markedly upon the spectrometer slit-widths unless the latter are small compared with the band half-widths, and this factor alone may account for our inability to transfer infra-red data from one instrument to another. Integrated band areas have a more absolute significance, especially if they are suitably corrected for the spectrometer characteristics so as to yield the true band intensities. The band areas can be computed in several ways, but there is still uncertainty about the exact function which reproduces the band envelopes. Quite apart from their use for analysis, however, band intensity data may lead to further refinement in structural group identification, and since the intensity is related to the variation of molecular dipole during vibration, they may also tell us something about the bond polar properties. These several aspects of work on band intensities were discussed by H. W. Thompson (Oxford) and illustrated by a collection of data so far available. The construction of simple automatic devices for the integration of band areas during spectral measurement will not be long delayed. Whether, owing to band overlap or for other reasons, the true intensities will prove more valuable than extinction coefficients determined with higher spectral resolving-power, is at present an open question.

Tables of molecular vibration frequencies of substituted benzenes, which appear to depend only upon the positions of the substituent groups and not upon their nature, have been collected together by R. R. Randle and D. H. Whiffen (Birmingham). While there may still be doubt about some of the assignments to specific normal modes, and some of the rules may fail with other substituents, these correlations will be valuable, especially in hydrocarbon chemistry. Similar data were listed by E. D. Kunst (Royal Dutch Shell, Amsterdam) for deutero-aromatics in the region 12–14 μ. H. Lüther (Technical High School, Brunswick) described spectral measurements designed to elucidate the mechanism of oxidation of hydrocarbon oils, using key bands for detection of hydroxyl, ketonic and other groups.

The comparison of vibrational spectra of molecules in different states of aggregation is now leading to important information. This was fully surveyed by N. Sheppard (Cambridge) with particular reference to measurements at low temperatures. The spectral variations observed, and their interpretation, vary according as the molecule is rigid or flexible and also depend upon the coupling of vibrations in the solid lattice. Conclusions have been drawn about the relative stability of rotational isomers and about the assignment of vibration frequencies of long-chain hydrocarbons. In solid nitric acid hydrate there is spectroscopic evidence for the occurrence of the

OH_3^+ ion. The sharpening of bands at low temperatures and other features may find application in certain analytical work; but this may involve some experimental problems, and the formation on solidification of an amorphous glass rather than a crystalline mass may be vital.

Attempts to study reaction intermediates and radicals through their spectra have not, so far, been entirely successful. D. F. Hornig (Brown University) described a new approach in which shock waves have been used to excite molecular species to a 'temperature' equivalent to that of reactions or combustion processes. The time required to induce this excitation—some microseconds—may be much less than the reaction times, and it is hoped, therefore, from spectral emission or absorption to study the subsequent kinetic behaviour of the species. Very fast photographic and photoelectric methods have been used to record spectra of certain radicals produced by passing shock waves into substances such as cyanogen halides or methyl halides, and the progress of such work should be interesting. The identification of radicals in flames by resolution of their vibrational–rotational emission bands was achieved recently by Plyler, Benedict and Silverman. G. R. Wilkinson, M. A. Ford and W. C. Price (King's College, London) have now made similar measurements on emission bands in the region 1–5·5 μ of simple molecules and radicals excited by a radio-frequency discharge in hydrogen halides, methane, water vapour and other gases. This method has definite advantages over absorption measurements in that band sequences are more fully developed, and both the rotational and vibrational constants can be measured conveniently. The results of recent absorption studies on a number of hydrocarbons using very high resolving-power were also outlined by H. W. Thompson. From all these data, more precise values are being obtained, not only for the main molecular rotational constants but also for the centrifugal stretching-coefficients and anharmonic vibration factors.

Among all the above fairly conventional themes, a new note was struck at the meeting—the study of nuclear magnetic resonance—and R. E. Richards (Oxford) illustrated its value by many examples of practical importance. The spin of a charged nucleus gives rise to a magnetic effect, and the associated magnetic vector can be oriented in different ways in an applied magnetic field. These orientations correspond to different quantized energy-levels, between which transitions can take place. For fields of 10 kilogauss the absorption frequency lies in the radio region, 'resonance' occurring between the two levels and different nuclei absorbing at characteristically different frequencies. When interaction occurs between the nuclei and their surroundings—to be exact between their respective magnetic effects—the absorption lines broaden in ways which depend upon the internuclear distances and other structural features. Thus groups such as CH_3, CH_2 or OH can be characterized. Information of the most varied kind, both qualitative and quantitative, can now be obtained, and it is certain that much will result from this new highly sensitive method.

It is clear that there is intense activity in this field. The difficult task of setting up a punched-card system for reference spectra was also discussed, and it is hoped that the committee set up several years ago in Britain to consider this matter may shortly be able to institute a scheme.

H. W. Thompson

FULMER RESEARCH INSTITUTE, STOKE POGES

OPEN DAY

An informal visit was made to the Fulmer Research Institute on November 2 by H.R.H. the Duke of Edinburgh on the occasion of an open day held to mark the opening of the new Mechanical Testing Laboratory of the Institute. After a tour of the laboratories lasting for an hour and a half, during which he pulled the first test-piece in the new 50-ton tensile-testing machine of the Laboratory, the Duke had luncheon at the Institute together with some three hundred guests representing industry and research. In his speech he said that he had always been convinced that the research business was a good investment and that he was interested to have practical proof in an establishment which, without outside support, does indeed make a profit entirely on research. After luncheon the laboratories were open to the other guests, and the scientific exhibits showed in detail some of the work of the Institute during its first seven years of existence.

Following the invention of the catalytic distillation process for refining of aluminium, Dr. P. Gross and his colleagues demonstrated similar studies applied to the extraction of titanium from impure titanium-bearing materials. Laboratory exhibits showed that titanium can be removed from an impure titanium-bearing alloy by reaction with a high-valency halide to form a halide of lower valency in the vapour phase. Disproportionation of the lower-valency halide then gives a deposit of pure metallic titanium with re-formation of the higher-valency halide. In connexion with the work on the purification of both aluminium and titanium, an intensive study is in progress of the reactions which may be involved in these processes, and an important feature of the work is the determination of the heats of formation of metallic halides. The apparatus, which includes dry boxes for handling deliquescent halides and a calorimeter made in the laboratory workshops, was on view. The heat of formation of aluminium fluoride has recently been re-determined by Dr. Gross, and a new value, differing appreciably from that previously accepted, has been established and the results published. The heat of formation of titanium tetrachloride has also recently been determined, but the results obtained are at present confidential to the sponsor. Further work is in hand on the heats of formation of other halides. A recent step forward in Dr. A. H. Sully's work on chromium and its alloys has been the preparation of a ductile form of chromium. Flakes of electrodeposited chromium which are capable of being bent were on view.

In the Physics Section apparatus was set up for studying by X-ray diffraction the structure of liquid metals. This involved the use of Geiger counters in plotting the variation in intensity of X-ray diffraction from a liquid metal surface. Apparatus for measuring the vapour pressure of reactive metals such as uranium was also in operation. Many novel types of camera and a curved quartz crystal monochromator were included in the apparatus for studying the progress of precipitation hardening and the ensuing structural changes. There was an extensive exhibit of the results of such an investigation on the ageing of aluminium copper alloys.

Dr. H. K. Hardy's studies on the thermodynamics of alloy systems and the mechanism of precipitation hardening were also demonstrated, together with the results of recent research on aluminium bronzes and on the aluminium–copper–cadmium alloys. In the Corrosion Laboratory one exhibit indicated the marked influence of directionality of structure on the corrosion and stress-corrosion behaviour of high-strength aluminium alloys. This was correlated with work on the properties of material at the flash line in aluminium alloy forgings where a very high degree of directionality has been observed.

New methods of chemical and spectrographic analysis were demonstrated in the Chemical and Spectrographic Sections. These included a combined chemical and spectrographic method for the estimation of tantalum and niobium in certain soils. Apparatus recently acquired in the experimental foundry includes a vacuum or argon melting furnace in which reactive metals such as uranium and titanium can be arc-melted on to a water-cooled copper hearth. In common with a great deal of other apparatus, this has been constructed in the laboratory workshops. Facilities for metal working included a 60-ton press for powder metallurgical and similar work, a new laboratory rolling mill, a 1-cwt. forging hammer and a small laboratory extrusion press. In connexion with an investigation on the properties of semi-conductors, a technique for melting and casting rods of pure silicon for subsequent purification by zone melting was demonstrated. An exhibit showed work in progress on the development of heat-resisting coatings, and the high-oxidation resistance of steel containing relatively small quantities of silicon and aluminium (3 per cent and 1 per cent, respectively) was demonstrated. Apparatus for the study on a pilot-plant scale of the process for catalytic distillation of aluminium was on view, together with a wide variety of furnaces for heat treatment, including those with facilities for rapid water quenching from vacuum or special atmospheres.

The new Mechanical Testing Laboratory contains a 50-ton Denison tensile compression machine and a thermostatically controlled creep-testing laboratory with seven Denison tensile creep-testing machines of conventional design and four compression-type creep machines. Machines for testing the creep of strip specimens were also in operation in the creep laboratory. Fatigue tests at both room and elevated temperature were in progress, and these included reverse bend tests on sheet specimens, rotating cantilever tests and reversed tension (Haigh) fatigue testing. An interesting exhibit in this section dealt with methods of testing and improving the resistance of aluminium and its alloys to fretting and blackening by abrasion. Work in collaboration with the Department of Colloid Chemistry at the University of Cambridge under the direction of Dr. J. H. Schulman has shown that friction between aluminium surfaces can be markedly reduced by the application of substances forming so-called 'penetrated' monomolecular layers.

The activities of the Institute were described in a booklet which shows that, since 1952, thirty-eight papers from the Institute have been published, or are about to be published, by scientific societies. In the library of the Institute it was shown that, while the research reports of the Institute are confidential to sponsors, a large number of reprints of published papers are available, and a particular feature was the large number of translations, which include many scientific papers translated from the original Russian.

STRUCTURE OF VITAMIN B_{12}

A Crystalline Nucleotide-free Degradation Product of Vitamin B_{12}

IN an earlier paper[1] we have described a detailed study of the course of hydrolysis of vitamin B_{12} under both acid and alkaline conditions. It was found that under rigorous experimental conditions there were produced 1-amino-2-propanol, ammonia, 5 : 6-dimethylbenziminazole-1-α-D-ribofuranoside-2′-(or 3′)-phosphate and a deep red cobalt-containing gum which behaved as a mixture of tetra-, penta- and hexa-basic acids in the case of alkaline hydrolysis, or as a mixture of tetra-, penta-, hexa- and hepta-basic acids in the case of acid hydrolysis. The mixture of cobalt-containing acids obtained from the alkaline hydrolysis of the vitamin has now been subjected to further fractionation in order to provide material for chemical degradation and physical examination.

Vitamin B_{12} was hydrolysed with 30 per cent sodium hydroxide at 150° for 1 hr., and the tetra-, penta- and hexa-basic carboxylic acids as well as the accompanying free nucleotide were separated by electrophoresis on Whatman seed-testing paper[1,2]. Of the three coloured fractions, that corresponding to the hexabasic acid was present in the largest amount. It was converted into its ammonium salt, absorbed on a column of 'Dowex 1 *X* 2' resin (2 per cent cross-linking) and eluted with 0·6 *M* ammonium acetate solution. Several minor fractions were eluted first and were followed by the major band, which was collected separately. It was worked up in the usual way by acidification with hydrochloric acid, extraction into phenol, removal of the inorganic salts from the phenol extract by washing with dilute hydrochloric acid and then water, dilution of the phenol with ether and re-extraction of the red acid into water. After evaporation of the water, the gummy residue was dissolved in aqueous acetone and diluted with ether and kept for several weeks, when a small quantity of red prisms was obtained. This crystalline product was submitted to Dr. D. C. Hodgkin and the elegant crystallographic examination described in the following communication was carried out on one selected crystal. Further dilution of the mother liquors with ether gave fine red needles which were soluble in aqueous acetone but insoluble in either water or acetone alone. Recrystallization was wasteful but could be effected by adding ether cautiously to the aqueous acetone solution, when crystalline material was obtained from the cloudy solution after removal of some amorphous material precipitated initially. (Found on material dried to constant weight at 54°/0·05 mm. : C, 52·8 ; H, 6·3 ; N, 7·85. $C_{47}H_{66}O_{16}N_6CoCl$ requires C, 53·0 ; H, 6·25 ; N, 7·9 per cent.) An aqueous solution of the product in dilute nitric acid contained chloride ions.

The ultra-violet absorption spectrum (Figs. 1 and 2) shows a strong resemblance to that of vitamin B_{12} ; differences in the 280 mμ region are due to the absence of the 5 : 6-dimethylbenziminazole nucleotide in the hydrolysis product. In the presence of excess cyanide a bathochromic shift of the spectrum is obtained similar to that observed with vitamin B_{12} and indicates that the chromophore of the hexabasic acid is closely related to that of the parent vitamin. The infra-red spectrum, determined on a 'Nujol' mull, showed maxima at 4·67, 4·73 (weak), 5·77, 5·85, 6·01, 6·15, 6·30, 6·64, 7·74, 8·64, 8·98, 9·15,

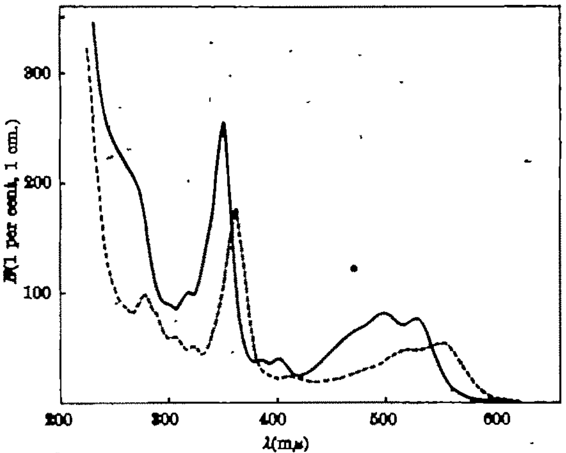

Fig 1. Ultra-violet absorption spectra of vitamin B_{12} (air-dried, - - - - - -) and the hexacarboxylic acid degradation product (———) in water

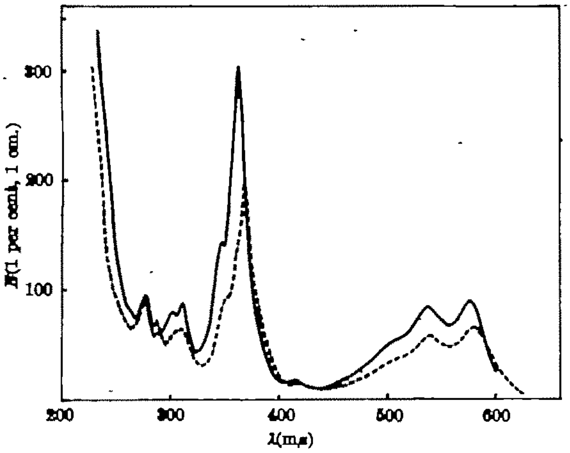

Fig. 2. Ultra-violet absorption spectra of vitamin B_{12} (air-dried, - - - -) and the hexacarboxylic acid degradation product (———) in 0·1 *M* potassium cyanide

9·40, 9·53, 9·85, 10·25 and 12·30 μ. The maximum at 4·67 μ indicates the presence of the cyanide ion, and the absorption in the carbonyl region together with a strong inflexion in the 3–3·8 μ region are consistent with the polycarboxylic nature of the pigment. The virtual absence of strong 'aromatic' bands in the 11·5–14·5 μ region of the spectrum is also noteworthy.

The red needles were unsuitable for X-ray studies, but it is probable that they are a polymorphic modification of the prisms obtained originally, for on one occasion the needles were converted into prisms on keeping in the presence of the mother liquors, and the crystals so obtained were identical (X-ray powder photograph) with those supplied earlier to Dr. Hodgkin.

Later experiments have suggested that the multiplicity of bands obtained by elution of the electrophoretically pure acids from ion-exchange columns with solutions of salts, for example, ammonium acetate, in the absence of excess cyanide, and also the great reluctance of all these compounds to crystallize, is caused mainly by the ease of exchange of anions other than cyanide attached to the central cobalt atom. Work on the changes occurring in the co-ordination state of these acids under various conditions, and further chemical degradations are in progress.

The award of a Beit Memorial Fellowship for Medical Research to one of us (J. R. C.) is gratefully acknowledged.

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A. W. Johnson
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University Chemical Laboratory,
Pembroke Street,
Cambridge,
Oct. 15.

[1] Armitage, J. B., Cannon, J. R., Johnson, A. W., Parker, L. F. J., Lester Smith, E., Stafford, W. H., and Todd, A. R., *J. Chem. Soc.*, 3849 (1953).

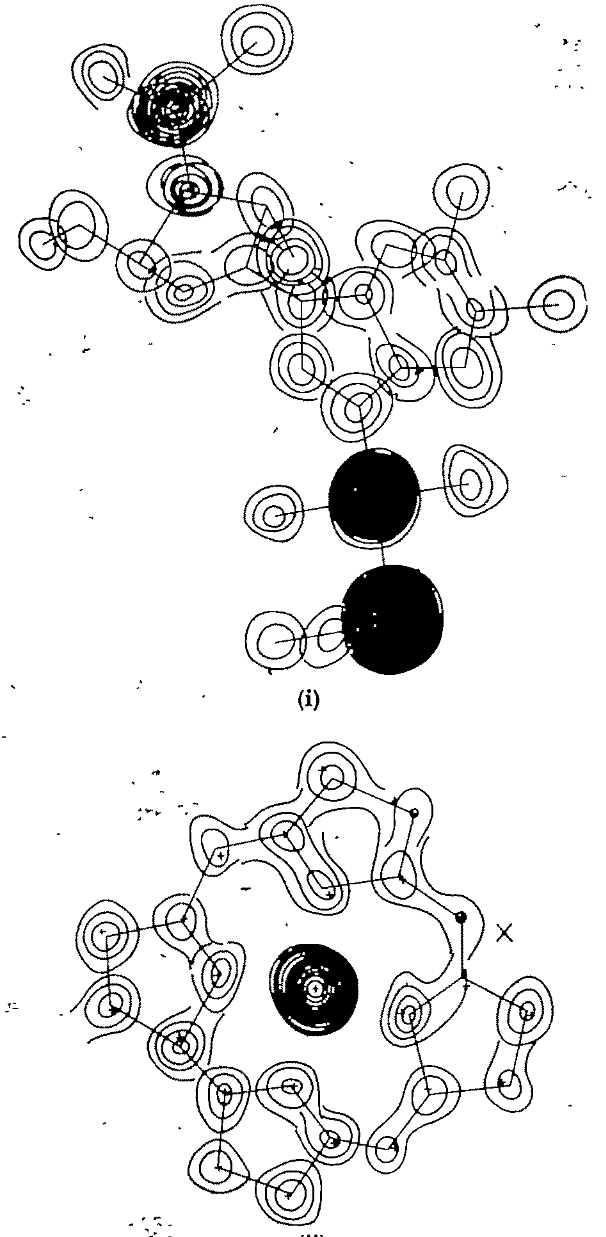
[2] Cannon, J. R., and Gibson, A. R., *Chem. and Indust.*, 120 (1954).

X-ray Crystallographic Evidence on the Structure of Vitamin B_{12}

It is not usual in X-ray analysis to present evidence of part only of a crystal structure. We have, however, reached a point in the investigation of the structure of vitamin B_{12} at which we have obtained strong evidence for the existence of a new type of ring system within the molecule, although we cannot yet describe in detail the nature of the groups attached to it.

Vitamin B_{12} has been shown[1] chemically to contain cobalt, a nucleotide-like group (5 : 6-dimethylbenziminazole 1-α-D-ribofuranoside (2′ or 3′)-phosphate), and a CN group, which together account for $C_{15}H_{18}O_7N_3PCo$ out of a total[2] of approximately $C_{61-64}H_{86-92}O_{14}N_{14}PCo$. There is chemical evidence in addition for the existence of groups which give rise to propanolamine on hydrolysis and to various simple acids on oxidation[3], but a major portion of the molecule is at present of largely unknown character. It is for part of this structure that we now have evidence.

We have obtained complete three-dimensional X-ray data for four crystals: air-dried vitamin B_{12} (two independent sets of data obtained at Oxford and at Princeton), wet vitamin B_{12} (the crystal in its mother liquor), vitamin B_{12}-SeCN (having the CN of B_{12} replaced by SeCN), and, very recently, a red degradation product of vitamin B_{12} from which the nucleotide and propanolamine have been removed. In each of these cases, we have found the positions of the heavy atoms in the crystal by direct Patterson methods, and calculated three-dimensional Fourier series using our observed *F* values and phases based only on the heavy atom positions: cobalt, or cobalt and selenium. The resulting distributions give a crude approximation to the correct electron density series, containing certainly many spurious peaks, but also containing peaks which must correspond to actual atomic positions. We first recognized peaks corresponding to the CN groups in the case of wet and dry vitamin B_{12} and proved our conclusions correct by the substitution of SeCN for CN. We next recognized the general outline of the nucleotide, placed between the cobalt and a second moderately heavy peak—the phosphorus atom—the ribose being linked to the phosphate at the 3-position[4] and one nitrogen atom of the benziminazole nucleus co-ordinated to the cobalt[5]. Between the nucleotide and CN group, and surrounding the cobalt atom, appeared a group of largely planar form, similar in dimensions to a porphyrin nucleus. Attached to this nucleus could be located, though less precisely, various side-chains and possible other ring systems.



(i)

(ii)

Fig. 1. Positions of certain of the atoms in vitamin B_{12}-SeCN derived from the second calculated three-dimensional electron density distribution

(i) The phosphate, ribose, benziminazole, cobalt and selenocyanide groups viewed along the *b*-axis

(ii) The 'planar' group viewed along the *a*-axis

In this figure, and in Fig 2, the contours drawn are those showing the electron density in sections in the three-dimensional distribution, passing at or near each individual atomic position

In the next series of calculations on air-dried vitamin B_{12}, made both in Oxford and Princeton, it was assumed that the planar group had in outline the form expected for a normal porphyrin. But more detailed comparison of all three series for vitamin B_{12} later obtained in Oxford suggested that, in fact, no true porphyrin was present. Three of the five-membered rings appeared separated each by a single atom, but the fourth seemed directly linked to the first. At this point, different refinements of the first electron density series were calculated. In those derived at Princeton, for vitamin B_{12} itself (J. W.), atomic positions corresponding to a normal porphyrin were inserted, together with successively increasing numbers of positions postulated for the rest of the molecule. In that obtained at Oxford, based on vitamin B_{12}-SeCN, the modified porphyrin-like structure was used, together with postulated positions for all the atoms in the unit cell. Comparison of results provides strong support for the modified planar group. The region of the directly linked five-membered rings appears most distinctly in the vitamin B_{12}-SeCN series. This is illustrated in Fig. 1, which shows the appearance of the planar group, projected along the *a*-axis (ii) together with that of the benziminazole–ribose–phosphate system viewed in the direction of the *b*-axis (i). The atomic positions in both these systems are individually resolved and of the height expected, except perhaps in the region marked *X*.

The atomic arrangement found in the planar group is so unexpected that we hesitated to accept this until we examined the degradation product isolated by Cannon, Johnson and Todd and described in the preceding communication. In this crystal the nucleotide is absent and is replaced by chlorine. The relative disposition of the planar groups in the crystal is entirely different from that in vitamin B_{12} itself; but, within the molecule, we can still trace the same essential pattern. The planar group here is considerably inclined to all three axes; a linear group, CN, projects on one side, and on the other, a heavy peak, the chlorine atom, completes the octahedron of peaks surrounding the cobalt. Fig. 2 shows the peaks directly traced from the first three-dimensional series, viewed from the *a*-direction.

There are a few points that we should make. While we are reasonably certain that atoms exist bonded essentially as shown in Figs. 1 (ii) and 2, we have no evidence of their chemical nature; it is natural to suppose that the four directly attached to cobalt are nitrogen, and the rest carbon. Secondly, we have evidence that the system as a whole is not completely planar, but our results are not yet precise enough for us to know at which points the rings are reduced. Again, though we have indications of the existence of side-chains attached to the nucleus, their corresponding electron density peaks are usually

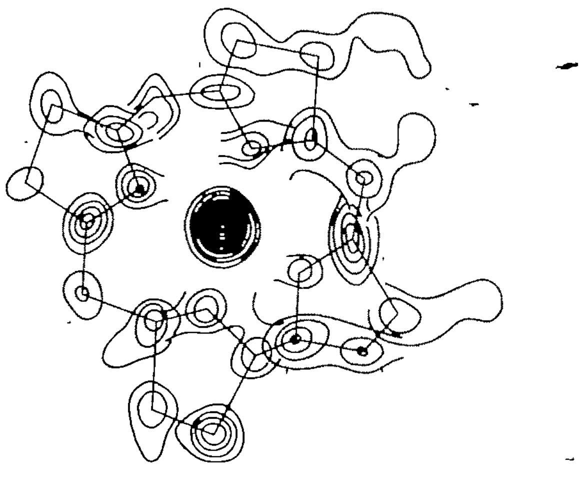


Fig. 2. Positions of the atoms in the 'planar' group as it appears in the first three-dimensional electron density distribution, calculated for the vitamin B_{12} fragment The structure is viewed along the *a*-axis

much less clear than those of the nucleus itself and we differ among ourselves in our deduction of their nature. A great deal more work is clearly necessary to discover in detail these remaining features of the vitamin B_{12} structure, but from our present experience we now have little doubt that a complete solution of the crystal structure by X-ray analysis is possible.

We are very grateful for gifts of material, and for invaluable conversations, to Dr. Lester Smith, of Glaxo Laboratories, Ltd., and to Sir Alexander Todd and his colleagues. One of us (J. W.) would like similarly to acknowledge a gift from the Merck Laboratories. We have had considerable assistance in our calculations from Miss Ruth Cox, Mrs. U. Ledwith, Mrs. M. Mackay and Mrs. I. Robertson, using machines supplied to us by the British Tabulating Machines, Ltd. Other computing has been carried out for us by the Scientific Computing Service, the National Physical Laboratory, and by XRAC, through the kindness of Prof. Pepinsky. Our researches in Oxford have been very generously supported by the Nuffield Foundation and by the Rockefeller Foundation. We also gratefully acknowledge the award of a fellowship by the International Federation of University Women (to C. B.) and of a grant from the Department of Scientific and Industrial Research (J. P.).

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OBITUARIES

Dr. C. G. L. Wolf

DR. C. G. L. WOLF, honorary consulting biochemist to the United Cambridge Hospitals, died at his home in Cambridge on November 9 at the age of eighty-two.

Charles George Lewis Wolf was born at Niagara, and graduated M.D., C.M. at McGill University. After a period of study in Cambridge and Würzburg, he joined the teaching staff of McGill University as a demonstrator in chemistry, and in 1899 was appointed head of the Department of Physiological Chemistry in Cornell University Medical College. Dr. Wolf relinquished this appointment in 1911, and for a short period worked in the laboratory of the late Sir Frederick Gowland Hopkins in Cambridge.

During the First World War Dr. Wolf held the rank of captain in the R.A.M.C., and in 1919 he became assistant director of the Institute for the Study of Animal Nutrition in the Department of Agriculture at Cambridge. In 1920 he was appointed to a lectureship in bacteriology in the same Department. He left the Department of Agriculture in 1920, and in 1921 became honorary biochemist to Addenbrooke's Hospital, Cambridge. In the same year he was awarded the degree of Ph.D. for a thesis upon the estimation of lactic acid.

Dr. Wolf's work was characterized by a meticulous regard for accuracy in laboratory technique and by a deep knowledge of his subject acquired by extensive reading in the original literature. He carried out research in widely differing fields. From Cornell University came a detailed study of cystinuria, while in 1917 he published a report to the Medical Research Committee (now Council) on the biochemistry of pathogenic anaerobes. This latter work was initiated at a base hygiene laboratory in Boulogne and continued in the Institute for the Study of Animal Nutrition in Cambridge. In 1921 Dr. Wolf published a paper upon the maintenance of the motility of mammalian spermatozoa during storage, and in 1926, in collaboration with Sir Eric Rideal, he published a study of the Wassermann reaction. About this date Dr. Wolf became interested in various serological methods which had been proposed for the detection of malignant tumours in man, and most of his original work from this time until his retirement lay in this field.

A man of strong personality and forthright in expression of his views, Dr. Wolf numbered many eminent colleagues among his friends. He had an exceptionally keen sense of responsibility towards all who worked under him and was always ready with helpful advice upon their problems. Their subsequent careers were a subject of deep and kindly interest to him, and their appreciation was shown by friendships that lasted until the end of his life.

In 1910 Dr. Wolf married Josephine Rebecca Tallerman, who died in 1949. N. R. LAWRIE

M. Albert Demolon

IN the death of Albert Demolon on October 23, France has lost her most distinguished soil scientist. The death of Mme. Demolon in a road accident in 1950 greatly saddened his last days. He will be affectionately remembered by the many hundreds of soil scientists who had the good fortune to know him as a dynamic personality, physically small but mentally and spiritually a giant.

When only twenty-eight years old, he became director of the Station Agronomique at Laon, and during the next eighteen years he threw himself with great energy into the study of the *limons* soils of northern France. His researches were remarkable for the width of their scope. He was just as competent in microbiology as in physics, and was keenly interested in practical agriculture while seeking for fundamental scientific truth. In the middle of this period he suffered the anguish of seeing his laboratory destroyed by bombardment.

In 1927 he was appointed inspector-general of the stations and laboratories of the French Ministry of Agriculture, a post which he retained until his retirement in 1946. Until 1940 he was also director of the Centre National de Recherches Agronomiques at Versailles. In this position he gathered around him an enthusiastic group of research workers, and was their constant source of inspiration. This period closed with the second destruction of his books and records by enemy action, in 1940, and he sustained further loss when the Centre was bombed in 1944. The fruits of this period are to be found on our shelves in such stimulating books as "Dynamique du sol", "Croissance des végétaux", "Guide pour l'étude expérimentale du sol", "L'évolution scientifique de l'agriculture" and "Génétique des sols".

In all his work we find Demolon rejecting the empirical approach in favour of a sincere attempt to understand the processes at work. He was convinced that this is the surest way to obtain results of practical value in agriculture.

His election to the Paris Academy of Sciences in 1946 marked the beginning of a final period in which he rendered valuable service as adviser to the International Superphosphate Manufacturers' Association, a post which brought him into close contact with many industrial organizations serving agriculture.

R. K. SCHOFIELD

NEWS and VIEWS

Carnegie Institution of Washington : Dr. C. P. Haskins

DR. CARYL P. HASKINS, president and director of research of Haskins Laboratories, New York City, has been elected president of the Carnegie Institution of Washington in succession to Dr. Vannevar Bush, who will retire on January 1, 1956. Dr. Haskins was born in Schenectady, New York, in 1908, and graduated from Yale University in 1930. After four years in the Research Laboratory of the General Electric Company and graduate study at Harvard University, where he received a Ph.D. in 1935, Dr. Haskins established the Haskins Laboratories, a non-profit scientific and educational foundation. This foundation has for eighteen years devoted itself mainly to basic scientific research and research training in selected pioneer fields. With a small staff supported by private funds and grants from various foundations, its original activities were confined mainly to the fields of biochemistry and biophysics; but in recent years it has moved into the field of psychoacoustics, which involves a new approach to some of the fundamental aspects of speech. One of Dr. Haskins's books, "Of Societies and Man" (1950), is particularly interesting in that it sets forth in a novel way significant trends in the formation, growth and duration of societies, drawing information from evolution, palæontology, genetics and biochemistry, and tracing parallels in the social evolution of many different kinds of organisms. Among its conclusions is that over-regimentation and over-specialization destroy in time the self-reliance and flexibility of individuals in the society, and the society then often fails to adjust itself to changes in environment. During the Second World War, Dr. Haskins served with the National Defense Research Committee and the Office of Scientific Research and Development, and since the War has acted as a consultant to the Departments of Defense and State. He has been a research professor in biophysics at Union College, Schenectady, since 1937, and president of the National Photocolor Corporation of New York City since 1938. In 1948 he was awarded the Certificate of Merit and in the same year received from Great Britain the King's Medal for Service in the Cause of Freedom.

Atomic Energy Authority : Appointments

MR. ERIC H. UNDERWOOD has been appointed director of public relations to the United Kingdom Atomic Energy Authority. He will take up his duties early in the New Year. He goes to the Authority from the Central Office of Information, where he was director of the Photographs Division and, earlier, chief editor of overseas magazines. Mr. Underwood, who is forty-one years of age, was educated at Dulwich College. He was a provincial newspaperman until 1940, when he joined the Royal Air Force. At the end of hostilities in Europe he was seconded to the Control Commission for Germany as a squadron-leader press officer until his demobilization at the end of 1945. In January 1946 he was appointed deputy director of public relations at the newly formed Control Office for Germany and Austria, and transferred to the Foreign Office in the following year, going to the Central Office of Information in 1949. Mr. Stanley White, who has been acting as press officer on secondment from the Ministry of Supply, has now been appointed to that post with the Authority. The Authority's Press Office will move from Bedford Chambers to St. Giles Court, St. Giles High Street, London, W.C.2, early in 1955.

Harwell Isotope School

THE Harwell Isotope School, which since it was founded in 1951 has had 329 students from twenty-nine different countries, is now preparing its programme for the forthcoming year. Training is given at this School in the applications of radioactive materials in research and industry and in the techniques of producing, measuring and handling such materials. Countries besides the United Kingdom from which students have already been trained are Australia, South Africa, Argentine, Austria, Belgium, Brazil, Chile, Denmark, Egypt, Finland, France, Germany, Greece, Holland, India, Ireland, Israel, Italy, Lebanon, Norway, Pakistan, Portugal, Spain, Sweden, Switzerland, Turkey, U.S.A. and Yugoslavia. The courses, which last for four weeks, include both lectures and practical work in the laboratory. Students should be graduates of a university. The courses for early 1955 are already fully booked, but there are at present vacancies on Course 27 (April 25–May 20) and Course 28 (June 27–July 22). Further information can be obtained on application to: The Isotope School, A.E.R.E., Harwell, Berks.

International Tin Research Council and Tin Research Institute : Appointments

FOLLOWING the retirement at the end of this year of Mr. John Ireland, Dr. Ernest S. Hedges will become director of the International Tin Research Council and director of the Tin Research Institute. In addition, Dr. W. E. Hoare and Mr. W. R. Lewis have been appointed assistant directors. Dr. Hedges, who was educated at the Universities of Manchester and London, was at one time Darbishire Fellow of the University of Manchester, and later lecturer in chemistry in the University of London. He was appointed to the staff of the Tin Research Institute in 1932 and has been director of research since 1939. He is the author of several books on chemistry and metallurgy, and of more than a hundred research papers. Dr. Hoare is head of the Tinplate Section of the Tin Research Institute, having originally begun his career as a metallurgist with the Talbot Motors Company, and Mr. Lewis is development manager at the Institute.

United States Research Fellowships to British Scientific Workers

Research fellowships tenable in American institutions under a technical assistance programme sponsored by the United States Foreign Operations Administration have been awarded by the National Academy of Sciences, Washington, on the nomination of the Royal Society, London, to five British scientific workers as follows: G. V. Chester, scientific officer, Radar Research Establishment (Ministry of Supply), to work at Yale University, under Prof. J. G. Kirkwood, in the field of statistical mechanics and, in particular, on the molecular theory of fluids; Dr. R. A. Gibbons, research assistant, Department of Biochemistry, Lister Institute of Preventive Medicine, London, to work at the Ohio State University, Columbus, under Prof. M. L. Wolfrom, on problems in connexion with the human blood-group substances; C. G. James, research student in the Department of Physical Chemistry, Cambridge, to work in the University of California, Berkeley, under Prof. Leo Brewer, in the general field of high-temperature thermochemistry and flame equilibria; I. M. Mills, research student in the Department of Chemistry, Oxford, to carry out research in infra-red spectra at the University of Minnesota, under Prof. Bryce Crawford, jun.; Dr. G. L. Squires, a senior research Fellow at the Atomic Energy Research Establishment, Harwell, to work under Dr. Robert Oppenheimer in the Institute for Advanced Study, Princeton, New Jersey, for about three months and then under Drs. John and Leona Marshall in the Institute for Nuclear Studies of the University of Chicago, on experiments in meson physics. This brings to sixteen the number of awards to candidates from the United Kingdom in a programme which, instituted in 1953, is intended to enable some hundred and fifty outstanding young scientific workers from fourteen Western European countries to carry out advanced study for up to two years at American universities and research institutions; part of the time may be spent in American industrial or applied science research laboratories. The grants are worth about 3,300 dollars (approximately £1,180) a year plus travel expenses.

The Nature Conservancy: Annual Report

According to the report of the Nature Conservancy for the year ended September 30, 1954 (see p. 1159 of this issue), by the end of that year the Conservancy had notified under Section 23 of the National Parks and Access to the Countryside Act, 1949, 1,098 sites of special scientific interest in England (coming under sixty-eight planning authorities) and 148 in Wales (coming under thirteen authorities). Progress in Scotland was slower; but by the end of the year seventy-seven sites had been notified to twelve authorities. By the end of the year 528 geological sites out of the 634 proposed for conservation had been inspected, and nearly two hundred photographs of such sites were taken. Only at the beginning of the year did it become possible to trace and write on a large scale to the owners and occupiers of such sites, which vary widely both in size and in the character of their scientific interest. Considerably less than half the owners notified have replied, the great majority promising co-operation; only a small minority has taken exception. In future, where tenants and proprietors can be traced, they will be consulted before further areas are notified to local planning authorities; but it is emphasized that notification is merely a means of informing authorities, owners and occupiers of the fact that they have something of outstanding natural and scientific interest on their land, and the Conservancy has been encouraged by the readiness of many owners to welcome scientists and to see that the scientific interest is preserved.

The report also deals at some length with the new statutory responsibilities of the Conservancy under the Protection of Birds Act, 1954, which came into force on December 1. Under Section 10 of that Act, the Conservancy is responsible for issuing licences in connexion with interference with bird life for scientific or educational purposes for work sponsored by the Conservancy; and it is also one of the bodies empowered to nominate an authorized person for pest control and other specified purposes. Despite certain difficulties, the Nature Conservancy believes that it will be possible to reach agreement on a broad policy in regard to wild-fowl refuges, which will combine the requirements of nature conservation with those of sportsmen, particularly wild-fowlers.

Viruses and the Control of Insect Pests

Outbreaks of insect pests are often brought to an end by outbreaks of infectious disease, and many attempts have been made to control harmful insects by spreading disease among them. In the past the results have been disappointing: the infective organisms have soon lost their virulence. But in recent years some strikingly effective epidemics of disease among insect pests have led to a renewed interest in the method. In 1945 the population of the spruce sawfly in eastern Canada, after reaching alarming proportions, just melted away before a virus disease. This episode served to focus attention on the insect viruses, and that has led in turn to the practical use of introduced virus diseases for insect control, on one hand, and a great increase in our knowledge of these diseases, on the other. In the November number of *Discovery*, Dr. Kenneth M. Smith, of the Agricultural Research Council's Virus Research Unit, at Cambridge, contributes an interesting article which outlines both the fundamental knowledge of insect viruses that has recently been obtained and some of the practical achievements. Thus the alfalfa butterfly in California has been effectively controlled by spraying the crop with stored polyhedra obtained from diseased caterpillars, and the pine sawfly in Canada has been controlled by a virus of polyhedral type procured from Sweden. A very interesting discovery is that some virus diseases are not highly specific, but can attack a number of different species of Lepidoptera; sometimes the virulence of the infection can be increased by mixing two viruses. In general, the persistent nature of the viruses and the fact that they do not affect the natural enemies of the pests make them a promising alternative to insecticides.

Third International Congress of Biochemistry, Brussels

The Third International Congress of Biochemistry will be held in Brussels during August 1–6, 1955, under the presidency of Prof. E. J. Bigwood, rector of the University of Brussels. The scientific programme of the Congress will be made up of symposia, sessions for members' communications and general lectures. There will be, in all, thirty-two symposia, which will cover the following seventeen topics: organic chemistry of substances of biological interest; chemistry and physical chemistry of proteins and polypeptides; chemistry and physical chemistry of nucleoproteins and nucleic acids; enzymology; intermediary metabolism; biological oxidations and oxidative phosphorylations; biochemical regulations; biochemistry of the cell; biochemistry of muscle and the central nervous system; biochemistry of micro-organisms; plant biochemistry and biochemistry of the soil; chemical zoology; nutrition; chemical pathology; chemical pharmacology; clinical chemistry; and industrial biochemistry. The two general lectures, to be given at the opening and closing sessions of the Congress respectively, will be as follows: Prof. Carl Martius (Physiological Chemical Institute of the University of Wurzburg) speaking on "Thyroxin und Oxydative Phosphorylierung", and Prof. Vincent du Vigneaud (Cornell University Medical College, New York) on "The Hormones of the Posterior Pituitary". Those intending to read papers must send in abstracts, not exceeding two hundred words, to the General Secretary of the Congress before April 1. The registration fee for the Congress is 600 Belgian francs (about £4 or 12 dollars) for active participants or 100 francs for associate members. Registration can be made through the American Express Co., Inc. (51 Cantersteen, Brussels, or any of its offices elsewhere), and should be made as soon as possible, in any event not later than May 31. All scientific communications should be addressed to the General Secretary of the Congress at 17 Place Delcour, Liège, from whom further information can be obtained.

Royal Society: Officers for 1955

The following have been elected officers and council of the Royal Society for the ensuing year: *President*, Dr. E. D. Adrian; *Treasurer and Vice-President*, Sir Thomas Merton; *Secretaries and Vice-Presidents*, Sir Edward Salisbury and Sir David Brunt; *Foreign Secretary*, Sir Cyril Hinshelwood; *Other Members of Council*, Prof. W. Baker, Prof. F. W. R. Brambell, Prof. F. Dickens, Sir Alan Drury, Prof. J. H. Gaddum, Prof. L. Howarth, Mr. A. E. Ingham, Prof. W. B. R. King, Prof. W. H. McCrea, Prof. K. Mather, Sir Edward Mellanby, Prof. P. B. Moon, Prof. W. H. Pearsall, Mr. J. A. Ratcliffe, Prof. J. M. Robertson and Dr. C. Sykes.

Mond Nickel Fellowships, 1954

The Mond Nickel Fellowships Committee announces the following awards for 1954: M. Brownlee (Dorman, Long and Co., Ltd., Redcar), to study British, Continental and American hot and cold metal basic open-hearth steel-making with particular reference to furnace design and construction and factors affecting ingot quality; R. D. Butler (Imperial Chemical Industries, Ltd., Liverpool), to study mineral dressing practice in Great Britain, on the Continent and in the United States and Canada, with particular reference to the design, layout and operation of small-scale mills; F. B. Peacock (Dorman, Long and Co., Ltd., Middlesbrough), to study rolling mill operation and maintenance with particular reference to soaking pits, blooming mills and the production of universal beams, structural sections and rails; A. M. Sage (British Iron and Steel Research Association, London), to study the manufacture and fabrication of structural steels in the United Kingdom, Europe, the United States and Canada.

Announcements

We regret to announce the death of Dr. G. F. C. Searle, F.R.S., formerly University lecturer in experimental physics in the University of Cambridge, on December 16, aged ninety.

The title of emeritus professor has been conferred by the University of Sheffield on Prof. I. C. F. Statham, who has recently retired from the chair of mining in the University (see *Nature*, August 7, p. 250).

The Council of the Royal Society has awarded Locke Research Fellowships to the following: M. de Burgh Daly, to work on carotid sinus reflexes and hæmodynamics of the pulmonary circulation, at University College, London; J. C. F. Poole, to work on the effects of fat absorption and blood coagulation and thrombosis, at the Sir William Dunn School of Pathology, Oxford.

Mr. A. D. Knox, lecturer at the London School of Economics and Political Science, has been appointed to the University readership in economics, with special reference to the economics of underdeveloped countries, tenable at the School. The title of reader in economics in the University of London has been conferred on Dr. A. W. H. Phillips in respect of his post at the London School of Economics and Political Science.

On the occasion of the annual general meeting of the Manchester and District Section of the Royal Institute of Chemistry, an exhibition of chemical laboratory apparatus, instruments and techniques will be held in the Manchester College of Technology and will be open to the public on January 5 (2–8 p.m.) and January 6 (10 a.m.–8 p.m.). Special emphasis will be laid this year on distillation and fractionation equipment.

A complete and informative catalogue of recent publications of the Institute of Physics, covering the "Physics in Industry" series, the Institute's two monthly journals and their supplements, the "Monographs for Students" series and numerous reports and pamphlets, together with various books published for the Institute by Edward Arnold (Publishers), Ltd., is now available and can be obtained free from the offices of the Institute, 47 Belgrave Square, London, S.W.1.

Dr. Maurice Cook, joint managing director of the Metals Division, Imperial Chemical Industries, Ltd., has been elected chairman of the British Non-Ferrous Metals Research Association in succession to the Hon. R. M. Preston, who retires from office at the end of this year. In addition to his many contributions to science and technology in industry, Dr. Cook is distinguished for his services to the metallurgical profession. He is a past president of the Institution of Metallurgists and senior vice-president and president-elect of the Institute of Metals, and, among his many activities connected with the Research Association, he has been chairman of the Research Board since 1950.

COMMONWEALTH OCEANOGRAPHIC CONFERENCE

THE idea of a Commonwealth Oceanographic Conference was first put forward at a meeting of the National Oceanographic Council in January 1953. It arose from arguments that the change of emphasis in oceanography, from exploration and survey to research directed towards the precise understanding of the basic physical and biological processes, makes it necessary to devote more effort to theoretical and experimental work. For example, biologists as well as physicists want to know more about the changes in the surface currents and the speeds and variations of the slow but powerful deep-water movements, and it is no longer possible or reasonable to attempt to keep a watch on them all with a network of oceanographic observations like that used in meteorology. The only practical thing is for oceanographers to learn how the water movements are governed by atmospheric pressure, wind and climate so that they can use the meteorological data, supplemented every now and then by their own upper- and lower-water observations.

It would, no doubt, be wrong to suggest that oceanographers took up the subject because they found mathematical and physical sciences too difficult and unattractive; but they have been rather slow in applying the precise techniques of these sciences to marine research. There is more than sufficient interest and profit in the study of the marine animals and plants to keep the marine laboratory busy; but there would be just as much interest and profit in the study of the magnificent interplay between sun, water, air and earth if only we knew rather more about it to begin with. To increase our knowledge the subject must be made attractive to men who do not mind facing up to the difficulties of fluid mechanics. The experienced investigators who have done so much exploration and survey and built up a realistic basic picture can scarcely be expected to turn their hands to the fresh intricacies of such new tasks.

The progress in any science can probably be measured by the interest which the universities take in it; and in oceanography their interest, with one or two notable exceptions, is limited to the biology of the coast and shallow seas. This is understandable, since the problems are interesting and important, and there is much that can be fitted conveniently into university life. As soon as the collection of data becomes too expensive for university departments, and the problems too difficult to afford reasonable expectation that a student can make sufficient progress in two years to sit for a higher degree, the work has to be left to State-aided marine laboratories, and men have to be paid to do it. Even then it is rather difficult to attract first-class men, and a fair number are needed, since nothing less than a team with similar interests is likely to make much headway with a really backward subject.

Most countries of the British Commonwealth engage in oceanography on a considerable scale, dividing their resources between long-term research and the application of existing knowledge to their immediate problems. They all want to increase their activity; but the difficulties of attracting sufficient men with special qualifications and experience, the rising cost of designing and constructing the necessary apparatus and of building, operating and maintaining ocean-going research ships will, sooner or later, make some sharing of the basic studies essential.

The purpose of the Commonwealth Oceanographic Conference held during October 18–22 at the National Institute of Oceanography at Wormley, which was attended by delegates and observers from all Commonwealth countries as well as representatives of authorities interested in marine research in the United Kingdom, was to review the progress of oceanographic research in the Commonwealth, to discuss what measures might be taken to promote its extension, and to further the co-operative use of the available effort and facilities.

The Conference considered the applications of oceanographic research to defence, coastal engineering, shipping, meteorology and fisheries, and concluded that more use could be made of oceanographic research. It was also generally agreed that the investigation of local problems would be furthered by a better understanding of the basic physical and biological processes. It was agreed that the processes most deserving attention are those involved in the interchange of energy between the atmosphere and oceans, response of the sea surface to winds and pressure changes, general circulation of the oceans, distribution of marine organisms and organic production in the oceans. It was recognized that there are other important aspects, but progress in them is more satisfactory, and the immediate need is to direct attention to subjects which require much closer study before our understanding of the underlying principles of oceanography can be sufficient to allow real progress.

The Conference agreed on a co-operative scheme for lending equipment that is expensive, difficult to obtain, and probably only used occasionally, and arranged for the scheme to be started by the National Institute of Oceanography, which had announced its intention to build up a reserve of equipment.

Arrangements for disseminating information similar to those used by the Fuel Research Organization and the Aeronautical Research Council in Commonwealth countries were also agreed. The subject was divided into ten branches, for each of which a chief co-ordinator, located somewhere in the Commonwealth, was proposed: a national representative would pass reports of work done in his country in each of these branches to the appropriate chief co-ordinators, who would summarize and edit information and distribute it annually. It may be doubted whether such a scheme will succeed, but oceanography is a science in which publication, with reasonable confirmation, tends to lag well behind the formation of ideas, and though the tasks of the national representatives and the co-ordinators will be heavy, men with great enthusiasm may produce very useful results. Some benefit will be obtained from the mere fact that the national representative has to judge what contribution his country is making to the systematic development of the subject rather than to knowledge of local conditions.

The need for training more oceanographers was emphasized, and it was decided that the universities should be asked to help by teaching oceanography and doing all they can to encourage postgraduate research in marine physics as well as marine biology.

The Conference endorsed the programme of the National Institute of Oceanography, and considered that its attempt to concentrate on the basic problems, which will benefit the Commonwealth countries by helping them to solve their local problems, should be supported as fully as possible.

The First Lord of the Admiralty, the Right Hon. J. P. L. Thomas, and the Civil Lord, Mr. Simon Wingfield Digby, chairman of the National Oceanographic Council, did much to encourage the work of the Conference. They were hosts at a reception to all members after the first day's session and at a dinner, at which the First Lord presided, given in honour of the Commonwealth representatives, at the close of the meetings.

NEW FORMS OF THERMIONIC CATHODE

A COLLOQUIUM on new forms of thermionic cathode, sponsored by the Institute of Physics and the Physical Society, was held on October 21 at Hirst Hall on the estate at Wembley of the General Electric Company, Ltd., An introductory survey was given by D. A. Wright (G.E.C., Wembley), who pointed out that, for continuous operation for many thousands of hours, none of the established cathodes (Nos. 1, 3 and 9 in Table 1) can be relied upon to give more than 1–2 amp./cm.^{2}. The oxide cathode will give some tens of amp./cm.^{2} in short pulses, but is limited for continuous high current by its sensitiveness to imperfect vacuum, by the dielectric properties of the coating and by evaporation and electrolysis of coating material. Thus, to improve the performance, a cathode with metallic properties is desirable, with a low rate of loss of emissive material. The lowest-temperature emitter obtainable without a dielectric coating appears to be that which maintains a monatomic layer of barium on a metal surface, possibly with some oxygen present. The work function of such a cathode is 1·6–2·0 eV., so that it must be operated at 950° C. or more. At these temperatures, surface barium is rapidly lost by evaporation, and must be replaced from a reservoir in the cathode. The next four papers at the colloquium described cathodes of this type.

Dr. A. Venema (Philips, Eindhoven) described the three forms of Philips dispenser cathode. In the original *L* cathode (No. 5 in Table 1) the reservoir is of barium–strontium carbonate, which decomposes to oxide during pumping and is placed beneath a plug of porous tungsten. The work of Rittner has clarified the mechanism of these cathodes, indicating that barium is formed following reduction of the oxide by the tungsten, and diffuses through the pores as vapour by Knudsen flow. A complete covering of barium on tungsten is maintained by diffusion over the outer surface of the tungsten particles. The life, as shown in the table, exceeds eight thousand hours at a brightness temperature of 950° C., at which the saturated emission is 1·3 amp./cm.^{2}. The life is determined by evaporation, and decreases by a factor of 2½ per 50 deg. C. rise of temperature. The impregnated cathode has similar properties, and is formed by heating a porous tungsten plug in contact with barium aluminate at 1,750° C. in vacuum. The aluminate penetrates the pores, and in operation is reduced by the tungsten. A third type of cathode is being developed, in which tungsten powder and barium aluminate are mixed in powder form, pressed and sintered, again at 1,700–1,800° C.

In discussing the chemical reactions which can be utilized to supply barium to a tungsten surface, Dr. H. Huber (C.S.F., Paris) said that the compounds barium aluminate, silicate, titanate, thorate and tungstate have been considered. The work of Eisenstein, John and Affleck has shown what reducing agents are appropriate for each compound, and Dr. Huber described the results of his study of the emission of cathodes formed by mixing the powdered oxide, tungsten and a suitable reducing agent, pressing and heating at 1,300° C. The preferred cathode is '103' (No. 6 in Table 1), containing five molecular parts of barium tungstate (Ba_3WO_6), fifteen molecular parts of aluminium powder and eighty of tungsten powder, though similar results are obtained if the aluminium is replaced by tungsten carbide, and molybdenum can replace the tungsten powder. Presintering at 1,500° C. is found to be necessary to give long life.

It is not possible to form a cathode by mixing barium/strontium carbonate with tungsten, as there is a reaction which prevents subsequent reduction of the oxide to free barium. The carbonate can, however, be mixed with a more inert metal containing a little reducing agent. Dr. J. M. Dodds (Metropolitan-

Table 1

Type	Operating temperature	Radiated power (watts/cm.^{2})	Maximum usable d.c. emission (amp./cm.^{2})	Life† (hr.)	Work function (eV.)	Richardson *A* value
(1) Tungsten	2,600° K.	80	0·5	10,000	4·5	60
(2) Tantalum	2,400° K.	55	0·5	10,000	4·1	37
(3) Thoriated tungsten	2,000° K.	25	1–3	5,000	2·6	3
(4) Lanthanum boride	1,680° K.	40	1	> 250	2·6	25
(5) Philips dispenser (barium–tungsten)	950° C.B.‡	4*	1·3	8,000	2·1	100
(6) Huber 103 (barium–tungsten)	1,050° C.B. 1,200° C.B.	6* 8*	1·0 4–5	4,000 ~ 400	1·72	3
(7) Dodds (barium–nickel)	950° C.B.	3·3*	6		Not yet measured	
(8) Beck (barium–nickel)	1,340° K. 1,270° K.	3·7* 3·0*	3 1·5	3,000 9,000	1·8	20
(9) Oxide cathode	1,100° K. 1,200° K.	2·8 4·2	0·5 1·0	~ 3,000 < 1,000	1·2	~ 1

* These figures assume thermal emissivities for Nos. 5 and 6 as for tungsten wire (that is, 0·25) and for Nos. 6 and 7 as for nickel sheet (that is, 0·2). In practice they are likely to be higher.

† The figures quoted for life are rough indications only, in all cases.

‡ Temperatures in ° K. are true temperatures. Temperatures in ° C.B. are pyrometer brightness temperatures.

Vickers) and A. H. Beck (Standard Telecommunications Laboratories, Ltd.) described cathodes of this type, formed by mixing 30–40 parts by weight of carbonate with 70–60 parts of nickel powder, pressing and sintering. Dr. Dodds adds as reducing agent 0·1 per cent silicon, and presses at 10 tons/in.^{2}. Mr. Beck uses 1 per cent zirconium hydride as reducing agent, and presses at 80 tons/in.^{2}. His study of the work function has indicated that the activated cathode is nickel with 70 per cent of the surface covered with barium. The temperature coefficient of the work function is $1\cdot4 \times 10^{-4}$ eV./deg. C.

C. P. Lea-Wilson (Services Electronics Research Laboratory, Harlow) described a high-temperature magnetron cathode which emits from thorium-on-tungsten. This again is formed by pressing and sintering, but employs either thorium oxide or thorium metal (about 2 per cent) mixed with tungsten carbide and tungsten. With thoria, gas is liberated over a long period of operation, and about 10 per cent of carbide is necessary to obtain emission. The thorium gives rapid outgassing and activation, and is to be preferred. In the discussion, Mr. Lea-Wilson said that the carbide is desirable even when thorium is used, possibly because it minimizes surface oxidation. There is no information as to whether thorium carbide is formed. The cathode gives a pulsed emission of 20 amp./cm.^{2} at about 1,700° C., and a number of valves have been operated satisfactorily for more than a thousand hours.

Another high-temperature cathode using lanthanum boride as the emitter was described by B. N. Watts (British Thomson-Houston Co., Ltd., Rugby). This is formed by reaction of metal and boron in hydrogen at 1,400° C., and is either painted and sintered on a tantalum filament, or pressed, sintered, machined and heated indirectly. It is activated at 1,600° C. and gives 1 amp./cm.^{2} at 1,400° C., the d.c. and pulsed emission being equal. No long-life test information is yet available.

Finally, P. O. Hawkins (Services Electronics Research Laboratory, Baldock) described an oxide cathode in which the normal disadvantages are overcome by applying the coating on the inner surface of a hollow box, and extracting the electrons through a small hole. From a hole ⅓ mm. diameter, spaced 2 mm. from the anode, the current is very small below 920° C. At high temperatures the current increases at first rapidly with voltage, and then linearly and less rapidly. It exceeded 50 m.amp. at an anode voltage of 5 kV. at 1,230° C. This current if uniform over the hole would be 60 amp./cm.^{2}; but, in fact, the beam is found to be hollow, and the current for varying hole size varies with the perimeter. The mechanism is not understood.

In discussion, Dr. D. Gabor suggested that Mr. Hawkins's cathode contains a plasma from which electrons emerge with high velocity, and the latter agreed that it does not appear to contain an electron gas at the cathode temperature. Dr. P. N. Daykin asked whether n small holes would multiply the emission, and was told that this is so, giving an n-fold multiplication until the hole spacing becomes of the order of the hole diameter. M. E. Haine said that the beam current density per unit solid angle has a definite limit, so that a quotation of amp./cm.^{2} can be misleading. In reply to a remark by Dr. O. Klemperer, Mr. Hawkins said that low-voltage measurements have not been made. Questioned about secondary emission, Mr. Watts said that the secondary-emission coefficient of lanthanum boride has not been measured. Mr. Beck said that his cathodes have a value 10 per cent higher than that for pure nickel, while Dr. Venema agreed that the value for the L cathode is between 1·0 and 1·5. Dr. Huber discussed with Dr. Venema the reason for the former's failure to obtain good emission from barium-aluminate tungsten mixtures containing no additional reducing agent, and it appeared that the barium content and the sintering temperature are the important factors.

BRITISH WEED CONTROL CONFERENCE, 1954

THE second British Weed Control Conference was held at Harrogate during November 2–4 and was attended by four hundred delegates, including representatives from the British Colonies and most European countries. The Conference was organized on lines similar to those of the first one in 1953; that is, the emphasis was on the technology of weed control rather than on the underlying fundamental principles. The papers were divided into two broad classes, one concerned with general reviews of various aspects and the other with research reports on individual topics. The general papers again fell into two groups: the first related to the problems of commercial application, the efficiency of the available spraying equipment, the rotation of weed-killers, schemes for the approval of commercial products, and the legal aspects of spray damage; the second group contained surveys of modern developments in the use of herbicides and the associated problems of the dispersal of weed seeds and the role of mechanical cultivation.

Dr. W. G. Templeman (Jealott's Hill Research Station) reviewed the present position of herbicides in British agriculture. He pointed out that, although great advances have been made in the control of annual weeds in cereal crops, there still remain some relatively resistant and extremely important weeds, such as *Avena fatua* and *Alopecurus agrestis*, for which there are no adequate methods of control. He also emphasized that, while for many crops herbicidal applications are proving of great practical value, the position is far less satisfactory for root crops and many horticultural crops. In the past, too much stress has been laid on the total eradication of the weeds, and in many instances a better approach would be an endeavour to inhibit growth through the disorganization of the physiological processes. For example, 2,4,6-tribromophenylnitramine causes germinating seedlings to lose their capacity to react to tropic responses; but so far no compound with these characteristics has been discovered which is sufficiently selective.

While agreeing that herbicidal applications are playing an important part in British agricultural systems, Prof. H. G. Sanders (University of Reading) nevertheless felt that there is some danger that effective cultivation is not being fully appreciated. He was of the opinion that the hoe does more than kill the weeds and that its use in many circumstances is of direct benefit to the crop.

The organization of weed control investigations sponsored by the United States Department of

Agriculture was outlined by Dr. C. Warren Shaw (Beltsville, Maryland). Apart from the screening of new compounds and some fundamental and development work at Beltsville, similar investigations are being carried out in all parts of the United States under the general direction of four regional coordinators. All this work in turn is linked with similar projects being undertaken by individual States. Dr. Shaw also outlined some of the modern developments which are taking place, particularly in relation to the value of such new herbicides as 2,3,6-trichlorobenzoic acid for the pre-emergence spraying of maize and sorghum, 2,4,5-trichlorophenoxypropionic acid for the control of woody plants in cotton-growing areas, 2,2-dichloropropionic acid for the eradication of graminaceous species, and the likely value of phenyl-substituted ureas for the control of weeds in sugarcane, pineapples, asparagus and possibly cotton. The other materials referred to included N-(1-naphthyl)phthalamic acid as a selective herbicide in cucurbitaceous crops and 3-amino-1,2,4-triazole, which apart from its merit for defoliating cotton is likely to find a variety of uses as a herbicide.

An interesting new development in selective weed control was described by Prof. R. L. Wain (Wye College). In seeking to unravel the basic physiological actions of substituted phenoxyacetic acids, evidence has been obtained of the β oxidation of ω-phenoxyalkylcarboxylic acids. The alternation of biological activity with an increasing number of carbon atoms in the side-chain is only exhibited by some species. From these observations it is concluded that some species do not contain enzyme systems capable of breaking down the original compound to the parent phenoxyacetic acid. Thus, species which do not contain such enzyme systems will be resistant, while others which do will be susceptible. Pot and small-scale field experiments have confirmed this conclusion, and among the susceptible species are many common weeds, such as *Urtica urens*; *Chenopodium album*, *Sinapis arvensis* and *Cirsium arvense*, while resistant crops embrace red and white clovers, parsnips, celery, flax, maize, etc. A survey of the biological activities of γ-phenoxybutyric acids has also demonstrated that the position and number of methyl and chlorine atom substitutions in the benzene ring alter the properties of the molecule, which in turn alter the selective action between species. It is therefore evident that, with the introduction of compounds with odd numbers of carbon atoms in the side-chain, the value of substituted phenoxyacetic acids as selective herbicides will be extended to new crops.

Sir Edward Salisbury (Royal Botanic Garden, Kew) gave an account of the main factors relating to the persistence of weed seeds under British conditions and the principles of dispersal. Examples of the introduction and rate of spread of foreign species, such as *Cardaria draba*, were described. Once the initial introduction has taken place, the spread of the species is dependent upon a number of factors. For example, *Veronica persica*, which seeds very freely, has spread all over the country, whereas *Veronica filiformis*, which seeds but rarely because it is self-incompatible, is still highly localized in its distribution but may extend its area in the locality through vegetative propagation. In discussing the various agencies which lead to weed dispersal, it was pointed out that for birds the interval between ingestion and evacuation varies between thirty minutes and three hours or more, according to the species; thus, the rate of spread is greater where the seeds are readily taken by the larger birds, such as pigeons. Other aspects of seed dispersal by machinery and the laws governing injurious weed seeds and noxious weeds were discussed respectively by F. Coleman (Cirencester) and J. A. McMillan (National Agricultural Advisory Service).

The forty-six research reports presented at the Conference were considered in a number of groups, of which the most important related to weed control in horticulture, grassland, legumes, cereals, row crops and flax, while other aspects considered were the eradication of perennial grasses, the techniques of application both in greenhouse experiments and field trials, and the eradication of woody species under temperate and tropical conditions.

Apart from the selective control of weeds in peas and carrots, in other horticultural crops little progress has been made in the development of compounds which are selective when applied as a post-emergence spray, and most of the contributions bearing on horticulture reviewed the merits and defects of well-established practices. H. A. Roberts (National Vegetable Research Station) discussed the problems connected with the use of pre-emergence techniques and thought that, for contact pre-emergence applications, oil formulations containing pentachlorophenol are of considerable promise. For the control of dicotyledonous annual weeds in peas, dinitrosecbutylphenol is still the most widely used compound, both in Great Britain and on the Continent of Europe, although H. I. Petersen (Denmark) stated that good results have been achieved by using a mixture of dinitrosecbutylphenol and sodium 2-methyl-4-chlorophenoxyacetate. The potential value of *iso*propylphenylcarbamate and its 3-chloro-derivative for the selective elimination of wild oats (*Avena* spp.) and other weeds in peas was also discussed. The best degree of control has been obtained by incorporating the herbicides in the soil before sowing the crop, but no final conclusions can yet be reached as to the direct action of these materials on peas.

The papers on the elimination of perennial weeds from grassland illustrated the complexity of the problem, and the value of the ecological approach in relation to the use of herbicides was emphasized by M. Norman (Grassland Research Station) and A. D. Q. Agnew (Bangor). Turning to other agricultural crops, I. S. Frederiksen (Denmark) and K. Fröier and H. Zienkiewicz (Sweden) advocated the use of mixtures of sodium dinitro*ortho*cresylate and sodium methylchlorophenoxyacetate in fibre flax, while W. Q. Connold and E. I. Prytherch (National Agricultural Advisory Service) commented on the value of sulphuric acid for the control of annual weeds in *Brassica* crops.

Of the papers dealing with weed control in cereals, there was much interest in the contribution of Dr. P. Riepma (Holland), who described the results obtained when weed-free crops of autumn-sown wheat and rye were sprayed with dinitro*ortho*cresol at various times during the winter period. In many instances, appreciable gains in yield were recorded, more particularly in rye; and the maximum gains occurred when spraying took place at the four- to five-leaf stage of development. Dr. Riepma was of the opinion that these increases could not be explained in terms of the nitrogen contained in the herbicide, since the response was independent of the level of available nitrogen supply.

S. Andersen (Denmark) and Prof. B. Rademacher (Germany) gave accounts of experiments which sought to correlate weather conditions with the effects of substituted phenoxyacetic acids on cereals. J. D. Fryer and J. G. Elliott (Oxford) and T. C. Breese (Plant Protection, Ltd.) were in general agreement that, while wheat and barley cannot safely be sprayed until the plants reach the five-leaf stage, the optimum time to spray oats with 2-methyl-4-chlorophenoxyacetic acid is in the one- to four-leaf stage. For perennial grasses the importance of the stage of development in relation to the timing of spray applications was illustrated in the contribution of R. S. L. Jeater (National Institute of Agricultural Botany), who described the complex inter-relationships between species, time of application and the abnormalities induced in the flower primordia and inflorescences.

Three papers were devoted to the means of controlling *Agropyron repens*; in Great Britain the emphasis has been on sodium trichloroacetate, while in Sweden, so Prof. H. Osvald and Dr. E. Aberg reported, comparisons are being made of sodium chlorate, sodium trichloroacetate and 2,2-dichloropropionic acid. Dr. H. P. Allen (Plant Protection, Ltd.) described trials carried out in Malaya with phenyl-substituted ureas for the eradication of *lalang* (*Imperata cylindrica*). Neither 3(3,4-dichlorophenyl)-1,1-dimethyl urea nor 3(*p*-chlorophenyl)-1,1-dimethylurea resulted in complete control of this species unless the rates of application exceeded 80 lb. per acre. On the whole, better results were achieved when the treatment consisted of sodium trichloroacetate at 150–200 lb. per acre.

Prof. G. E. Blackman (Oxford) outlined the programme of investigations being conducted in East Africa by Dr. G. W. Ivens (Colonial Insecticide Research Unit, Tanganyika) in conjunction with the Agricultural Research Council's Unit at Oxford. The main object is to determine how far defoliants and arboricides can be used as means of eliminating tsetse flies through vegetation control. Experiments have shown that aircraft applications of the *n*-butyl ester of 2,4,5-trichlorophenoxyacetic acid are capable of defoliating, or even killing, a range of trees and shrubs found in communities which provide habitats for important species of tsetse fly. Besides applications from aircraft, other uses for such materials are being studied, and there is some evidence from Uganda that in high forest species of valueless trees can be eliminated by spraying the base of the tree with a suitable formulation of an arboricide, such as 2,4,5-trichlorophenoxyacetic acid.

FEDERATION OF MATHEMATICS AND PHYSICS SOCIETIES OF YUGOSLAVIA

CONGRESS IN ZAGREB

THE second congress of the Federation of Mathematics and Physics Societies of Yugoslavia was held in Zagreb during October 4–9, more than six hundred delegates attending. The congress considered a wide range of subjects—in the unanimous opinion of all present, too wide a range—indicating, among other matter, the growth of mathematics and physics in Yugoslavia. Some of the questions the congress examined were the teaching of mathematics and physics in secondary schools; the teaching at universities; and the organization of research in mathematics and physics. Eight sessions were devoted to research papers on mathematics, and nine to papers from the field of physics.

The present writer, being concerned mostly with nuclear physics, can give only a sample subject survey of papers in that field. One should bear in mind that this is the first time in the history of Yugoslavia that research papers in physics were reported at a nation-wide reunion of physicists. Altogether, a hundred and five research papers in physics were given, fifty-seven in the field of particle and nuclear physics, and forty-eight in optics, structure of crystals, geophysics, mathematical equipment, etc. A brief mention of the subjects of some of the papers in the field of nuclear and particle physics will indicate the range of interest. Theoretical research papers included one on the derivation of the nuclear forces from quantum field theory, one on the selection rules in meson theory and another two with Coulomb excitation of nuclei. Two communications dealt with the measurement of cosmic rays underground. A series of papers was on nuclear spectroscopy: beta decay of carbon-14, decay schemes of cæsium-133, cæsium-134, tungsten-185, etc. Other topics considered were the angular distribution in beryllium-9 reactions with deuterons, Auger spectrum of thorium B, the positive particles purported to be accompanying the beta decay of phosphorus-32, the duration of fission, etc. A number of papers dealt with neutron sources, neutron diffusion and calculations of distributions of neutron fluxes. The Stefan Institute of Ljubljana reported on the construction of a mass spectrograph, the Boshkovich Institute of Zagreb on the design of a cyclotron in the range of 20 MeV., and the Kidrich Institute of Belgrade on the functioning and improvement of the ion beam of a Cockcroft–Walton accelerator of 1·5 MeV.

At the final plenary session the congress adopted a series of decisions to be brought to the attention of the Yugoslav Government and the general public. Those pertaining to physics stressed the necessity of developing research in physics at the universities and urged greater material support of the Physics Department of the University of Belgrade. A systematic study was recommended for the development of physics in the country in the light of the development of its economy and the development of physics abroad. Especially underlined was the necessity for a more balanced development of physics research, with support for other branches of research in physics at least equal to that given to nuclear studies. There was considerable discussion, though no formal decision was taken, on the question of starting a central Yugoslav review of physics. At the congress an opinion was expressed that since physics in Yugoslavia is in the process of standing on its own feet, there should be, from an organization point of view, greater autonomy and independence of physics and mathematics activities in Yugoslavia. This point of view was reflected in the election of officers for the executive committee of the Federation, when Prof. G. Kurepa, a mathematician from Zagreb, was elected president, and Mr. A. Milojevich, a physicist from Belgrade, as secretary for physics.

STEVAN DEDIJER

ASSOCIATION OF SCHOOL NATURAL HISTORY SOCIETIES

ANNUAL EXHIBITION, 1954

THE annual exhibition of the Association of School Natural History Societies was held in London at the British Museum (Natural History) on November 6. The main contribution this year was made by member schools, one-third of which exhibited; this was a larger proportion than hitherto and resulted in the welcome criticism that the supply of bench space was too limited.

In spite of the lateness in the year, a wide variety of living material was exhibited. A collection of freshwater gastropods by Oundle School admirably illustrated the importance of accurate identification in limnological work. Bishop's Stortford College had reconstructed with living plants a quadrat from a derelict railway siding, and St. Paul's School, London, displayed living specimens to illustrate a genetical investigation of the shaker mutant in mice. Next year the London exhibition will be held in mid-October. It is hoped that this will encourage schools to produce even more living material.

Where it was impracticable to bring living specimens, most schools had brought preserved ones. University College School, London, filled a long bench with specimens illustrating the littoral biology of Skokholm, while Haileybury and Imperial Service College displayed a collection of the butterflies of France, made by present members of their Society. Lord Wandsworth College, Hampshire, showed a specimen of the water-beetle, *Agabus affinis*, which is a new record for the vice-county of North Hampshire. Further 'new records' were exhibited by naturalists of Kimbolton School who, in their survey of an overgrown Huntingdonshire orchard, have added seven new naturalized species, including *Anemone ranunculoides*, *Doronicum pardalianches*, *Tulipa sylvestris* and *Ornithogalum nutans*, to their county flora.

Many schools made good use of charts, diagrams and photographs to illustrate their work. Those exhibited by Bishop's Stortford College—on starling ringing, watches for visible migration and other ornithological problems—were exceptional for combining complexity with clarity, many being three-dimensional. Dulwich College and Reading School also provided well-documented accounts of their surveys. An interesting item was the 16-mm. colour film of the emergence, from the pupa, of a hornet clearwing moth, filmed by a member of Oundle School. Several schools demonstrated techniques which they had found useful, such as the plant-recording scheme shown by Uppingham School, and a method of mounting seaweeds demonstrated by Orange Hill Girls' Grammar School, Middlesex.

In addition to exhibits by member schools, there were displays by the Botanical Society of the British Isles, the British Naturalists' Association, the School Nature Study Union, the Universities Federation for Animal Welfare and several organizations connected with the British Museum (Natural History).

The increase in the number and size of exhibits received this year is an encouraging sign for the Association. Yet there are many members whose distance from London is such that they cannot attend. It is difficult for them, particularly if they are boarding schools, to arrange to bring a party to London; there is usually no possibility of being away from school overnight. For the benefit of its more distant members, the Association plans to hold an additional exhibition in Leicester next year. This should be within easy reach of schools situated in the Midlands and Northern England.

O. N. BISHOP

FINANCIAL EFFECT OF LABOUR TURNOVER

THE Research Board of the Faculty of Commerce and Social Science, University of Birmingham, has published a further monograph in its series of "Studies in Economics and Society", this latest being on "The Financial Effect of Labour Turnover", by Dr. F. T. Pearce*. The monograph, which is a mimeographed production, can be divided conveniently into three sections. The first section, of sixty pages, reviews many variants of the analytical definition of 'labour turnover' and its complement 'labour stability'. Not unnaturally, the author concludes that the definition adopted by the Birmingham School is to be preferred. This defines the rate of turnover as the number of employees who leave in a given period and have to be replaced expressed as a percentage of the average number employed during the period.

It should be pointed out that the rate so defined confuses current trends with the past economic fortunes of the employing company. A number of recent surveys (including one carried out by the Birmingham School) have established that the rate of labour wastage diminishes as length of service increases. If $F(t)$ is the proportion of an entrant group remaining in employment after t years service, if the rate of wastage $\varphi(t)$ is defined (by analogy with the demographer's 'force of mortality') by

$$\varphi(t) = -\frac{\mathrm{d}}{\mathrm{d}t}\{\log F(t)\},$$

and if n_j is the number of entrants into the firm during the year j, then the rate of labour turnover for the year x, to a first approximation, may be written:

$$\frac{\sum_t n_{x-t}\,F(t+\tfrac{1}{2})\,\varphi(t+\tfrac{1}{2})}{\sum_t n_{x-t}\,F(t+\tfrac{1}{2})}$$

Clearly the numbers n_{x-t} depend only upon past history and have no bearing upon current man-power problems. Equally clearly the formula will yield different rates of turnover for firms with identical rates of wastage but varying in their rates of growth or decay. This confusion of past and present makes it difficult to find any useful meaning for the calculated rate.

The second and largest section, which occupies the next hundred and ten pages, is an essay in accounting. A preliminary chapter outlines the theoretical approach and is followed by two detailed case studies. This section considers the effect on profits of the elimination of *all* labour wastage, and of all those extra charges which are incurred by management (for example, reserves of labour) in order to keep production flowing in spite of constant change in the labour force. A given output yields a gross profit margin of £P and requires N man-hours of 'direct' labour. If all workers had been experienced men, the same output would have required $N - l$ man-hours. The difference is due to the lower output of recruits during their first 21 weeks of employment. The 'ineffective' l hours are a fraction $l/(N-l)$ of the notional 'effective' time worked. The consequential loss of profit is assumed to be £$Pl/(N-l)$. The computation of 'ineffective' time rests upon a comparison of the piece-work earnings of recruits and experienced workers. The additional cost of 'indirect' labour is also estimated.

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* The Financial Effect of Labour Turnover. By Dr. Frank T. Pearce. (Monograph A.4 of the Research Board, Faculty of Commerce and Social Science, University of Birmingham.) Pp. 228; 1954. 15s.

The value of these painstaking case-studies is difficult to assess. The author has made a courageous attempt to provide a theoretical basis for his procedures, but the information he needs is just not available. Consequently, he is forced into numerous assumptions, particularly of linearity, that seem quite unreal. Moreover, the initial assumption of zero wastage is quite unattainable, except perhaps for isolated cases of very small concerns. Can it really be said that we are measuring the financial effect of labour turnover if we compare the actual outcome of a year's trading with what might have happened if the impossible had been achieved? The last, and shortest, section is an excellent summary of the remainder of the book. H. SILCOCK

SWEATING MECHANISM IN THE DOMESTIC BUFFALO

By DR. E. S. E. HAFEZ and M. M. SHAFEI
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WATER evaporation from the surface of the skin is the major factor in thermal regulation in mammals. Water comes to the surface as insensible perspiration, which is a physical process, and as sensible perspiration or sweating, which is a physiological process affected by the microanatomy, histology and surface area of sweat glands, as well as the blood and nerve supply of the gland.

We have investigated, by histological methods, the sweating mechanism in the domestic buffalo. Skin specimens from sixteen different regions of the body of three adult male buffaloes have been examined. Bouin's fluid was used for fixation and terpineol for clearing. Embedding was carried out under a vacuum of 67 cm. mercury using paraffin wax (m.p. 50° C.). Serial sections were cut at 25 μ and stained by Delafield's hæmatoxylin and 1 per cent aqueous eosin.

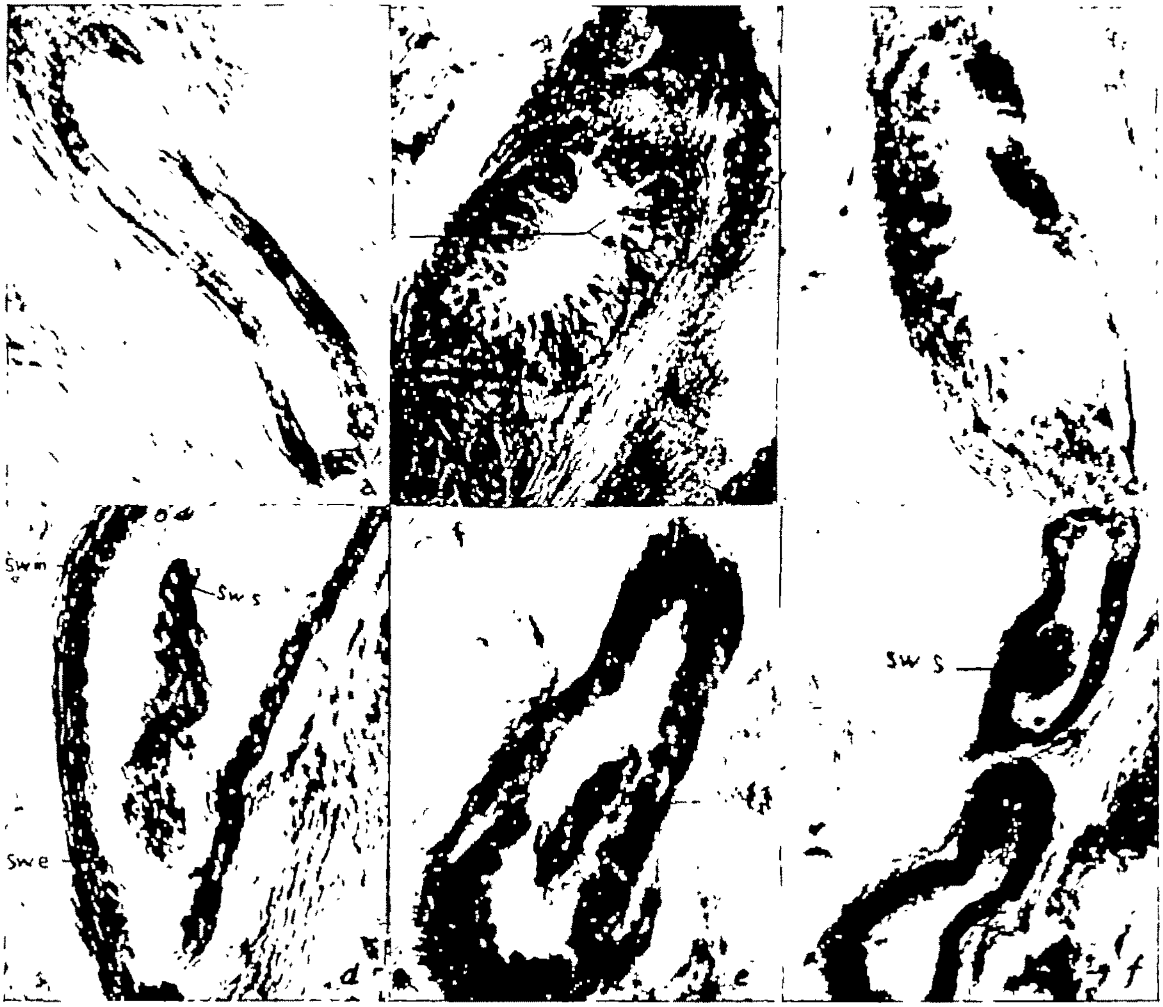

Fig. 1. Successive stages in the formation and intraluminal transformation process of the secretion of sweat glands in the buffalo (× 250)

(a) First formation of the cytoplasmic protrusions from the glandular epithelial cells
(b) Globular protrusions attached to the cells
(c) Chains of the globular protrusions
(d) Detached globules aggregated in the lumen
(e) Fusion of the globules
(f) A gel-like homogeneous material; note that the glandular epithelium is similar to (a)

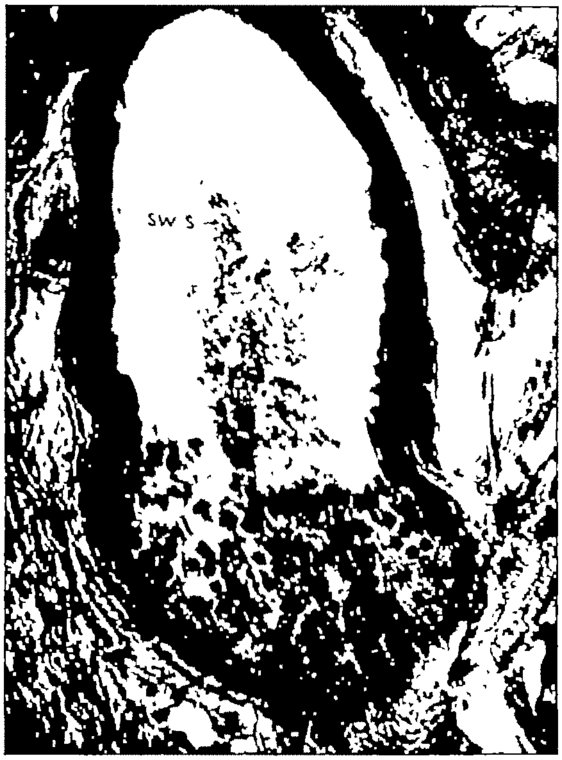

Fig. 2. Simple form of sweat glands in buffaloes (× 250). The glandular epithelium is composed of cubical or flattened cells with small nuclei. The material inside the gland consists of fine granules

In the buffalo, the body of the sweat gland is oval and convoluted, and the duct is twisted at its attachment to the body. The blood supply of the gland is very poor. The body wall is composed of two structures: an outer myoepithelium and an inner layer of glandular epithelium. The gland showed two types of active cells. In the first, a typical apocrine type, the glandular epithelium was made up of columnar epithelial cells with spherical nuclei and cytoplasmic protrusions at the apical portion. The lumen of the gland contained a stainable material which varied in form from separate globular pieces to homogeneous gel-like regions (Fig. 1). In the second type, the glandular epithelial cells were cubical or flattened, with small nuclei, the gland lumen was often empty and some glands contained a fine precipitated substance (Fig. 2).

Both types of glands were observed in the same section of skin and the apocrine form predominated. It would appear that the apocrine glands in the buffalo have only one phase in different stages, and that this stage of secretion is merely preparatory to the ensuing phase. The hypothesis of intraluminal transformation from coarse granules to a fluid-like substance[1] is thus supported. The microanatomy of the sweat gland may be involved in determining the form of secreted substance and may affect the expulsion of sweat. In the buffalo, the twisted duct delays the emptying of the sacular body; this may induce a back pressure which interferes with the elaboration of sweat substance.

Further work is needed to correlate these histological findings with the physiological background of the sweating mechanism. The chloride concentration in bovine skin will be important in determining the nature of insensible perspiration often observed in certain body regions such as the base of the ear, lateral and ventral neck, axilla and groin. Geographical locality of the animal will probably also affect the sweating mechanism.

This work was carried out at the Animal Breeding Research Farm and the Agricultural Zoology Department, Cairo. Thanks are due to Prof. A. L. Badreldin for his encouragement and suggestions. Work is still in progress and detailed results will appear elsewhere. [Aug. 2.

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[1] Findlay, J. D., and Yang, S. H., *J. Agric. Sci.*, 40, 126 (1950).

DIGESTIBILITY OF A SAMPLE OF PASTURE GRASS BY CALVES

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and R. H. ARMSTRONG

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THE possibility of rearing calves on pasture grass from an early age has recently received a considerable amount of attention in Great Britain. The method, which possesses certain economic advantages, has been common practice in New Zealand for a number of years.

Relatively little information exists concerning the utilization of grass by calves. Conrad and co-workers[1], in a study of the effect of rumen inoculations on the digestibility of roughage by young calves, determined the digestibility of lawn clippings, and one of us (Preston, unpublished results) has obtained preliminary figures using fæcal index techniques with the grazing animal. In view of the limited observations available and the need for confirming coefficients of digestibility obtained by fæcal index methods, it was decided to determine the digestibility of a sample of pasture grass by calves aged 10–12 weeks. To allow for the material being fed in the fresh condition, the cold-storage technique developed by Raymond *et al.*[2] was used.

A uniform sample of herbage from a long-established ley was cut on May 25 at the pre-flowering stage. Botanical analysis showed it to contain 91·9 per cent of grass and 5·7 per cent of clover. Accurately weighed quantities of the herbage (15 lb. or 20 lb.) were placed in sacks, which were immediately frozen and cold-stored at 0–5° F. The above amounts were estimated to provide a daily intake of 3 lb. or of 4 lb. of dry matter. As every ten sacks were filled, a 200-gm. sample was taken for dry-matter determination and for the provision of a representative sample.

Four unrelated Ayrshire male calves each reared from birth on pasture, and 34 gal. of milk were put into metabolism crates at the age of nine weeks. Fæces were collected in rubber bags, the bags and harness being based upon a design supplied by Dr. K. L. Blaxter. During the experimental period, which comprised a 10-day preliminary and a 10-day collection period, each animal received the contents of one sack of herbage daily. Calves 1, 3 and 4 were fed 15-lb. quantities; calf 2, by reason of its greater live weight, was fed 20 lb. Feeding times were 9.0 a.m., 11.30 a.m., 2.30 p.m. and 5.0 p.m. With the first and last feed of each day, a gelatine capsule containing 2 gm. chromium oxide (Cr_2O_3) was given. When first fed the frozen grass, calf 3 scoured badly, but quickly recovered following the administration of 20 mgm. of aureomycin on three consecutive days. The remaining calves were dosed simultaneously.

The large weights of fæces voided necessitated the bags being changed twice daily. The weights of fæces were determined by weighing the bags prior to, and immediately after, use. After the contents of each bag had been thoroughly mixed, duplicate 80–100 gm. samples for dry matter were weighed on to tared pieces of grease-proofed paper and thinly spread by means of a spatula to ensure efficient drying. The papers were dried to constant weight in a 'Unitherm' oven at 100° C. Using this technique, agreement between duplicates was invariably excellent. Aliquots of the fresh fæces (10 per cent by weight) were transferred to waxed cartons and kept in cold storage until the end of the trial, when they were bulked to provide representative samples.

The representative samples of wet fæces were treated as follows: 150 gm. was intimately mixed with approximately 100 gm. water in a 'Magimix' blendor, and accurately weighed quantities of the resulting suspension were analysed for dry matter, nitrogen and 'macerate crude fibre'[3]. The remainders of the bulked samples were oven-dried at 60° C. for 48 hr., ground and afterwards analysed for residual moisture, ash, ether extract and crude fibre, by the conventional methods. All samples were further analysed for lignin by the method of Norman and Jenkins as modified by Common[4], and for cellulose by the method of Norman and Jenkins[5]. Chromium oxide was determined according to the procedure of Schürch, Lloyd and Crampton[6].

Table 1. ANALYSIS OF GRASS AND THE DIGESTIBILITY COEFFICIENTS DETERMINED FOR CALVES

	Analysis of feed (per cent of dry matter)	Digestibility coefficients				
		Calf 1	Calf 2	Calf 3	Calf 4	Mean
Dry matter	—	74·6	74·5	78·5	72·4	75·0
Organic matter	92·76	76·6	76·9	80·5	74·5	77·1
Crude protein	13·57	60·1	58·9	65·7	54·5	59·8
Ether extractives	3·69	44·0	43·3	52·9	42·2	45·6
Crude fibre	25·41	78·7	79·0	82·9	77·3	79·7
Nitrogen-free extractives (by difference)	50·09	82·5	82·8	85·3	80·9	82·9
Cellulose	35·22	83·2	85·4	87·7	79·8	84·0
Lignin	3·79	2·1	−7·1	14·7	2·4	3·0

The analysis of the grass and the digestibility coefficients determined are shown in Table 1. While, in general, the digestibility coefficients for calves 1, 2 and 4 show satisfactory agreement, the values obtained for calf 3 are consistently higher. The high digestibility of the organic matter and of the cellulose fraction in particular, and the relatively low value for the apparent digestibility of protein, are noteworthy features of the results. Lignin is clearly almost indigestible.

TABLE 2. CHROMIUM OXIDE RECOVERY

Weight fed (gm.)	Weight recovered in fæces (gm.)				Mean percentage recovery
	Calf 1	Calf 2	Calf 3	Calf 4	
40·00*	41·10	40·78	38·90	42·79	102·30±1·93

* The capsules were guaranteed to contain 2 gm. chromium oxide with a maximum variance of 3 per cent.

From the results shown in Table 2, it can be seen that, with perhaps the exception of calf 4, the recovery of chromium oxide in the fæces has been very satisfactory.

It has already been noted that only one of the calves (calf 2) received the higher intake of 20 lb. a day throughout the experimental period. Before the conclusion of the collection period, calf 3 was clearly capable of eating more than the 15 lb. offered. That this underfeeding may have been responsible for the more efficient digestion of the grass by this animal is suggested by the work of Mitchell *et al.*[7], who, in experiments with steers, showed that the digestibility of dry matter in a ration increased as the level of feed was reduced.

Perhaps the outstanding feature of the results is the very high digestibility of dry matter in the fresh herbage. The coefficients of digestibility for cellulose are even higher. Figures of this magnitude can only reflect an advanced development of the rumen, which is surprising considering the age of the calves. It will be recalled, however, that the calves had been reared on grass from birth, during which period live-weight gains of up to 1 lb. a day were made, and certainly their appearance denoted good paunch development. It should be added that similar values for dry matter and cellulose digestibility, namely, 72·0 per cent and 82·0 per cent, were obtained by Conrad *et al.*[1] during the course of feeding freshly cut lawn clippings to nine-week old calves.

The relatively low apparent digestibility of the protein is difficult to account for in view of the high coefficients obtained for dry matter. It may be that they result from the excretion of considerable quantities of metabolic nitrogen in the fæces. Blaxter and Wood[8] have quoted a value of 2 gm. metabolic fæcal nitrogen per 100 gm. dry matter excreted, for very young calves; and if this factor is used to correct the values for nitrogen excretion, the mean true digestibility coefficient of the protein is found to be 82·9 per cent.

The satisfactory recovery of chromium oxide obtained in this instance would appear to justify the use of this substance as a reference material for indirect digestibility studies with calves.

In studies on the digestibility of herbage, Raymond *et al.*[9] have calculated a regression equation for sheep which relates organic matter digestibility with (1) macerate crude fibre content in fæces ($y = 93 \cdot 42 - 0 \cdot 6582\,u$, where y is digestibility of organic matter and u is per cent macerate crude fibre in fæces on an organic matter basis), and (2) nitrogen in fæces ($y = 44 \cdot 85 + 7 \cdot 947\,v$, where v is per cent nitrogen in fæces on an organic matter basis). Applying regressions 1 and 2 to the results obtained in the present experiment, the mean calculated digestibility coefficients for organic matter are 78·69 and 77·56, respectively. These values compare favourably with the determined value, namely, 77·14. While further confirmatory evidence is needed, these results would suggest the possibility of using the above regressions in digestibility studies with calves at pasture.

We wish to thank Mr. G. A. Cragghill for his assistance in the investigation. [Sept. 24.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Direction of Polarization of Proton Spin produced by Elastic Scattering

BEAMS of high-energy protons with spin polarization are produced by scattering unpolarized protons from nuclei[1,2]. If the protons are scattered elastically, the polarization is considerably larger than if the scattering occurs by inelastic processes[3,4]. A theoretical interpretation has been suggested by Fermi and others[5], which demonstrates that the polarization of the elastically scattered beam may be accounted for as a consequence of the spin orbit-coupling postulated in the nuclear shell model of Mayer and Jensen. This hypothesis gives correctly the magnitude of the observed polarization, and in addition predicts the direction of the polarization. In particular, if the scattering is to the right at small angles, this hypothesis requires the predominant spin direction to be downward.

The object of the present experiment was to measure the direction of the polarization, a property impossible to determine by the usual double-scattering experiments. The measurement depended on knowledge of the polarization resulting from interference of the energy-levels involved in the elastic scattering of protons on helium in the energy region 1–15 MeV. From the cross-section data for this reaction, Critchfield and Dodder[6] have evaluated the phase shifts. In fact, two representations of the data were found, for both of which the ^2P phase shifts were positive (attractive potential). In one solution the ^2P-states were inverted, and in the other solution they were normal. Interference of the states of the doublet produces a polarization of the scattered protons. Heusinkveld and Freier[7] observed the second scattering asymmetry resulting from this polarization, and by its magnitude at a given energy were able to conclude that the P-state is an inverted doublet.

This information allows one in principle to determine the spin direction of a beam of polarized protons by a similar experiment.

In the present investigation, a 435-MeV. 60 per cent polarized proton beam was produced in the cyclotron by scattering elastically the circulating protons of 450 MeV. maximum energy at 14° from an internal beryllium target. The polarization of the emergent proton beam was determined in the usual way, by measuring the asymmetry of elastic scattering from beryllium at the same angle, namely, 14°. Then the protons were slowed down by passing through a thickness of copper approximately equal to their mean range, after which they were expected still to be polarized[8]. The protons of various low energies in the region 0–20 MeV. were then collimated carefully. Next they entered a scattering chamber filled with helium at atmospheric pressure (see Fig. 1). Nuclear emulsions (Ilford *E*1) were placed to right and left in the scattering chamber in such a way that protons scattered by the collimating system could not reach them, and in such a way that protons scattered in the horizontal plane by helium and at ± 90° to the beam entered the emulsion in a direction normal to the surface.

There were approximately 30,000 high-energy protons arriving per second at the copper attenuator. The flux, however, was drastically reduced by scattering during energy degradation and subsequent collimation. The frequency of occurrence of events in the plates is found to be in rough agreement with the estimated slow-proton flux and with the elastic scattering cross-section of helium.

From the direction in which a scattered proton enters the emulsion and from its energy as determined by its range in the emulsion, one computes the energy of the proton before scattering. Only those events are accepted for measurement in which the proton enters the emulsion within 45° of the normal to the surface of the emulsion. At present, approximately fifty events have been found. In Fig. 2 the number of events is plotted against the incident energy computed for the scattered proton.

For comparison purposes we have calculated the helium cross-sections for a proton beam polarized with spin down, for scattering to right and to left, as a function of energy and angle using the phase shifts at present available[6,9]. The differential cross-sections have been integrated over the solid angle of

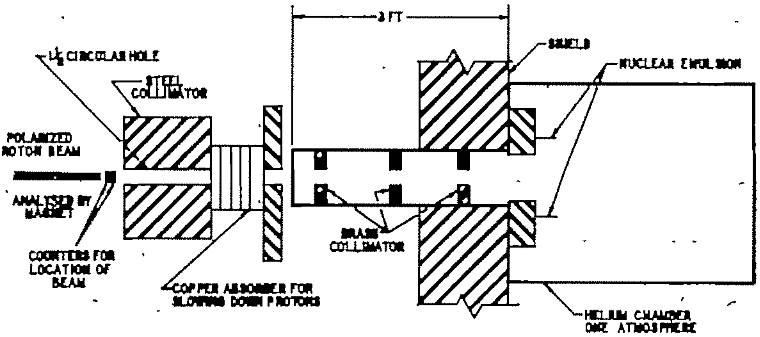

Fig. 1. Schematic drawing of experimental arrangement for exposure of nuclear emulsions to energy-attenuated polarized beam

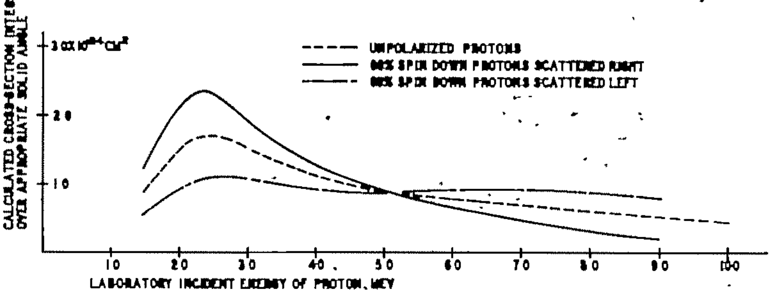

Fig. 2. Helium elastic scattering cross-sections for protons versus proton energy, calculated from phase shifts, and integrated over solid angle in which scattering events were accepted. The cross-section for unpolarized protons scattered either to left or right is shown, and also the cross-sections for protons 60 per cent polarized with spin down, scattered to left and to right. For the case of protons 60 per cent polarized with spin up, the designations on the two latter curves are interchanged

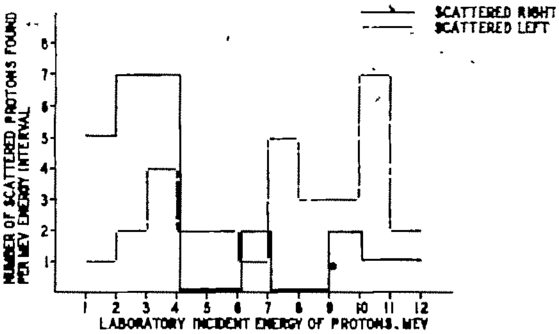

Fig. 3. Number of polarized protons observed to be scattered to left and to right between θ = ± 45° and θ = ± 135° laboratory angle shown plotted versus energy of incident proton

acceptance and corrected for the fact that the incident beam is 60 per cent polarized. The resultant cross-sections, plotted in Fig. 3, show right scattering stronger than left scattering near 3 MeV., and at 7–11 MeV. right scattering weaker than left scattering. If, on the other hand, the incident beam were assumed polarized with spin up, the cross-sections in Fig. 3 for scattering to the left and right would be interchanged.

The results in Fig. 2 show, however, a behaviour similar to the curves of Fig. 3, within the large statistical errors. Consequently we reach the tentative conclusion that the proton beam incident on the helium is polarized with spin down.

We now return to a consideration of the first scattering which produced the polarized beam. The first scattering, in the cyclotron, was to the right, for which, for an attractive potential, $\vec{L}$ is directed downward.

But the tentative conclusion allowed by the foregoing evidence is that the spin of the right scattered beam is downward, that is, parallel to $\vec{L}$. Then the elastic scattering is stronger at small angles for spin parallel to $\vec{L}$, in agreement with the proposal[8] that the polarization is due to the spin orbit-coupling effective in nuclear shell structure.

We hope to publish soon a more detailed discussion of this experiment, including better statistics of the scattering events. We are grateful to Robert March for help in plate scanning, and to Dr. Frank Solmitz, who helped in the calculation of the cross-sections in Fig. 2.

This investigation was supported by a joint programme of the U.S. Office of Naval Research and the U.S. Atomic Energy Commission.

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Chemisorption on Metals

The criterion for chemisorption on metals is the occurrence of an electron switch, the resulting complex having a dipole moment orientated vertically to the surface. The method of contact potentials has been employed to evaluate the magnitude of the change in work function of the surface as a result of chemisorption, and recently the vibrating condenser method has been used for the same purpose. There are some disadvantages attached to these methods. In the former, thermal radiation from the emitter may alter the composition of the chemisorbed layer on the cold surface; in the latter, the presence of a large amount of metal and the assumption that only parts of the system are affected by the introduction of the gas militate against the exact determination of the dipole-moment surface-coverage (μ, θ) relationship.

We have recently explored the potentialities inherent in the determination of this relationship by photoelectric methods. The method consists essentially in measuring the photo-current produced on illumination of a freshly formed metallic mirror with ultra-violet light of suitable wave-lengths transmitted through a quartz window. From the adsorption isotherms it is possible to evaluate the coverage as a function of dosage and to make simultaneous measurements of the photo-currents. Some values for the change in work-function potential are given for $\theta = 1$ in Table 1.

Table 1

Surface	Ta—H	Ta—CO	Fe—H	Fe—CO	Co—H	Co—CO	Ni—H
potential in volts	+0·43	−0·67	−0·19	−1·15	−0·06	−0·27	−0·12

Of great interest is the fact that the curve of dV against surface coverage (θ) is not linear over the whole range of coverage but shows a curvature at the commencement. In addition, as seen from Fig. 1, when θ is equal to or greater than 0·6, there is a falling off in the value of the apparent dipole moment, thus providing additional support to the view, based upon experimental determination of the adsorption isotherms and on heats of adsorption, that at least in many cases of chemisorption the bond-strength between adsorbate and adsorbent is not constant but changes as the electron density in the

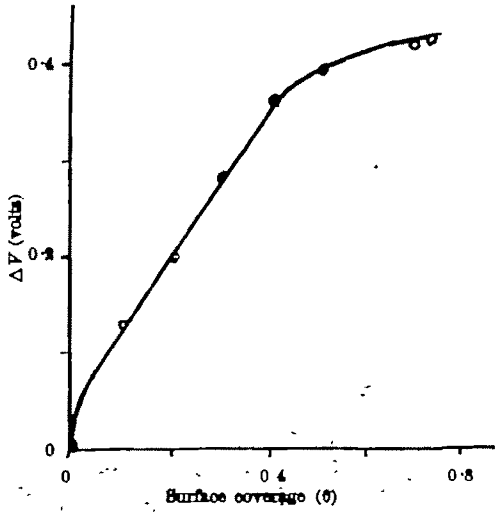

Fig. 1. Variation of surface potential with surface coverage (hydrogen adsorption on tantalum)

metal surface undergoes changes as a result of chemisorption.

It is hoped to publish a more detailed account of the method shortly.

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Transition Temperature of Polymethyl Methacrylate at Ultrasonic Frequencies

Pulse method measurements by Krishnamurthi and Sastry[1] and Melchor and Petrauskas[2], of the variation of ultrasonic velocities with temperature for polymethyl methacrylate ('Perspex'), showed that the transition temperature was independent of frequency (0·5–10 Mc./s.). Protzman[3], using an optical diffraction method, found that the transition point for 'Plexiglas II' (unplasticized 'Perspex') varied from 63° C. at 3 Mc./s. to 49° C. at 11 Mc./s. The authors claim an accuracy of ± 1 per cent for their results, which are shown in Fig. 1, together with some of my own results. The following comments are made on these results.

(*a*) Results on different samples of commercial plastic materials are likely to vary. This has recently been pointed out in low-frequency work on polymethyl methacrylate by Deutsch, Hoff and Reddish[4]. Heating may also cause irreversible changes in plastic materials.

(*b*) Protzman's[3] velocity results differ from Melchor's[2] by a maximum of 6 per cent, the agreement being good at room temperature. One possible error in Protzman's[3] work is that several watts of ultrasonic energy could have been transmitted into the sample. This would cause internal heating, and the observed temperature in the surrounding liquid would not be the true sample temperature. Protzman does not state the energy used, but he mentions that 500–1,000 volts (radio-frequency) were applied to the quartz crystal. This is much higher than is usual. This internal heating would be dependent on frequency and could cause the variation of transition temperature with frequency. A further possible error, if the transducer was small and high energy was used, may have been that ultrasonic waves were transmitted into the oil-bath from the sample. If this occurred, then the light beam would have been diffracted in the liquid as well as the solid. Willard[5], using an improved optical diffraction method for plastics, allows a parallel ultrasonic beam to be transmitted into the solid and surrounding liquid medium. He then corrects his velocity results for the variations in velocity of sound in the liquid with temperature.

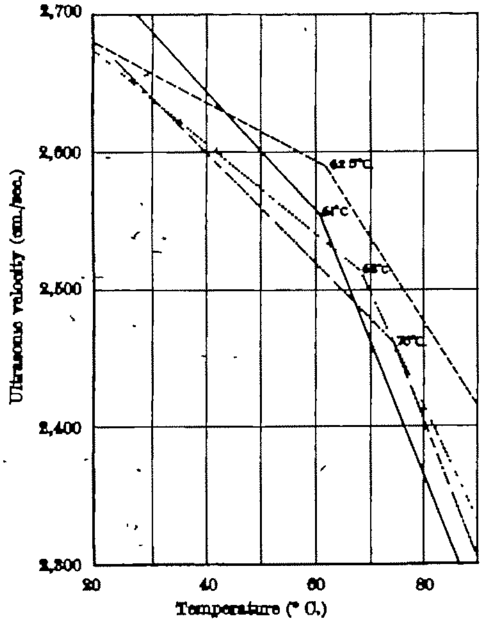

Fig. 1. Ultrasonic velocity – temperature curves for polymethy methacrylate. — — —, Protzman's results at 3 Mc./s., frequency-dependent; ....., Hatfield's results at 350–750 kc./s.; —·—·, Melchor and Petrauskas's results at 0·5–10 Mc./s.; ———, Krishnamurthi and Sastry's results at 1–6 Mc./s.

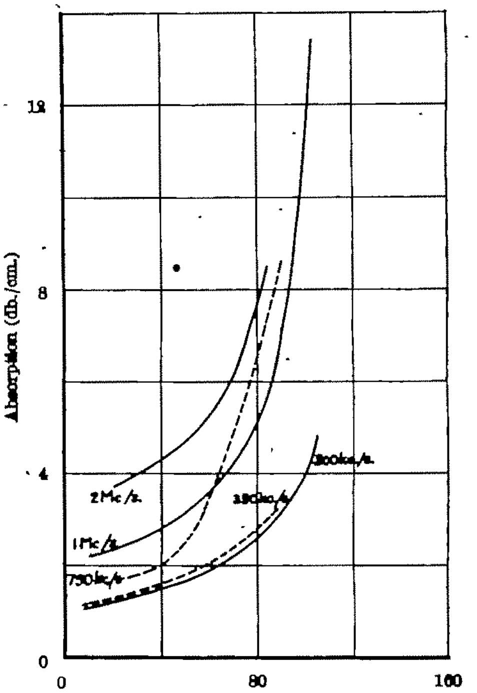

Fig. 2. Absorption in polymethyl methacrylate. ———, Melchor's results; – – – –, Hatfield's results

(*c*) The slopes of the curves obtained by Krishnamurthi[1] and Melchor[2] are similar, but the transition temperatures differ by approximately 14° C. Melchor points out that the determination of this transition temperature to within a few degrees is not easy because of the high absorption of polymethyl methacrylate, at temperatures above 60° C. and frequencies greater than 1 Mc./s. Fig. 2 shows results obtained by Melchor and myself (accuracy ± 1 db.) for the variation of absorption with temperature at frequencies less than 2 Mc./s.

(*d*) The pulse method has been greatly improved by Mason[6], and it would be interesting to repeat the pulse experiments on polymethyl methacrylate using this method.

(*e*) Fig. 1 shows my velocity measurements for polymethyl methacrylate plotted against temperature at frequencies less than 1 Mc./s. These results were obtained using a low-power (less than 1 watt) continuous-wave phase method[7]. The absolute accuracy of this method is not as good as the attainable accuracy of the optical diffraction or pulse method, particularly for materials the acoustic impedances of which differ appreciably from those for water or oil, but the low absorption at high temperatures at less than 1 Mc./s. is not a source of error. The velocity results at 350 and 750 kc./s. are not significantly different, and the transition temperature over a series of runs varied between 66° and 71° C. These results are similar to those obtained by Melchor[2] and by Krishnamurthi[1].

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Low-temperature Sintering of Titanium Dioxide for Ceramic Capacitors

THE investigations carried out by Berberich[1], Von Hippel[2] and Wainer[3] and their associates on titanium dioxide point to certain optimum firing conditions. In particular, a temperature of 1,350° C. is found to be suitable for obtaining most of the desirable electrical characteristics. Among these characteristics may be specially mentioned low water absorption, high permittivity, high insulation resistance and low loss-angle. From the known values of the two principal permittivities of the single crystal of rutile, the permittivity for randomly oriented powdered rutile would be about 114. The values of the permittivity reported in the literature vary from 96 to 100, and water absorption is known to be about 0·1 per cent. The rutile form of titanium dioxide used in their experiments was prepared by calcining commercial quality titanium dioxide, probably of the anantase type, at 1,350° C.

In some large-scale experiments carried out at the National Physical Laboratory of India on a particular brand of commercial quality of titanium dioxide bearing the trade name "Rutiox CR" (Kronos), it has been possible to obtain ceramic bodies with excellent dielectric properties when fired at temperatures as low as 1,100° C. in electric furnaces. It was not found necessary to calcine the material first, and a straight firing schedule was adopted which gave well-sintered bodies. The neutral atmosphere of the electric furnace and the partially reducing atmosphere of a gas furnace gave identical results. It was also found that the sintering temperatures were not very critical, as reported by earlier investigators. Satisfactory bodies could be obtained when fired over a range of temperatures from 1,100° to 1,400° C.

X-ray diffraction studies and the density measurements showed that the raw material was of the rutile crystalline form. Measurements by microscope of particle-size indicated sizes generally in the range 1–5 microns, with crystal edges sharp, indicating that the titanium dioxide was perhaps manufactured in these particle sizes, by chemical processes and not by grinding calcined material.

Some typical values obtained with bodies prepared as stated above are: water absorption, 0·01 per cent; permittivity, 110.

It would appear that the low sintering temperatures, coupled with good electrical properties, are due to the rutile crystalline form and the finely divided active state of the titanium dioxide used.

Fuller details of the experiments will be reported elsewhere. We are indebted to Sir K. S. Krishnan for his advice and guidance.

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Polymerization Reactions occurring during Dinitrophenylation of α-, β- and ω-Amino-acids with Sanger's Reagent

NUMEROUS papers have been published concerning the identification and determination of amino-acids by the dinitrophenylation method introduced by Sanger[1]. We are not aware, however, of any indications in the literature about the occurrence of polymerization reactions during dinitrophenylation. In an attempt to work out a procedure for the quantitative determination of minute amounts of ε-aminocaproic acid and its linear oligomers, we have found that such polymerization reactions do occur. Similar results have been found during dinitrophenylation of other ω-amino-acids and of glycine and β-alanine. Since these side-reactions may lead to complications in investigations on the separation and determination of dinitrophenyl amino-acids in general, it seems useful to communicate these facts briefly.

Dinitrophenylations were carried out by Sanger's method[1], using 1-fluoro-2,4-dinitrobenzene in aqueous ethanol in the presence of sodium bicarbonate. Isolated products as well as samples of reaction mixtures were analysed by chromatography on paper strips using a descending technique (see Table 1). Since pure ε-aminocaproic acid and the nearly pure synthetic dimer and trimer of the acid[2] were at our disposal, chromatographic spots of the corresponding dinitrophenyl derivatives could be easily identified. With the eluent used, R_F-values decrease with increasing molecular weight (Table 1). The purity of our samples of aminocaproic acid was checked by chromatography of aminocaproic acid as such (method worked out by van der Want[3], slightly modified).

From a mixture of initial composition 0·75 m.mol. ε-aminocaproic acid, about an equimolecular amount of fluorodinitrobenzene and 1·6 m.mol. sodium bicarbonate in 10 ml. aqueous ethanol (25 per cent of water), reacting at room temperature, samples were taken at successive intervals. Each sample served to place ten spots (of 10 µl. each) on a chromatographic strip. Depending upon the duration of reaction, one or more additional spots appeared on the eluted chromatograms besides the expected spot of dinitrophenyl–aminocaproic acid. From their R_F-values relative to that of the latter, these spots could be identified as the dimer, trimer and so on.

Table 1. – Polymerization Products produced during Dinitrophenylation of the Monomers and their Relative R_F-values (R_F-values of the corresponding Dinitrophenyl-monomers taken as Unity)

Chromatography on Whatman No. 1 paper (soaked in 0·1 *M* citric acid and dried in air) with a mixture of *n*-propanol (diluted with water to spec. gr. 0·818), glacial acetic acid (containing 1·5 per cent of water) and kerosene (b.p. 100–140° C.) in the volume proportions 20 : 6 : 100

ω-Amino-undecanoic acid	ω-Amino-heptanoic acid	ε-Amino-caproic acid	β-Alanine	Glycine	Dinitro-phenyl-
1	1	1	1	1	monomer
0·50	0·48	0·46	0·37	0·39	dimer
0·33	0·31	0·27	0·23	0·12	trimer
—	0·16	0·17	0·11	—	tetramer
—	—	0·10*	—	—	pentamer

* Only found once in a dinitrophenyl-aminocaproic acid sample synthesized by a method not mentioned in this communication.

This proves that polymerization occurs during the dinitrophenylation reaction.

Mixing the reagents and reaction products (including the products of other side-reactions known to occur, like dinitrophenol, dinitrophenetol) in various combinations and examining the products eventually obtained, we found that at least the components fluorodinitrobenzene, aminocaproic acid (and dinitrophenyl–aminocaproic acid) must be present to produce polymerization.

As pointed out recently by Bunnet and Davis[3] and by Zahn and Kocklauner[4], dinitrophenyl halogenides behave as acid halogenides in many respects. Frankel, Liwschitz and Zilkha[5] have found that acetyl chloride can produce polymerization of amino-acids even at room temperature. It seems that fluorodinitrobenzene can give rise to analogous reactions.

Other amino-acids such as ω-aminoheptanoic acid, ω-amino-undecanoic acid, β-alanine and glycine also show some polymerization when dinitrophenylated by the method described above.

In the dinitrophenylation of aminocaproic acid with reaction times from 1 to 120 hr., the proportion of the dimer to the dinitrophenyl–aminocaproic acid varied from about 2 to 20 mol. per cent (also depending upon the water content of the mixture). After 120 hr., only about 40–50 per cent of the expected quantity of dinitrophenyl–aminocaproic acid was present, and total conversion of ε-aminocaproic acid into the dinitrophenyl compounds was about 60 per cent. This was established by elution of the spots from the paper, followed by ultra-violet light absorption measurements.

More complete conversion of aminocaproic acid into dinitrophenyl–aminocaproic acid and its oligomers was achieved only after evaporation of the reaction mixture until dry at elevated temperatures. This is in agreement with the work of Schroeder and Le Gette[6], who reported that conversion is enhanced by raising the concentration of the amino-acid in the reaction mixture.

From the other amino-acids we have not measured the proportions of the polymerization products, but from the intensity of the spots on the chromatograms it can be estimated that the proportion of dinitrophenyl–amino-acid dimer found under equal reaction conditions is in the following order of increasing magnitude:

Glycine < β-alanine < ε-aminocaproic acid ~ ω-aminoheptanoic acid ~ ω-amino-undecanoic acid.

Since dinitrophenyl–glycine dimer formation is very small, this may also pertain to other α-amino-acids and may explain the favourable results achieved by Mills[7] for glycine, aspartic and glutamic acid. Nevertheless, certain losses in quantitative dinitrophenylation experiments with α-amino-acids may be due to polymerization, and the occurrence of parasite spots on the chromatograms would then also be accounted for.

Table 1 gives a review of the relative R_F-values of the dinitrophenyl oligomers of the various amino-acids.

We are indebted to Dr. G. M. van der Want[2] (Delft) for supplying the samples of ε-aminocaproic acid dimer and trimer, and to Dr. H. Zahn (Heidelberg) for a supply of fluorodinitrobenzene. Grateful acknowledgment is made to Mr. F. Woutman (Arnhem) for carrying out the ultra-violet extinction measurements and to Miss E. A. Smit for performing the numerous experiments. This work has arisen from a programme of fundamental research on polyamides carried out in co-operation with the Plastic Research Institute T.N.O., Delft, and sponsored by AKU (General Rayon Union), Arnhem, and Netherlands State Mines, Geleen.

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Alternation in the Adsorption of Aliphatic Acids on Porous Carbon

Alternation in many of the properties of successive members in homologous series of solid long-chain compounds is well known. We are reporting the direct observation of a similar alternation in the maximum adsorptions of mono-[1] and di-carboxylic acids from aqueous solutions on two series of coconut shell charcoals of different degrees of activation. Some alternation in the adsorptions of these acids on a single 'Norite' charcoal was found indirectly by Linner and Gortner[2], who made a Langmuir extrapolation of their isotherms to maximum adsorption.

In the present work the adsorptions were measured by the change-in-titre method. The results for a more activated charcoal are given in Fig. 1. As the activity[1] of the charcoals decreased, the degree of alternation in adsorption decreased. In the case of the mono-acids, alternation disappeared entirely for the lesser activated charcoals; apparently it was masked by molecular sieving.

The alternation in adsorption is compared with the alternation in melting points of the acids in Fig. 1. The scales for the two acid series were displaced so that each series would appear separately. The arbitrary elements in the graph are the temperature and adsorption scales themselves, and the approximate overlapping of the melting point and the adsorption of one of the acids in each acid series. The results suggest that there is a close correlation

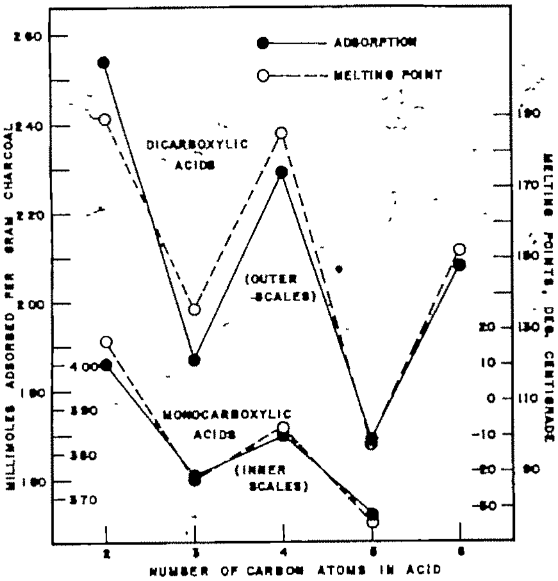

Fig. 1

between the alternations in melting points and adsorptions. Thus it would appear that the saturated adsorbed film is in a highly oriented state such as in crystalline solids.

We believe that an explanation for the alternation in the case of adsorption must be looked for in differences in lateral packing rather than in the lengths of the chains[3]. Moreover, our observations tend to refute the suggestion that adsorption from binary mixtures on porous adsorbents is always by a pore-filling mechanism[4]. Rather, they strongly suggest that adsorption of the aliphatic acids from aqueous solutions on porous carbons is in unimolecular layers.

We wish to acknowledge financial assistance from the National Research Council of Canada for a part of this work, and also helpful discussions with Prof. R. U. Lemieux. A complete report of the work is appearing in the *Canadian Journal of Chemistry*.

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Identification of an Artefact on Chromatograms of the Keto-acid 2,4-Dinitrophenylhydrazones

DURING a study of plant keto-acids carried out by one of us (G. H. N. T.) under the direction of Prof. F. C. Steward at Cornell University, an unknown substance, hereafter designated compound I, was found in the keto-acid fraction of all plant tissues examined[1]. This substance was isolated in crystalline form (sint. 206°, decomp. 214°) from the keto-acid dinitrophenylhydrazone fraction of *Mentha piperita* leaves by elution from an alumina column with 1 per cent sodium carbonate. Its position on chromatograms was similar to that of the slower-moving spot of pyruvic acid dinitrophenylhydrazone (Fig. 1, ref. 1). The pyruvic acid spot developed a chocolate colour when sprayed with alkali, whereas compound I gave a yellow colour. On hydrogenation, compound I yielded a ninhydrin-reactive substance (compound II) which was chromatographically similar to γ-aminobutyric acid (Fig. 2, ref. 1). The infra-red absorption spectrum of compound I did not display the carboxyl peak characteristic of α-keto-acid dinitrophenylhydrazones.

We have utilized the same procedures[1] for a study of the relation between the keto-acids and the fixation of carbon-14 dioxide in leaves. Compound I consistently recurred on chromatograms of the keto-acid dinitrophenylhydrazones. Although under favourable conditions radiocarbon was incorporated by the leaf into most of the recognized keto-acids, it never entered compound I. We therefore suspected that it might be an artefact.

When the reagent (2,4-dinitrophenylhydrazine) was dissolved in ethyl acetate and extracted with alkali in the manner used in the keto-acid method, a brown gum was recovered from the alkaline extract. Chromatograms of this gum showed two main spots: one, a fast-moving brown spot; the other, identical in position with compound I. Alkali-extracted and recrystallized 2,4-dinitrophenylhydrazine still gave these substances on a second extraction with alkali.

A survey of the literature showed that an alkali-soluble compound, 1-hydroxy-6-nitro-1 : 2 : 3 benzotriazole, is obtained on treating 2,4-dinitrophenylhydrazine with alkali. Accordingly, some of this compound was prepared by refluxing 2,4-dinitrophenylhydrazine with hydrazine hydrate[2], and its physical and chemical properties were compared with those of compound I isolated from *Mentha* leaves. The two substances were found to be identical with respect to infra-red spectra, melting characteristics and chromatographic co-ordinates.

This finding has an important bearing on the current use of 2,4-dinitrophenylhydrazine as a reagent for the detection of keto-acids. The artefact may interfere on one-directional paper chromatograms of keto-acid dinitrophenylhydrazones because its position overlaps that of pyruvic acid dinitrophenylhydrazone. The effect may, however, be minimized by avoiding an excess of reagent. In addition, the artefact may be partially separated from the slower-moving spot of pyruvic acid dinitrophenylhydrazone with certain solvents as shown in Table 1.

Table 1

	Rf values		
	Solvent *A*	*B*	*C*
1-Hydroxy-6-nitro-1 : 2 : 3 benzotriazole	0·56	0·43	0·81
Pyruvic acid dinitrophenylhydrazone (slower-moving spot)	0·60	0·40	0·84

A, *t*-amyl alcohol/ethanol/water (ammonia vapour), 9/1/2.
B, *t*-amyl alcohol/*n*-propanol/ammonium hydroxide, 13/1/6.
C, 0·5 per cent sodium carbonate.

We wish to acknowledge the helpful suggestions of Dr. M. Kates.

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Classification of the Antifungal Antibiotics from *Bacillus subtilis*

SEVERAL papers have recently appeared describing substances produced by *Bacillus subtilis* which exhibit antifungal activity with only incidental antibacterial action. Though the chemical and physical properties of these substances were not thoroughly investigated, it appears that some of them are similar and can be grouped together. Table 1 summarizes the known properties of nine of these antifungal antibiotics. It shows that whenever tested, these substances proved to be extracellular, acidic, non-dialysable and heat-stable polypeptides, not affected by pepsin and trypsin. They are soluble in polar, and insoluble in non-polar, organic solvents. Peptides I, II and III have an acid equivalent weight in the neighbourhood of 1,000, and an acid dissociation constant of about $pK = 5 \cdot 5$; as acidic polypeptides, they are soluble in alkali and insoluble in water and in dilute acids. Similar solubility properties were found for other substances of this group, as given in Table 1.

Two-dimensional paper chromatograms, made at Rehovot, of the acid hydrolysates of I, II and III, using phenol–water and butanol–acetic acid, showed that these three peptides are composed of the same amino-acids. In all three substances aspartic acid, glutamic acid, serine, threonine and tyrosine predominated, while alanine, leucine, phenylalanine and valine were found in relatively small quantities. An unidentified ninhydrin-positive spot was found in the neighbourhood of aspartic acid (Tint and Reiss[5] stated that their most purified samples of II contained the first five amino-acids only). A similar amino-acid composition was reported for IX[7]; aspartic acid, glutamic acid, tyrosine and leucine were found in VI[9]. No tryptophan, basic or sulphur-containing amino-acids were found in these antifungal antibiotics. The amino-acid composition of these substances is in agreement with their acid character and relatively low nitrogen and amino-nitrogen content.

Further evidence for the similarity of I, II and III may be found in their antibiotic spectra, as tested by us under identical conditions (Table 2). A survey of the literature showed that the other antifungal antibiotics listed in Table 1 have similar antimicrobial properties. No complete comparison of the antibiotic spectra could, however, be made, since different assay methods and various organisms have been used for the study of these substances.

Table 2. COMPARATIVE ANTIMICROBIAL SPECTRA OF BACILLOMYCIN *R* (I), BACILLOMYCIN (II) AND FUNGOCIN (BACILLOMYCIN *A*) (III)
Methods of assay have been described elsewhere (ref. 1)

	Substances		
	I	II	III
Bacteria:			
Escherichia coli	−	−	−
Klebsiella pneumoniae	−	−	++
Staphylococcus aureus	−	−	−
Pathogenic fungi			
Epidermophyton inguinale	++	+	++
Trichophyton mentagrophytes gypseum	±	−	−
Trichophyton rubrum	+	−	++
*Trichophyton violaceum**	+	+	++
Candida albicans	±	−	++
Plant pathogens and saprophytes			
Aspergillus niger	++	+	++
Botrytis cinerea	+	±	±
Fusarium sp.	+	±	+
Penicillium notatum	++	+	++
P. roqueforti	+	+	++
Rhizopus nigricans	+	−	+

Key:
++ Complete growth inhibition at 25–50 μgm./ml.
+ Complete growth inhibition at 50–100 μgm./ml.
± Complete growth inhibition at 100–200 μgm./ml.
− Growth not inhibited at 200 μgm./ml.

Although the three other antifungal polypeptides produced by *B. subtilis*, namely, fungistatin (antibiotic *XG*)[8], mycosubtilin[11] and "rhizoctonia factor"[8], are in many respects similar to the above nine substances, they differ in the following important properties: fungistatin is an amphoteric polypeptide, containing basic amino-acids and tryptophan; mycosubtilin is intracellular, does not dissolve in the lower aliphatic alcohols, does not contain glutamic acid and serine, and its acid equivalent weight is 1,980; "rhizoctonia factor" is dialysable, insoluble in butanol and ethanol and is inactive against *Aspergillus niger*. Thus these three cannot be included in the same group.

It is suggested that the nine substances listed in Table 1 be classified under one name. Although eumycin was the first substance of this group reported, it was not clearly enough characterized to warrant designating the whole group by this name. We

Table 1. COMPARISON OF THE PHYSICAL AND CHEMICAL PROPERTIES OF NINE ANTIFUNGAL ANTIBIOTICS PRODUCED BY *B. subtilis*
Additional results for II and III obtained at Rehovot are marked *

Property	Substances								
	I	II	III	IV	V	VI	VII	VIII	IX
Extracellular	+	+	+	+	+			+	+
Dialysable	−	−	−*		−	−	−		
Heat-stable	+	+	+	+	+	+	+	+	+
Absorbed on charcoal	+	+	+*			+		+	
Inactivated by pepsin and trypsin	−	−	−*		−	*a*			
Soluble in: Water	−	−	−				+*b*		−
Lower aliphatic alcohols	+	+	+	+	+	+	+	+	+
Ether	−	−	−	−	−	−	−	−	−
Chloroform	−	−*	−		−			−	
dil. NaOH	+	+	+	+	+	+			+
dil. HCl	−	−	−	−	−	−			−
Conc. acids	+	+	+		+				
Ninhydrin reaction	−	+*	+*		+	−			+
Type of polypeptide	acid	acid	acid		acid	acid			acid
Acid equiv. weight	1,000	940	1 100*						
pK	5·5	5·6	5·4*						5·8
Per cent NH_2/N	0·15	0·75*	0·30*			0·27			
Per cent total N	13	12·4*	11·7*			10–11			
Hæmolytic at 1:10 000	+	+*	+*	*c*					*c*

(*a*) Not inactivated by bacterial proteinase (non-papain type).
(*b*) The reported water-solubility of VII may be due to its method of preparation, in which a soluble salt was formed.
(*c*) Strongly hæmolytic, concentration not reported.

Key.
I Bacillomycin *R* (ref. 1).
II Bacillomycin (ref. 5).
III Fungocin (ref. 2) (bacillomycin *A*).
IV Eumycin (ref. 4).
V Toximycin (ref. 10).
VI Bacillomycin *B* (ref. 9).
VII 'Aspergillus factor' (ref. 6).
VIII (ref. 8) and IX (ref. 7), unnamed.

suggest, therefore, the name 'bacillomycin' be used, particularly since it indicates both the synthesizing genus and the organisms most susceptible to this group of antifungal antibiotics. Until they are completely characterized the various members of this family may be designated by letters following the name. In accordance with this suggestion, one of us (A. P. C.) agrees to change the name of 'fungocin' to 'bacillomycin A'.

We wish to thank Dr. G. H. Warren, of the Wyeth Institute of Applied Biochemistry, Philadelphia, Penn., for a sample of bacillomycin, lot *P*-10*A*.

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Separation of Proteolytic Enzymes of *Clostridium histolyticum*

PREVIOUS attempts to separate the proteolytic enzymes found in culture filtrates of *Cl. histolyticum* have been largely unsuccessful. Methods for preparing proteinase free of collagenolytic activity have been described[1]; but collagenase free of other proteolytic activity has never been obtained.

Complete separation with more than 80 per cent recovery of all enzymatic activity has now been achieved by a simple method of fractional precipitation with saturated ammonium sulphate solutions neutralized with ammonium hydroxide to a pH of 7·5.

The starting material was a 2 per cent solution of crude enzyme prepared by precipitating the culture filtrate with 400 gm./l. of solid ammonium sulphate[1,2]. To this solution the saturated ammonium sulphate was added slowly and stepwise at room temperature. After each stepwise addition the precipitate was centrifuged off, dialysed and freeze-dried, and a further amount of saturated ammonium sulphate added to the clear supernatant.

In this way four peaks of different enzymatic activities could be distinguished: a proteinase peak (*A*), a collagenase peak (*B*), an amidase-esterase peak (*C*) and a peptidase peak (*D*) (see Fig. 1).

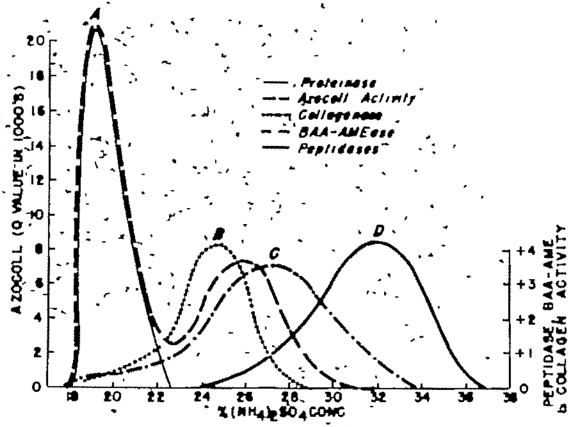

Fig. 1. Fractional precipitation of crude enzyme

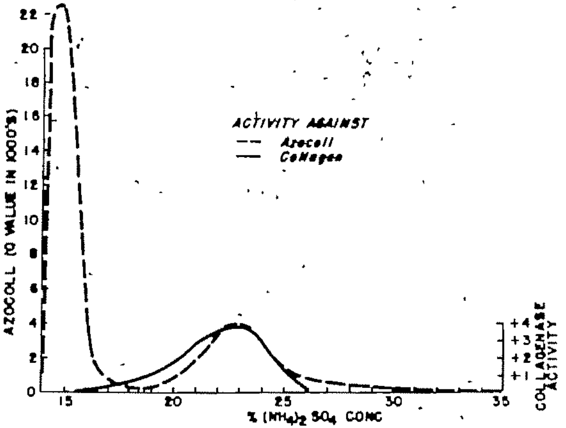

Fig. 2. Reprecipitation of proteinase peak

The proteinase of peak *A* is identical with that previously described by us[1] and referred to as δ-enzyme. However, this fraction is free of blood-group *A* substance and has a potency fifty times greater than that of our previous preparations. By refractionation (see Fig. 2) it has been completely freed of collagenase and peptidase activity and most of the amidase-esterase. It is active against the following substrates: azocoll[2,1], gelatine, hide-powder, casein, hæmoglobin, coagulated egg albumin, coagulated bovine plasma albumin and fresh fibrin clots (Table 1).

At 24–27 per cent saturation (peak *B*) collagenase is reprecipitated, free of proteinase and low in peptidase activity; amidase-esterase is still present.

Table 1. SPECIFICITY OF *Cl. histolyticum* ENZYMES

	Proteinase	Collagenase	Amidase-esterase	Peptidases
Azocoll	+	+	?	0
Collagen	0	+	–	0
Gelatine	+	+	?	?
Casein	+	0	0	0
Hæmoglobin	+	0	0	0
Egg albumin	+	0	0	0
Bovine plasma albumin	+	0	0	0
Fresh fibrin clots	+	0	0	0
Benzoyl arginine amide (cysteine-activated)	0	0	+	0
Arginine methyl ester (cysteine-activated)	0	0	+	0
Leucylglycine (cobalt-activated)	0	0	0	+
Leucylglycylglycine	0	0	0	+
Valyl deca peptide	0	0	0	+

The collagenase is active against native collagen, azocoll and gelatine, but has no effect against casein, hæmoglobin, albumin and fibrin (see Table 1).

The amidase-esterase is the third enzyme to be precipitated from solution, reaching a point of maximum precipitation at about 28 per cent (peak *C*). At this point most of the collagenase has been salted out. Because of the large difference in ratio of collagenase to amidase at peaks *B* and *C* respectively and for other reasons which will be published elsewhere, we consider the amidase-esterase a separate enzyme. It attacks benzoyl arginine amide and arginine methyl ester and is strongly activated by cysteine (Table 1).

The peptidase peak (*D*) appears to correspond to several peptidases not separated from each other as yet. The later fractions (32–35 per cent) are free of collagenase, other proteinases and amidase-esterase. One constituent is a cobalt-activated dipeptidase attacking leucylglycine, leucylalanine, etc., and the other is an aminopolypeptidase needing no activation. It is active against leucylglycylglycine and the decapeptide synthesized by Erlanger *et al.*[4] which contains valine at the terminal amino-position. Activity against other peptides is being studied (Table 1).

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Production of Unsaturated Uronides by Bacterial Hyaluronidases

PNEUMOCOCCAL hyaluronidase has been shown to hydrolyse only the glucosaminidic bonds of hyaluronate[1]. The pneumococcal enzyme and other bacterial hyaluronidases have further been shown to differ from hyaluronidases of animal origin in their thermal lability, and in their capacity to hydrolyse hyaluronate faster and more completely. The main product of exhaustive hydrolysis of hyaluronate by testicular hyaluronidase is a tetrasaccharide[2], whereas the end-product of the action of pneumococcal hyaluronidase is a fraction having the reducing values of a disaccharide[1].

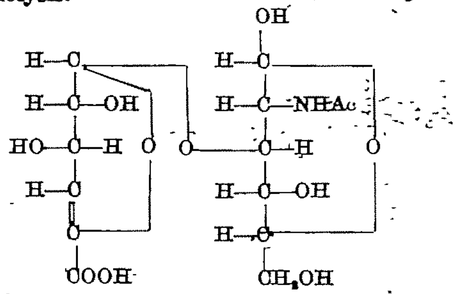
The pneumococcal product differs markedly, however, from N-acetylhyalobiuronic acid, the repeating unit of hyaluronate[3], and of the oligosaccharide fractions obtained on digestion with testicular hyaluronidase[2] as demonstrated in Table 1. The values indicate that the bacterial product is a disaccharide. It is also produced with hyaluronidases of varying degree of purity prepared from cultures of streptococci, staphylococci and *Clostridium welchii*.

Table 1

Analysis	'Bacterial' disaccharide	N-acetyl-hyalobiuronic acid
Reducing sugar* (hypoiodite)	1·05 mgm./mgm.	0·70 mgm./mgm.
Reducing sugar* (ferricyanide)	0·58 mgm./mgm.	0·68 mgm./mgm.
Hexosamine	42·3 per cent	44·4 per cent
Uronic acid (CO_2)	44·8 „ „	48·2 „ „
Uronic acid (carbazole)	40·3 „ „	48·6 „ „
Acetylglucosamine end-group colour (ref. 4)	0·99 mgm./mgm.	1·15 mgm./mgm.
$[\alpha]_D^{25}$	−20·0	−32·0
RF	0·38	0·24

* As glucose.

On acid hydrolysis of the bacterial disaccharide, D-glucosamine has been obtained as the hydrochloride in a yield of 74 per cent and characterized as the carbobenzoxy compound. The bacterial disaccharide shows the following behaviour, which further distinguishes it from N-acetylhyalobiuronic acid. It consumes one mole of bromine, and has an absorption maximum at 230 mμ typical of α-β-unsaturated carbonyls, and yields on ozonolysis oxalic acid. On hydrogenation with palladium on charcoal, the disaccharide takes up two moles of hydrogen. This product, homogeneous by paper chromatography, no longer absorbs at 230 mμ, fails to give the carbazole reaction of uronic acids and is not decarboxylated on heating with acid. Its aldehydic function, however, is still intact as evidenced from the hypoiodite titration and the colour value in the modified Elson–Morgan reaction[4]. The results indicate a 4–5 unsaturated uronide of the following tentative structure (I). The consumption of the second mole of hydrogen appears to be due to hydrogenolysis.



(I)
'Bacterial' disaccharide

The exhaustive hydrolysis of hyaluronate by bacterial enzymes yields the unsaturated disaccharide in almost quantitative yield, whereas from tetrasaccharide, obtained with testicular hyaluronidase, the bacterial enzymes yield equal quantities of N-acetylhyalobiuronic acid and the unsaturated disaccharide (the acid itself was recovered unchanged after incubation with bacterial hyaluronidase). When the hydrolysis of hyaluronate by bacterial enzymes is not allowed to go to completion, oligosaccharides are isolated which differ chromatographically from those obtained from testicular digests. Resistance of these fractions to β-glucuronidase[4] indicates that the non-reducing glucuronidic end-group is modified. These results strongly suggest that the double bond is formed during hydrolysis of the glucosaminidic bonds by dehydration of the glucuronidic groups.

One enzyme appears to catalyse both the hydrolysis and the dehydration. The mechanism of the reaction may be explained by the assumption that the water of hydrolysis of the hexosaminidic bonds is furnished by the adjacent uronidic group instead of by the medium. The glucosaminidic linkages of hyaluronic acid are claimed to be in the 3-position on the basis of a negative periodate consumption (see ref. 3). Therefore the double bond either migrates into the conjugated 4–5 position or the original bond actually is not in the 3- but in the 4-position. The latter is more probable.

The dehydrative hydrolysis is not limited to hyaluronate and to oligosaccharide fractions prepared from it. The naturally occurring polysaccharide chondroitin and partly desulphated oligosaccharide fractions obtained by acid hydrolysis from chondroitin sulphate *A*[6] are hydrolysed by bacterial hyaluronidases with concomitant dehydration.

It is to be expected that other glycosidic bonds will be hydrolysed dehydratively and that unsaturated sugars and products derived from them similar to those described here may occur in Nature.

The work has been supported by the U.S. Public Health Service, by the Eli Lilly Company and the New York Chapter of the Arthritis and Rheumatism Foundation.

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Lungworms (*Metastrongylus* spp.) in Pigs, and their Development in the Guinea Pig

THE three species of the genus *Metastrongylus*, *M. apri* Gmelin, *M. pudendotectus* Vostokov and *M. salmi* Gedoelst, occur in the pig; but the last has only been found in the Belgian Congo, the United States and the U.S.S.R. The two former species occur in Great Britain[1]; but opinion differs as to their incidence, probably because of a failure to recognize the rather inconspicuous lesions they produce in adult pigs (personal replies to a questionnaire).

During the past two years we have studied the incidence of the worms in pigs at a bacon factory in Cheshire, the occurrence of lungworm eggs in the fæces of pigs, the development of lungworms in earthworms (intermediate host), and the experimental infection of laboratory animals. A short note on the first year's findings has already appeared[2], and the present communication records briefly the most important results of the work of two years. Detailed accounts will be published elsewhere.

The discovery of virus pneumonia in pigs and the suggestion that it is very widespread and causes considerable economic loss[3] make it desirable to distinguish it from other conditions that cause pigs to cough.

Of 1,308 bacon pigs examined between February 1954 and March 1954, the lungs of 18·2 per cent were infected. These pigs came from 224 individual consignments, 44·2 per cent of which contained one or more infected pigs; this means that lungworms existed in almost half the batches of bacon pigs coming to the factory from north-west Britain. We have found lungworms as frequently in other areas, too. Many naturally infected pigs harbour only very light worm burdens, and the lesions in such pigs may be confined to the extreme tip of the diaphragmatic lobe. Often the parasites can be found only if the finest bronchi are opened. The usual lung lesions in bacon pigs are pale wedge-shaped areas of emphysema, situated mainly along the postero-lateral border of the diaphragmatic lobe. Pneumonic changes are seldom associated with these lesions, and are much more common in the apical and cardiac lobes.

Examination of a large number of samples of fæces from naturally infected pigs failed at first to yield lungworm eggs. The explanation was later found to lie in the failure of saturated sodium chloride solution (spec. grav. 1·200) to bring the eggs to the surface when 2-gm. samples of fæces were examined by centrifuging at 1,500 r.p.m. for three min. Experiments showed that saturated sodium chloride yielded only 1/200 to 1/20 of the eggs given by saturated magnesium sulphate ($MgSO_4,7H_2O$, spec. grav. 1·285) used in the same way. Table 1 shows the counts of lungworm eggs with the two flotation solutions for six samples of fæces chosen from a total of twenty-three samples examined. Magnesium sulphate will reveal with great accuracy very small numbers of lungworm eggs, and counts of 2–5 eggs per gm. have been obtained regularly over a series of weeks from infected pigs. Low egg-counts are common in naturally infected pigs and would be missed if the usual routine fæces examination with sodium chloride were used. The mean of the counts for the twenty-three samples was 4·4 eggs per gm. for sodium chloride and 294 eggs per gm. for magnesium sulphate. That the superiority of magnesium sulphate is not due solely to its specific gravity is shown by the fact that a saturated solution diluted to specific gravity 1·200 was almost as effective as the fully saturated solution. The failure of sodium chloride to float the eggs of the pig lungworms was pointed out nearly twenty years ago by Russian workers[4], who also showed the value of magnesium sulphate; but their findings do not seem to have been widely recognized.

Cultures of various species of earthworms have been successfully established[5] and a number of species have been infected with lungworms. *Eisenia foetida* was the species most easily cultured and infected, but is rare on pig pastures. *Allolobophora nocturna*, *A. caliginosa*, *A. chlorotica* and *Lumbricus rubellus* have also been infected, and all these species occur in pasture land.

Table 1. COMPARISON OF SATURATED SODIUM CHLORIDE AND SATURATED MAGNESIUM SULPHATE FOR FLOTATION OF EGGS OF LUNGWORMS (*Metastrongylus* SPP.) IN THE FÆCES OF NATURALLY AND EXPERIMENTALLY INFECTED PIGS

Sample No.	Eggs per gm. of fæces	
	Sodium chloride	Magnesium sulphate
1 (*E*)	10·5	2,226
2 (*E*)	5	544
3 (*E*)	3	130
4 (*N*)	1	56
5 (*N*)	0	44
6 (*N*)	0	6

(*E*), Experimentally infected; (*N*), naturally infected

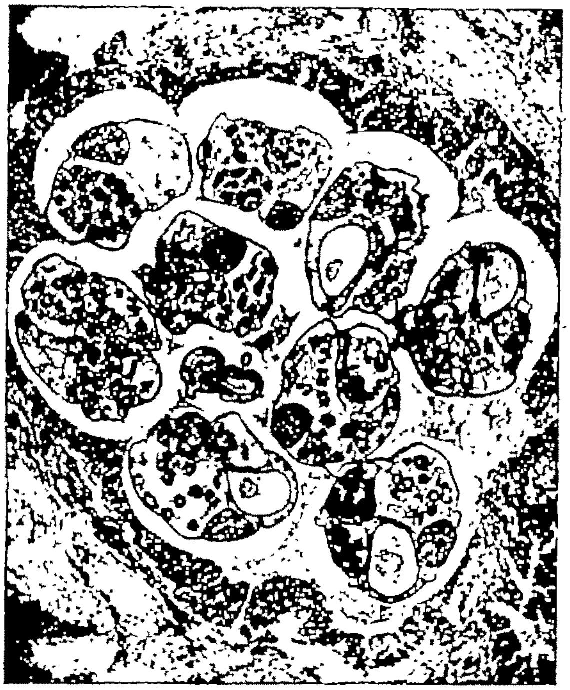

Fig. 1 Section through bronchus of guinea pig infected with *M. apri* showing ten adult worms in the lumen. Eight of the nine females show embryonated eggs containing larvæ. Hæmatoxylin and eosin. × 145

Guinea pigs have proved to be the most satisfactory laboratory animal for infection with the pig lungworm, and a total of 116 young guinea pigs (150–350 gm. body-weight) have been given third-stage infective larvæ by mouth. More than 50 per cent have become infected with lungworms, and in the most recent experiments the infection-rate has been 80–100 per cent. In one experiment with eight animals, all became infected and six of them showed at autopsy four to seven weeks later a large number of mature adult female worms containing viable embryonated eggs (Fig. 1).

Lungworm eggs, identical in appearance with those found in pigs, were found in the fæces of three of the guinea pigs by magnesium sulphate flotation. Eggs recovered from the female worms in the guinea pig lung produced infective larvæ in *Eisenia foetida*, and a guinea pig was successfully infected with these larvæ. Previous workers have reported that experimental infections in guinea pigs have failed to yield fertile eggs[5], and we believe this to be the first such record. We are now trying to adapt the lungworm to the guinea pig in the hope of obtaining 100 per cent infection with regularity. This would provide a useful experimental tool for the study of lungworms in domestic stock, because there would then be both an intermediate host (earthworm) that could be maintained and infected with ease and also an experimental animal as definitive host (guinea pig) which would be available in large numbers for chemotherapeutic tests and biological studies.

In our experimental work on guinea pigs, we have confirmed the finding of Porter[6] that basophilia is a feature of infection in the guinea pig and have found it to be preceded by an eosinophilia, which soon subsides. Re-infection when the basophilia and eosinophilia had lapsed produced a recurrence of the same blood picture.

All our experimental work on pigs and laboratory animals has been carried out with *M. apri*, which is the more common of the two species in the pig in Great Britain. *M. pudendotectus* is usually present along with *M. apri*, but in much smaller numbers. We have not found *M. salmi*.

These investigations were carried out with a grant from the Agricultural Research Council.

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Effect of Acetate on the Fasting Blood-Sugar Level of the Rat

Chari and Wertheimer[1] state that intraperitoneal injection of acetate (100 mgm./100 gm. body weight ?) into rats "caused hypoglycæmia and increased alkalosis" but give no details of their experiments. In view of the known interrelationship between glucose and acetate in the ruminant[2], it was considered of interest to investigate this point further.

Blood samples were taken by heart puncture under 'Nembutal' anæsthesia from adult rats previously fasted for 17 hr. before and 30, 60, 120 and 180 min. after intraperitoneal injection of sodium acetate or an equivalent amount (in terms of sodium) of saline. The solutions injected were isotonic at a dose-rate of 100 mgm./100 gm. body-weight and of twice this concentration at a 200 mgm./100 gm. level. Acetate appears to produce a slight hyperglycæmia of short duration, the effect being most marked when 100 mgm./100 gm. was given; in no case was there any subsequent marked hypoglycæmia compared with the results in animals given saline at the corresponding level. The type of diet apparently had little, if any, effect on the response to acetate. A transient hyperglycæmia may be expected in view of the known effect of acetate on depressing glucose uptake by various rat tissues[3,4] and agrees with the findings of Reid in the sheep[2].

The effect of incorporation of acetate in the diet of weanling rats was also investigated. One group of seven animals was given 8 gm. of powdered rat cubes per rat daily, mixed with milk, and a second group of six animals was maintained on the same diet mixed with increasing amounts of acetate in the form of a solution of sodium acetate. It was evident from the growth curves that only a limited amount of acetate could be incorporated in the diet if growth was to continue normally. The maximum level tolerated appears to be of the order of 13 per cent of the diet. Acetate fed at this level had no effect on 17-hr. fasting blood-sugar levels. A transient hypoglycæmia induced in rats on a diet containing

16·5 per cent sodium acetate was presumably largely due to starvation.

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A Method of collecting Fluid leaving the Omasum of Sheep

IN ruminants a large proportion of the ingested food is digested in the fore-stomachs. In order to know the final result of this digestion, it is necessary to know the composition of the material leaving the fore-stomachs and the rate of flow at the omaso-abomasal orifice. To study this problem a special cannula has been devised (Fig. 1). It consists of a main tube, *B*, of ebonite (2 cm. internal diameter), into which runs a smaller one, *C* (1 cm. internal diameter). The main tube is 10 cm. long and is connected at one end with a funnel, *A*, of which the diameter of the top is 6 cm. and its height 4 cm. The side tube, *C*, is screwed perpendicularly on to the middle of the main tube. It is threaded on the outside over its whole length, so that an ebonite ring (*D*) of 3 cm. diameter can be screwed on to it, making it mobile over the whole length of the tube.

For the operation, the anæsthetized sheep is put on its left side. The abdominal wall is incised just behind the ribs from the median line about 20 cm. upwards. After opening the abdomen, the abomasum is exposed and a small incision is made in it through which the large tube is slid so that the opening of the funnel fits against the omaso-abomasal orifice, and the main tube lies completely in the abomasal lumen. After screwing the side tube on to the main one, the abomasal wall is sutured. A ligature is put around the abomasum just under the funnel in order to keep the tube in place; when inserting this ligature, care is taken not to damage the main nerves and blood vessels. It is tightened just sufficiently to prevent the funnel from passing through. Just behind the ribs and next to the main incision a stab wound is made in the abdominal wall through which passes the side tube. The various layers of the abdominal wall are then sutured. The ring is screwed on the side tube just up to the skin and the tube is corked.

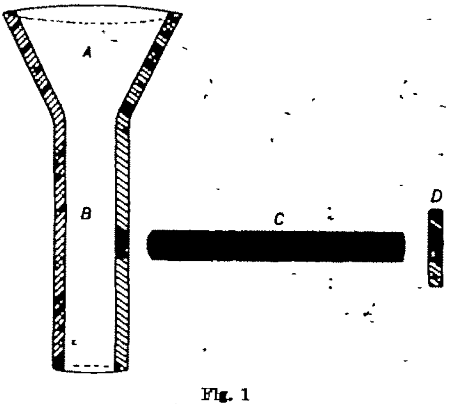

Fig. 1

For the collection of fluid leaving the omasum, a balloon is passed through the side tube into the distal part of the main tube, which is blocked by insufflation of air into the balloon. The fluid leaves the side tube at fairly regular intervals; its dry-matter content varies between 5 and 10 per cent. The *p*H is usually slightly higher than the *p*H of the ruminal fluid.

Living protozoa are found in the fluid. A very great variation has been found in its chlorine content, although this is always much higher than that of the ruminal fluid. The amount of pepsin, usually present in traces, depends upon the position of the front part of the funnel. It has been shown that the cannula does not interfere with the normal movements of the rumen and reticulum.

More detailed results obtained with this procedure will be published elsewhere.

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Serous Cells in Brunner's Glands of the Rabbit

IN Brunner's glands of the rabbit's duodenum there are numerous groups of serous-type cells lying among the mucous acini. It has long been believed that these cells are of a nature similar to those of the pancreatic acini. According to Patzelt[1], Schwalbe (1872) was the first to make the suggestion, and he quotes the work of later authors who have added confirmatory evidence: the cells have similar staining reactions to those of the pancreatic acini, and they undergo compensatory hypertrophy after the pancreatic duct is ligated; rabbits so treated remain in good health.

In a previous communication[2], it was pointed out that in sections of rabbit duodenum treated histochemically by Gomori's 'Tween' technique for 'lipase', these serous cells are strongly 'lipase'-positive and stand out sharply among the 'lipase'-negative mucous acinar cells. The suggestion was made that the 'lipase'-positivity might be a point in favour of the above view. This has now been explored further.

It was felt that if it could be shown that the 'lipase' reaction given by these cells is due to true lipase, then the above view would be substantiated very considerably, since true lipase is almost confined to the pancreatic acinar cells. True lipase can be readily distinguished from non-specific esterase by the influence of bile salts upon the activity of the enzyme. It has been demonstrated chemically[3] and histochemically[4] that bile salts activate true lipase and inhibit non-specific esterase. This fact formed the basis of the present work.

Specimens of duodenum from each of six rabbits were fixed in absolute acetone, cleared in benzene, embedded in paraffin and serially sectioned at 7 µ. A histochemical study was made of the 'lipase' activity of the sections, employing a modification of Gomori's 'Tween' technique[5], namely, a method in which the sections are introduced directly into the substrate without prior dewaxing[6]. Adjacent sections of each specimen were taken; one was incubated in the usual 'Tween' substrate bath ('Tween 40' was employed throughout) and the other in a 'Tween' substrate bath containing 0·2 per cent sodium

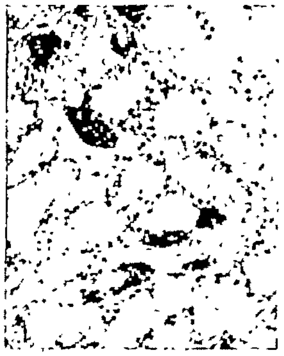

Fig. 1

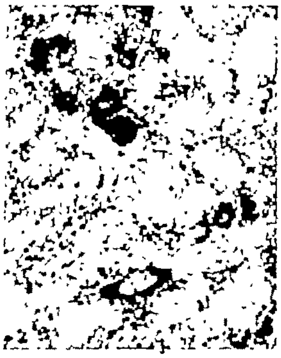

Fig. 2

Fig. 1. Brunner's glands of rabbit duodenum. × 110. 2 hr. incubation in a normal 'Tween' substrate bath. There is a reaction in groups of serous cells lying among the lipase-negative mucous acinar cells

Fig. 2. Adjacent section to that of Fig. 1. × 110. 2 hr. incubation in a 'Tween' substrate bath containing 0·2 per cent sodium glycocholate. Note marked intensification of the reaction in the serous cells

Nuclei were lightly counter-stained with hæmatoxylin

glycocholate. The incubation periods were the same for each of the two sections.

The results were quite definite and striking. After incubation over-night, all the sections incubated in the normal 'Tween' substrate bath showed the usual reaction in the serous cells among Brunner's glands and in the surface epithelial cells of the villi and upper parts of the crypts. In all sections that had been incubated in the presence of bile salt, the reaction in the villi and crypts either had not appeared at all or was very faint (indicating that the enzyme activity there is due to non-specific esterase); but the reaction in the serous cells among Brunner's glands was particularly intense.

In order to demonstrate more clearly that activation of the reaction in the serous cells takes place, adjacent sections were incubated in the two substrates for such short periods as 1, 2 and 3 hr. After 1 hr. there was already a reaction in the sections incubated in the presence of bile salt, but none in those incubated in the normal substrate bath. After 2 or 3 hr., a reaction was present in both sections, but was much more intense in that incubated in the presence of bile salt. A typical result obtained after 2 hr. incubation is illustrated in Figs. 1 and 2.

This experiment shows that these serous cells, like the cells of the pancreatic acini, contain true lipase. Moreover, the reaction is localized mostly in the apical parts of the cells, as it is in the acinar cells of the pancreas. This finding adds strong support to the view that these serous cells in Brunner's glands of the rabbit are of the same nature as the acinar cells of the pancreas.

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Biochemical Changes in Cultured Cells

THE *in vitro* culture of blood or bone marrow cells is frequently employed in hæmatological studies. Since it is uncertain how far *in vitro* conditions approximate to *in vivo* ones, it is important to collect as much evidence as possible bearing on the life of cultured cells. It is not enough that they should merely exist in a state of torpor; but there should be some indication of the occurrence of proliferative activity or of cell maturation and differentiation. Although ample morphological evidence of both these processes in bone marrow cells in fluid media has been put forward[1,2], it is desirable to demonstrate that such cultures are also 'biochemically alive'. Measurements of cellular nucleic acids may reveal maturation and differentiation of cells of the hæmopoietic system, for it has already been shown that the ribonucleic acid content of the cytoplasm of primitive marrow cells is much greater than that of the mature differentiated forms[3,4]. We have studied the quantitative changes taking place in nucleic acids during the culture of bone marrow cells.

Some results of a number of experiments on the culture of bone marrow cells from patients suffering from pernicious anæmia, using a standard technique[5], are summarized in Table 1. The nucleic acid content of the culture was estimated by a microchemical method[6] and correlated with the number of cells per cu.mm. The mean amounts of deoxyribonucleic acid phosphorus per cell at 0 hr. and 48 hr. were found, in any one experiment, to be very similar, indicating that the cellular contents of deoxyribonucleic acid phosphorus did not vary during culture.

Grand mean of the 19 cultures at 0 hr. = 8·06 × 10^{-7} μgm. per cell.
" " " " 19 " " 48 " = 8·88 " " " "

The mean content of ribonucleic acid phosphorus per cell, on the other hand, was in most experiments lower at 48 hr. than at 0 hr., indicating cell maturation and differentiation. The most useful information, however, was obtained from consideration of changes in the ratio of ribo- to deoxyribo-nucleic acid phosphorus, for this avoids the errors in cell enumeration. Examination of the figures suggests strongly that a fall in this ratio is the rule, but that the rate of fall varies from experiment to experiment. However,

Table 1. RATIO OF RIBO- TO DEOXYRIBO-NUCLEIC ACID PHOSPHORUS IN CULTURE MEDIA AT 0 AND 48 HR.

Exp. No.		50% pernicious anæmia serum	50% pernicious anæmia serum + vitamin B_{12} (0·05 μgm./ml.)	50% pernicious anæmia serum + folinic acid (7·5 μgm./ml.)	50% normal serum
2	0 hr.	4·8	6·2	3·0	—
	48 "	1·1	1·1	1·4	—
3	0 "	2·0	—	—	—
	48 "	1·7	—	—	—
4	0 "	2·2	2·0	2·3	
	48 "	1·9	1·9	2·2	—
5	0 "	1·4	—	—	2·1
	48 "	0·9	—	—	1·3
6	0 "	1·2	1·0	—	0·9
	48 "	1·6	2·4	—	3·6
8	0 "	2·4	4·2	—	—
	48 "	2·2	1·9	—	—
9	0 "	3·1	3·1	—	—
	48 "	3·1	2·7	—	—
10	0 "	3·1	2·7	3·2	—
	48 "	2·8	2·2	1·9	

Table 2

Exp. No.	Mean ratio ribo- to deoxyribo-nucleic acid phosphorus 0–48 hr.	t^*	Deg. of freedom	P'	$-\log_e P'$
2	3·46	3·721	4	0·0102	4·5854
4	0·16	1·250	4	0·140	1·9661
5	0·65	1·612	2	0·124	2·0875
6	−1·3	2·169	4	0·952	0·0492
8	1·30	1·422	2	0·146	1·9242
9	0·195	0·812	2	0·251	1·3823
10	0·90	4·658	4	0·0048	5·3391
					17·3338

P', fiducial probability that the true mean difference is not positive that is, $P' = \frac{1}{2}$ (P of Fisher) except in Exp. 6, where $P' = 1 - \frac{1}{2}$ (Fisher's P).

* The 0- and 48-hr. series were treated separately in calculating t. Use of the series of differences leads to $\chi^2 = 29·88$, $P < 0·01$.

we are not concerned here with varying rate of change, or with effects of added substances which, apparently, are unimportant. When each experiment is used for providing independent evidence of a fall in the ratio and the results are pooled by the method advocated by Fisher[7], results are obtained as shown in Table 2. It is evident that, although the fall in the ratio is significant only in experiments 2 and 10, the aggregate evidence for a fall is very significant; $\chi^2 = 34·6676$ with 14 degrees of freedom, $P < 0·01$.

We consider that the results indicate that in these bone marrow cultures maturation and differentiation of cells is proceeding, a process that involves loss of ribonucleic acid phosphorus from the cell, which maintains a relatively constant content of deoxyribonucleic acid phosphorus.

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Nuchal Crests in Australopithecines

In his reply to my recent communication in *Nature*[1], Prof. S. Zuckerman questions my statement that direct evidence is available that the Swartkrans prehominid did not have a "powerful and shelf-like"[2] nuchal crest even when a sagittal crest was present.

This evidence is most clearly seen in the Swartkrans skull *SK*.49, the occipital region of which has now been prepared in acetic acid. The skull has been sheared considerably, but the region from slightly posterior to the glabella to approximately the position of the bregma, as well as a good deal of the occipital region, are little disturbed and the bone surface in these regions is so well preserved as to show the minutest details of structure. Approximately five and a half centimetres of the frontal region is preserved in the mid-line, and this bears a low sagittal crest, 2·6 cm. of which is preserved. This crest is lower than those of skulls *SK*.46 and *SK*.48. The well-preserved occipital portion extends from the left mastoid to approximately 1 cm. to the right of the mid-line—here indicated by the posterior end of the sagittal suture and by the inion. In the mid-line the bone surface is undamaged from half a centimetre below the inion to nearly 3 cm. above it. To the left of the mid-line the preserved area is greater. The whole of the superior nuchal line is well preserved on the left side between the mastoid and the inion. A clearly defined but small external occipital protuberance is situated 2·8 cm. below the lambda. The sagittal and lambdoid sutures are here quite apparent. Disturbance of the bone just above the lambda has resulted in both sutures being pulled slightly apart in this region and it is manifest that no fusion had yet occurred. There is no trace of a sagittal crest in the mid-line, along either the 2·8 cm. of perfectly preserved bone from inion to lambda, or on the centimetre of disturbed bone above lambda, where the bone is well enough preserved to have shown it had there been a crest. A small sagittal crest is therefore actually present near the bregma but none in the occipital region, nor does the left temporal line reach anywhere near the mid-line in this region.

The superior nuchal line is very weakly developed for 1·9 cm. to the left of the inion, is then drawn out into a low ridge for a distance of 2·7 cm., after which it is again a barely perceptible line for the remaining 2·4 cm. of the specimen. At its maximum development this ridge is 3 mm. high, measured on the upper side. Even at this point of maximum development the planum nuchale passes downward and forward directly from the ridge crest, that is, the ridge results largely from the planum occipitale being a little depressed just above it. There is, therefore, not even a continuous ridge across this region, let alone a "powerful and shelf-like" nuchal crest.

Zuckerman[1] suggests that the Makapan occiput belonged to an immature individual because the sagittal and lambdoid sutures had not yet completely fused—although he gives no reasons for supposing that this criterion is applicable to the australopithecines. In *SK*.49 the upper post-canine dentition is *in situ* and well preserved. M^1 is so much worn that the enamel is worn through over the protocone and is about to go through over the hypocone, M^2 is worn on all four cusps and M^3 already shows some wear. By any reasonable standards this specimen must be considered fully mature, yet its sagittal and lambdoid sutures are not fused. The corresponding sutures of the Makapan specimen had already started fusing[3], hence there is no reason for supposing that it is not fully mature also. A second calvarial fragment from Makapan has the temporal lines approaching the mid-line fairly closely but not reaching it, and this shows that the point of nearest approach to the mid-line is distinctly anterior to that at which the former specimen is broken. If the temporal lines of the former specimen conform to the same pattern, as they appear to do, then they must have met farther forward and formed a small crest.

SK.48, from Swartkrans, is also a mature adult skull—the molars are in much the same stage of wear as are those of *SK*.49. Although the occiput is distorted and displaced, almost the whole of the right superior nuchal line from near the mid-line to the mastoid is present. This shows a condition similar to that of *SK*.49, except that the central part is drawn out into a ridge which reaches a maximum height of 6 mm. The length of the ridge is about two and a half centimetres. In the bregma region the anterior 2 cm. of a sagittal crest is well preserved. Although the preserved anterior part of this crest is shorter than that in *SK*.49, it is already higher at the point at which the break occurs and was therefore almost certainly an appreciably larger crest. Nevertheless, this specimen, like *SK*.49, did not have a continuous or shelf-like nuchal crest.

Zuckerman says that my description of *SK*.48 differs from the 'official' one. Broom[4] said that "all the lower part of the occiput is preserved, but much crushed forward and upward into the brain region"—which says nothing about the state of preservation of the occiput, merely that in the crushing of the skull it has been displaced forward and upward. I stated[1] that "the greater part of the occiput is present but is a bit distorted and displaced", that is, it is not only displaced but also distorted. Except that Broom said nothing about the distortion, our statements differ only in regard to the exact degree of displacement—which tells nothing about the amount of detail to be observed on the occiput. Zuckerman[2], on the other hand, referring to *SK*.48 and *SK*.46—which were at that time the only skulls mentioned in the literature as having sagittal crests—says, "Unfortunately the occipital region of both skulls is lacking". It might be added that in the introduction to the volume which Zuckerman regards as official we state that it is "only a preliminary account".

Zuckerman doubts the correctness of referring the pelvis and spinal column from Sterkfontein to the Sterkfontein australopithecine on the grounds that "a manifestly human mandible has been found in the same deposits as have yielded the australopithecine apes". The 'human' mandible is presumably that of *Telanthropus*. The pelvis and spinal column were recovered from Sterkfontein, from the same single mass of consolidated breccia as were the several score of australopithecine remains. No other hominoid remains have been found at this site. The *Telanthropus* remains occurred *in situ* at Swartkrans, nearly a mile away, in company with the remains of an australopithecine quite different[5] from that at Sterkfontein. Swartkrans is geologically more recent than Sterkfontein—as is clearly shown by the fact, among others, that *Equus* and *Papio* occur at the former site but not at the latter. To doubt the relationship of the pelvis to the cranial remains at Sterkfontein because *Telanthropus* occurs in a quite different and geologically younger site is clearly inadmissible.

Zuckerman has given much information about the occurrence of nuchal crests associated with sagittal crests in many different primates. The question whether these two were also associated in the australopithecines will not be solved by studying bigger and better collections of modern pongids, monkeys, etc., but by studying australopithecines. So far they have yielded no evidence in support of this thesis, but some direct evidence against it.

J. T. ROBINSON

Transvaal Museum,
Pretoria.
Sept. 9.

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[1] Robinson, J. T., *Nature*, 174, 262 (1954).

[2] Zuckerman, S., in "Evolution as a Process" (Allen and Unwin, London, 1954).

[3] Dart, R. A., *Amer. J. Phys. Anthrop.*, n.s., 6, 259 (1948).

[4] Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, No 6 (Pretoria, 1952).

[5] Robinson, J. T., *Amer. J. Phys. Anthrop.*, n.s., 12, 181 (1954).

THE essential point at issue, which Dr. Robinson contested in his first communication[1], is the general proposition[2] that the presence of a sagittal crest in the skull of an Old World primate implies the presence of a nuchal (= occipital) crest; and further, that if one of the two is absent, it is usually the sagittal crest. "Unless *Paranthropus crassidens* is the one exception to a morphogenetic process common to all known Primates", I therefore suggested that the fact that two presumed female *Paranthropus* skulls were furnished with high sagittal crests implied that they had also possessed powerful occipital crests and an ape-like planum nuchale. In turn this implied a nuchal musculature and a carriage of the head on the vertebral column of the kind that is seen in the ape. I also suggested that this conclusion was consistent with certain other features of the Australopithecine skull.

Dr. Robinson now admits that *SK*.49, a specimen to which he referred before[1] in a few lines, and which he now describes for the first time—and all students of the subject will be grateful to him for this description—has a nuchal crest which is drawn out into a ridge that projected 3 mm. He also now states that the corresponding figure in *SK*.48, which he previously described as having a "well-marked occipital crest"[3], is 6 mm. Nuchal crests which are no more prominent—and indeed some less prominent—will be found in many adult apes. He and I have, therefore, no argument, regardless of the concluding sentence of his communication. Both his specimens possess nuchal or occipital crests, and both conform to the generalization to which he had previously taken exception. His observation that the crests were deficient in the mid-line also fits in with what I was at pains to point out in my previous communication[4]—namely, that in the ape the least prominent part of the nuchal crest is not infrequently in the mid-line, where, indeed, it is sometimes deficient.

For the rest, I fear that I still find it difficult to equate Broom and Robinson's[3] description of the occipital region of *SK*.48 as "very considerably crushed upwards and forwards" with Robinson's present statement[1] that it is merely "a bit distorted and displaced". Nor do I share his assurance (*a*) that it is possible to assess the maturity or otherwise of a fragment of one skull by appealing, via an apparent correspondence of sutural closure, to the dental wear of another specimen; or (*b*) that the question of the relation of post-cranial to cranial fragments in the deposits in which the South African australopithecine fossils have been found is as simply settled as he would have us believe. All that need be said about the belief that *SK*.49 possessed a low sagittal crest anterior to its bregma, but none in the region of the lambda, is that if this condition is regarded as characteristic of all *Paranthropus* skulls, the temporal muscles in this beast must have developed somewhat differently from the way they do in the great apes, and that the condition presumably corresponds to those unusual cases in the gibbon when the temporal lines meet each other, and fuse, just behind the bregma, to form such a crest.

S. ZUCKERMAN

Department of Anatomy,
University of Birmingham.

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[1] Robinson, J. T., *Nature*, 174, 262 (1954).

[2] Zuckerman, S., chapter in "Evolution as a Process", 300 (Allen and Unwin, London, 1954).

[3] Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, No. 6 (Pretoria, 1952).

[4] Zuckerman, S., *Nature*, 174, 264 (1954).

FORTHCOMING EVENTS

Wednesday, December 29

British Institution of Radio Engineers, London Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Discussion Meeting on "Education and Training of Radio Engineers".

Institution of Mechanical Engineers, Applied Mechanics Group (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Gaps in the Knowledge of Applied Mechanics".

Wednesday, December 29—Monday, January 3

39th Conference of Educational Associations (at University College, Gower Street, London, W.C.1).

Wednesday, December 29

At 5 p.m. (in the Friends' Meeting House, Euston Road, London, N.W.1)—Sir Charles R. Morris: "Education and the Family" (Presidential Address).

Friday, December 31

Institution of Mechanical Engineers (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. S. Turnbull: "Lost-wax Process of Precision Casting, 1949–1953".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Laboratory Technician (with experience of food and toxicological analysis) in the University of Edinburgh Department of Veterinary Hygiene and Preventive Medicine—The Secretary to the University, Old College, South Bridge, Edinburgh (January 1)

Research Assistant (with a good honours degree in physics and experience in the design of electronic circuits, and preferably practical acquaintance with television or sound-film recording techniques) in the Department of Physics and Mathematics, to take part in the development of an electronic aid for the blind, and to undertake a certain amount of teaching—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (January 1).

Research Assistant in the Department of Geology—Clerk to the Governors, Chelsea Polytechnic, London, S.W.3 (January 10).

Physicist and Physical Chemist (with at least H.S.C. (science) or equivalent), at the Ministry of Supply Research and Development Establishment, Waltham Abbey, Essex, to undertake laboratory studies of the basic structure and physical properties of plastics, rubbers and fibres, and to assist in applying these materials to Service projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.843/54A (January 14).

Lecturer (graduate in chemical engineering or graduate in chemistry with postgraduate training and/or experience in chemical engineering) in Chemical Engineering—The Registrar, College of Technology, Manchester 1 (January 17)

Lecturer/Senior Lecturer in Botany, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, January 19).

Chair of Agriculture tenable at Wye College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 27).

Reader in Archæology of the Roman Provinces, at the Institute of Archæology—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 31).

Research Scholar in the Department of Chemistry, for work on problems connected with aluminates—The Secretary, The University, Aberdeen (January 31)

Henry and Charlotte Payne Research Fellowship in cytology and/or cyto-chemistry, with special reference to malignant cells—The Assistant Secretary, The Royal Society, Burlington House, Piccadilly, London, W.1 (February 1).

Lecturer (graduate in science or agricultural science) in Botany, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, February 1).

Professor of Physics in the Newcastle Division of the University of Durham, and a Professor of Physics in the Durham Colleges in the University of Durham—The Registrar, University Office, 46 North Bailey, Durham (February 12).

Chair of Physics—The Registrar, The University, Hull (February 28).

Agricultural Education Officer (with a degree in agriculture and experience in teaching) in Basutoland, to take administrative and academic charge of a new training centre for subordinate staff of the Agricultural Department—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD 63/76/07.

Assistant Experimental Officers in the Department of Scientific and Industrial Research, Headquarters, Intelligence Division, for abstracting and technical information work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.113/54A.

Assistant Professor (with a special interest in low temperature research) in the Department of Physics—Prof. W. H. Watson, University of Toronto, Toronto, Canada.

Lecturer or Assistant Professor in Mathematics—The Chairman, Department of Mathematics, McMaster University, Hamilton, Ontario, Canada.

Melville Wills Chair of Botany—The Registrar, The University, Bristol 8.

Physicist, Scientific Officer grade (with an interest in physics of the solid state, and preferably electronics experience) in the Radio Division, Royal Aircraft Establishment, Farnborough, Hants, to study the application of titanate ceramics and similar materials to radio frequency problems; and an Electrical Engineer or Physicist, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree or equivalent, and for the senior grade at least three years postgraduate research experience), for research on special radio transmitting systems, in particular concerned with microwave region and with studies of modulation characteristics and frequency spectra—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.353/54A

Physicist, Senior Scientific Officer or Scientific Officer grade (with a first- or second-class honours degree in physics, and preferably with some experience of methods of fast neutron flux measurement, and an interest in the development of fast neutron counters), for experimental work in neutron physics—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 322/WGE/2.

Physicist (with a good honours degree), for work concerned with the physical principles (excluding electronics) and incidental problems associated with the development and manufacture of scientific instruments—The Director, British Scientific Instrument Research Association, "Sira", Southill, Elmstead Woods, Chislehurst, Kent.

Physicists or Physical Chemists (with a good honours degree, and preferably with some research experience), for work which will involve both fundamental and applied research on textile fibres and related materials—Appointments Officer, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

Research Assistant (with a degree in physics or chemistry) in the Department of Colloid Science, to develop and maintain techniques applied to the investigation of macromolecules in solution (for example, sedimentation, diffusion, light scattering, etc.)—Dr. P. Johnson, Department of Colloid Science, The University, Cambridge.

Scientific Officer (with a first- or second-class honours degree in naval architecture, or alternatively in physics or mathematics with an interest in fluid dynamics), at the National Physical Laboratory, Teddington, for general research in the Ship Division—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.826/54A.

Senior Lecturer in Mechanical Engineering, at the Technical College, Bradford—Director of Education, Town Hall, Bradford 1.

Senior Lecturer (with sound experience in teaching and research at a university or a comparable level) in Animal Husbandry—The Registrar, Wye College (University of London), Ashford, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Housing and Local Government. Report of an Informal Working Party on the Treatment and Disposal of Sewage Sludge. Pp. iii+64. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [2510

Air Ministry: Meteorological Office. Meteorological Reports No. 15: Cumulus and Cumulonimbus Cloud Over Malaya. By R. Frost. Pp. ii+18. (M.O. 535j.) (London: H.M. Stationery Office, 1954.) 1s. net [2510

Department of Scientific and Industrial Research. Memoirs of the Geological Survey, Scotland. The Economic Geology of the Fife Coalfields. Area 3: Markinch, Dysart and Leven. By J. Knox. Palæontology by Dr. F. W. Anderson. Pp. viii+125+5 plates. (London: H.M. Stationery Office, 1954.) 12s. 6d. net [2510

Aero Research Technical Notes. Bulletin No. 141 (September, 1954): "Aerolite" 300 for Boat Building. Pp. 6. (Duxford: Aero Research Limited, 1954.) [2510

Society for the Promotion of Nature Reserves. Handbook, 1954. Pp. 64+8 plates. (London: Society for the Promotion of Nature Reserves, British Museum (Natural History), 1954.) 5s. [2510

Birkbeck College (University of London). Calendar for the year 1954–55. (132nd Session.) Pp. 162. (London: Birkbeck College (University of London), 1954.) [2510

Monographs of Malt and Malt Products. The Identification of Threshed Barley. Pp. 18. (Bedford: Muntona Limited; Stowmarket: Edward Fison, Ltd., 1954.) [2510

University of Leeds. Publications and Titles of Theses, 1951–52. Pp. 57. (Leeds: The University, 1954.) 6d. [2510

Institution of Naval Architects. Catalogue of the Scott Collection of Books, Manuscripts, Prints and Drawings. Compiled by Betty M. Cooper. Pp. 192. (London: Institution of Naval Architects, 1954.) 42s. [2510

Artificial Illumination of Seedlings. Second edition. (John Innes Leaflet No. 11.) Pp. 7. (Edinburgh and London: Oliver and Boyd, Ltd., 1954. Published for the John Innes Horticultural Institution.) 9d. [2510

General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages; Infectious Diseases; Weather; Population Estimates—Quarter ended 30th June, 1954. Pp. 31. (London: H.M. Stationery Office, 1954.) 2s. net. [2510

International Association for the Exchange of Students for Technical Experience. Seventh Annual Report. Pp. 70. (London: International Association for the Exchange of Students for Technical Experience, Imperial College, S.W.7, 1954.) [2510

Building Research Station Digest. No. 36 (revised): Sound Absorbent Treatments. Pp. 10. (London: H.M. Stationery Office, 1954.) 3d. net. [2510

Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 5: Food, Chemistry and Nutrition. By Dr. Magnus Pyke. Pp. ii+20. (London: Royal Institute of Chemistry, 1954.) [2510

British Museum (Natural History). Expedition to South-West Arabia, 1937–38. Vol 1, Nos. 20–24 No. 20: Coleoptera: Histeridae. By Dr. Giuseppe Muller. No 21: Coleoptera. Malachiidae und Dasytidae By W. Wittmer. No. 22 Coleoptera: Brenthidae. By J de Muizon. No. 23 Coleoptera · Scydmaenidae By Jean Lhoste. No. 24 · Coleoptera · (Nitidulidae) Meligethes Stephens By Alan M Easton. Pp. 307–350 + plates 16–17. (London British Museum (Natural History), 1954) 7s. 6d. [2510

British Universities Film Council. 6th Annual Reports, 1953–54. Pp. 11. List of Films Nos. 1–600 (B U F C. Card Catalogue 1952–1954) Pp. iii+25 (Edinburgh: Dr. C. B. Childs (Hon. Secretary), c/o The University 1954) [2510

Institute of Personnel Management. Annual Report, 1953–54 Pp. 19. (London: Institute of Personnel Management, 1954) [2510

Electrical Industries Benevolent Association. Year Book, 1954, including Annual Report and Accounts for the year 1953 Pp. 32. (London: Electrical Industries Benevolent Association, 1954.) [2810

The Sure Mercies of David: a Study in the Fulfilment of Messianic Prophecy. By Prof. F. F Bruce (Annual lecture of the Evangelical Library, 1954) (London. Evangelical Library) [2810

The Third Freedom. (Seven broadcasts on the freedom from want—the meaning and threat of world poverty and the ways in which it is being attacked) Pp. 16. (No. 3168) (London: British Broadcasting Corporation, 1954) 6d [2810

Queen Mary College Department of Electrical Engineering—Nuclear Particle Laboratory. Pp. 27. (London: Queen Mary College (University of London), 1954) [2810

British Cast Iron Research Association. Thirty-third Annual Report for the year ending June 30th, 1954. Pp. 14+1 plate. (Birmingham: British Cast Iron Research Association, 1954.) [2810

Higher Education in the United Kingdom · a Handbook for Students from Overseas Revised edition. Pp. 168 (London: Longmans, Green and Co, Ltd., 1954. Published for the British Council and the Association of Universities of the British Commonwealth.) 4s. net. [2910

Annual Report of the Director of the Meteorological Office for the year April 1, 1953 to March 31, 1954. Pp. 61. (London: H.M Stationery Office, 1954.) 2s. net. [2910

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences No. 652, Vol. 238 (28 October, 1954): A Consideration of Ostracoderms. By Prof. D. M. S. Watson Pp. 1–25 (London: The Royal Society, 1954.) 8s. [2910

Boiler Design and Availability. By W. F. Simonson. Pp. 28. (Bulletin No MC/255.) (London: Boiler Availability Committee, 1954.) [2910

Air Ministry: Meteorological Office Professional Notes No. 112 · Classification of Upper Air Temperature According to Tropopause Pressure By J. K. Bannon. Pp 20. (M O. 5241.) (London H.M. Stationery Office, 1954) 9d net. [111

Bowaters Build a Mill in Tennessee. Pp. ii+48. (London: Bowater Paper Corporation, 1954.) [111

Parks for the Nation: a Survey of How the National Parks Act is Working. By Tom Stephenson Pp. 12 (London: Ramblers' Association, 1954.) 6d [211

Freshwater Biological Association. Scientific Publication No. 15: A Revised Key to the Adults of the British Species of Ephemeroptera, with notes on Their Ecology By D. E Kimmins. Pp. 71. 2s Twenty-Second Annual Report for the year ended 31st March, 1954. Pp. 63+1 plate 3s (Ambleside: Freshwater Biological Association, 1954.) [211

Nimonic 90 for Springs. Pp. 4. (Birmingham: Henry Wiggin and Co, Ltd, 1954) [211

Calendar of the Pharmaceutical Society of Great Britain, 1954–1955. Pp. vi+806. (London: Pharmaceutical Press, 1954.) 12s. 6d [211

Institution of Electrical Engineers List of Members—Part 2: Associates, Graduates and Students. Pp. 416. Supplement to List of Members, Part 1: Corporate Members and Companions. Pp. 8. (London. Institution of Electrical Engineers, 1954) [211

Other Countries

The Chemical–Biological Co-ordination Center of the Nationa Research Council. Pp. iii+33. (Washington, D.C.. Chemical–Biological Co-ordination Center, 1954.) [2510

Southern Rhodesia. Report of the Trustees and Director of the National Museums of Southern Rhodesia for the year ended 31st December, 1953. Pp. iii+20. (Bulawayo · National Museums of Southern Rhodesia, 1954.) [2510

Nouvelle Carte du Ciel. Par Robert Changeux (Paris: Gauthier-Villars, 1954) 1200 francs. [2510

Beach Erosion Board: Corps of Engineers Technical Memorandum No 47 · Stability of Oscillatory Laminar Flow Along a Wall Pp v+48. Technical Memorandum No 48: Sand Movement by Waves Pp. iii+37 Technical Memorandum No. 49: Bore Hole Studies of the Naturally Impounded Fill at Santa Barbara, California. Pp iii+86. (Washington, D C · Beach Erosion Board, Corps of Engineers, 1954.) [2510

Science Reports of the Tokyo Bunrika Daigaku. Section B, No 110: The Periodic Reversal of the Heart-beat in *Salpa Fusiformis* By A. Ebara. Pp. 199–209. (Tokyo: Tokyo Bunrika Daigaku (Zoological Institute), 1954) [2510

World Health Organization. Monograph Series—No 9: Biology of Anopheles Gambiae—Research in French West Africa. By Dr M. H. Holstein. Pp. 172 (Geneva World Health Organization; London: H.M. Stationery Office, 1954.) 13s. 6d. net; 2 dollars; 640 French francs; 8 Swiss francs [2510

Bulletin of the World Health Organization. Vol. 10, No. 6 · Therapeutic, Prophylactic, and Diagnostic Substances. Pp 867–1038. 10s.; 1 50 dollars. Vol. 11, Nos. 1–2. Health Statistics. Pp. 1–314 20s; 3 dollars. (Geneva. World Health Organization; London: H.M. Stationery Office, 1954.) [2510

Tokyo Astronomical Observatory. Astronomical Bulletin. Second Series, No. 65 (May 25, 1954): Coronal Observation at Mt. Norikura. By Masao Notuki. Pp. 601–614. Second Series, No 67 (May 25, 1954): Meridian Observations of the Right Ascension of Minor Planets during the year 1954. By S. Nakano and R. Fukaya. Pp. 623–624. Second Series, No. 68 (August 5, 1954): Meridian Observations of the Right Ascensions of the Moon and Planets during the year 195 By S. Nakano and R. Fukaya. Pp. 624–630. (Tokyo: Tokyo Astronomical Observatory, 1954) [251

Kumamoto Journal of Science. Series A (Mathematics, Physics and Chemistry). Volume 1, No. 1 (October 1952). Pp 84. (Kumamoto Faculty of Science, Kumamoto University, 1952.) [2510

Nigeria Report on the Forest Administration of the Eastern Region of Nigeria, for the year 1951–53 Pp. i+56 (Lagos: Government Printer; London Crown Agents for Oversea Governments and Administration, 1954) 9d. net [2810

New Zealand. Department of Scientific and Industrial Research. Twenty-eighth Annual Report. Pp 68. (Wellington: Government Printer, 1954) [2810

Fisheries Research Board of Canada. Bulletin No 101 Effects of a Rock Slide on Babine River Salmon By H. Godfrey, W R. Hourston, J. W. Stokes and F. C. Withler. Pp ix+100. (Ottawa: Queen's Printer, 1954) [2810

Annals of the Astrophysical Observatory of the Smithsonian Institution. Volume 7. By L B Aldrich and W. H. Hoover Pp. vii+184+8 plates. (Washington, D C.. Smithsonian Institution, 1954.) 1.75 dollars. [2810

Indian Journal of Fisheries Vol 1, Nos 1 and 2 (May, 1954) Pp. ii+416+8 plates (New Delhi Ministry of Food and Agriculture, 1954.) 7 rupees, 8 annas. [111

Somaliland Protectorate Annual Report of Geological Survey, April, 1953–March, 1954. (C D. and W. Scheme D 1626 and 1626 A.) Pp. ii+11+2 maps (Hargeisa · Chief Secretary to the Government; London Crown Agents for Oversea Governments and Administrations, 1954.) 2/50 Shs [111

Tanganyika: Geological Survey Department. Bulletin No 22 A Study of the Metamorphic Rocks of Karema and Kungwe Bay, Western Tanganyika. By Dr. J. Sutton, Dr. J. Watson and T. C. James Pp. vi+70+2 maps. (Dodoma. Department of Geological Survey, 1954.) 12/50 Shs [111

Central Glass and Ceramic Research Institute Bulletin, Vol 1, No 1 (August 1954). Pp. 44. (Calcutta: R. L. Thakur, on behalf of the Central Glass and Ceramic Research Institute, 1954.) Annual subscription 6 rupees; 12s.; Single issues 2 rupees; 4s [111

Indian National Scientific Documentation Centre. Report 1953–54. Pp. 17. (New Delhi. National Physical Laboratory of India 1954.) [111

United States Naval Observatory. Circular No. 52 (August 16, 1954) · Positions, Areas and Counts of Sunspots, May–June, 1954 By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: U S. Naval Observatory, 1954.) [111

Transactions of the American Philosophical Society. New Series—Vol. 44, Part 4, 1954: Jean-Sylvain Bailly: Astronomer, Mystic, Revolutionary, 1736–1793. Pp. ii+427–538 (Philadelphia: American Philosophical Society, 1954.) 2 dollars. [111

Publications de l'Observatoire de Genève. Série A: Astronomie, Chronométrie, Géophysique Fascicule 49 Étude des conditions d'application des cellules à multiplicateur d'électrons en photométrie astronomique. Par Marcel Golay Pp. i+247–310. (Genève: Observatoire de Genève, 1954) [111

World Health Organization. Technical Report Series No. 88 · Vaccination Against Tuberculosis. Sixth Report of the Expert Committee on Tuberculosis Pp. 10 (Geneva: World Health Organization; London: H M. Stationery Office, 1954.) 1s. 9d., 0.25 dollars; 1 Swiss franc. [111

Transvaal Museum Report for the year ending 31st March, 1954. Pp. 46. (Pretoria · Transvaal Museum, 1954.) [211

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